GEO BON

**Group on Earth Observations
Biodiversity Observation Network**

2023
HIGHLIGHTS

21
March
2024

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Welcome message

Building upon the successes of the previous year, 2023 has been a remarkable year for GEO BON as we continued our commitment to advancing biodiversity monitoring and conservation worldwide. The GEO BON Secretariat has been hard at work, and we are excited to share the key highlights with our dedicated members.

A major focal point of our efforts this year was the GEO BON Global Conference, "Monitoring Biodiversity for Action", a four-day event that brought together nearly 500 participants from 46 countries. With over 200 talks across 50 different sessions, the conference served as a dynamic platform for knowledge exchange and collaboration. You can read more about this impactful event in the Conference Report, accessible here.

Our network witnessed substantial growth in 2023, welcoming 650 new members and reaching a significant milestone of 3000 members from 146 countries just before the end of the year. The addition of the EcoCode Working Group and Knowledge-to-Action (K2A) Hub further enriched our community, contributing valuable modelling and mitigation insight to our collective mission.

Collaboration and partnership have been at the forefront of our endeavours in 2023. We are proud to have strengthened ties with the Convention on Biological Diversity (CBD), Parks Canada, and the business sector. These partnerships have allowed us to expand our reach and impact, fostering a collaborative approach towards global biodiversity conservation.

As you delve into the pages of this Highlights Report, we hope you find inspiration in the stories of collaboration, growth, and impact that define GEO BON in 2023. We invite all members to continue actively participating in our shared mission as we look ahead to further advancements in biodiversity monitoring and conservation in the coming years.

GEO BON Secretariat

Message from Co-Chairs

Dear colleagues,

This proved to be another fantastic year for GEO BON. We consolidated our partnership with the CBD to support the implementation of the Kunming-Montreal Global Biodiversity Framework (KMGBF) and particularly its monitoring framework. A new working group "EcoCode" was formed to work on advancing biodiversity models. And we also brought GEO BON's community together in Montreal for our global conference.

Our global conference—monitoring biodiversity for action—was a huge highlight. It brought together almost 500 people, from fifty countries, including GEO BON members and many participants from partner organizations. The energy during the conference was palpable, which showed us how important it is to bring our community together regularly. The quality of the science presented revealed so many exciting technological developments and applications of monitoring science in support of research and conservation action.

An important event at the conference was the launch of BON in a Box 2.0. The first fully functioning version was presented, and its applications were showcased. The team received much positive feedback and offers of collaboration from several organizations and governments. It is an exciting platform built on open science linking data with state-of-art models to support the calculation of indicators and guides the design of observation networks to support the collection of data.

GEO BON members have been taking part in the Ad Hoc Technical Expert Group (AHTEG) of the CBD on indicators. This group is providing guidelines on the application of existing indicators of the monitoring framework. GEO BON indicators are part of this process, and we are expected to provide support on the headline and complementary indicators that we have produced and published. The AHTEG also identified ways to fill gaps in the available set of indicators. Supporting an enhanced monitoring framework will be a big part of GEO BON's offer to the Parties of the CBD in the lead-up to COP 16 in Cali, Colombia.

We also published a blueprint for a Global Biodiversity Observing System (GBiOS) in *Nature Ecology and Evolution*. This is a view that a global monitoring system can be built from interlinked BONs, that together to form a network of networks sharing data and information and provide the capacity to track national and regional trends and report progress under the global goals of the GBF.

We were sad to say goodbye to Adriana Radulovici but we thank her for her dedication to her role as Executive Secretary of GEO BON and wish her well in her new position at iBOL. We thank the whole Secretariat team for their tireless efforts to make the conference a huge success and for supporting the work of GEO BON's members. We look forward to working with you in 2024!

**María Cecilia Londoño &**
Andrew Gonzalez

The year 2023 has been the culmination of two years of hard work for the Québec and Colombian teams working on BON in a Box. During the GEO BON Global Conference, two major milestones were launched:

- A biodiversity projects portal, where any GEO BON member can add their projects. This gives a webpage to many small projects, otherwise often invisible to the web. It makes them findable and promotes collaboration between projects.

María Cecilia Londoño presenting at the BON in a Box intro session.
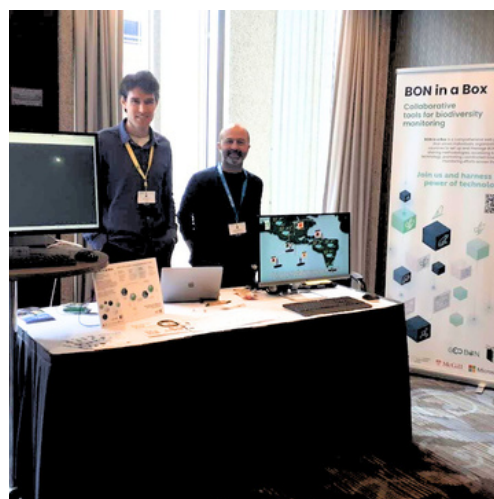
Jean-Michel Lord and César Gutierrez at the BON in a Box Booth

- An indicator and EBV pipeline editor, runner, and results viewer. It includes a few complementary indicators of the Global Biodiversity Framework. We now believe that any GEO BON members with EBV or indicator code at hand should strive to contribute it to the platform, making it openly accessible for colleagues around the world - and especially to the countries that will need to report on the targets! The focus of the pipelines is for each region to parameterize and run it themselves, using a combination of local and global data. See available pipelines. Contributions are welcome through the BON in a Box pipelines GitHub.
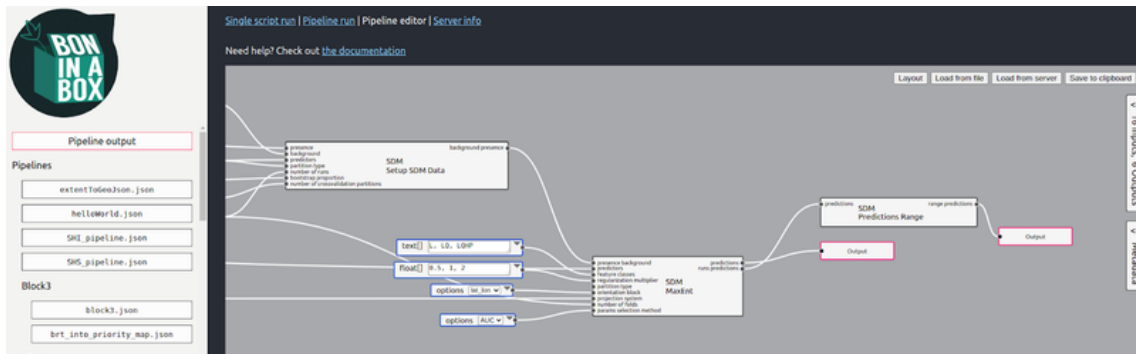
Pipeline Editor - Snapshot of the MaxEnt species distribution pipeline
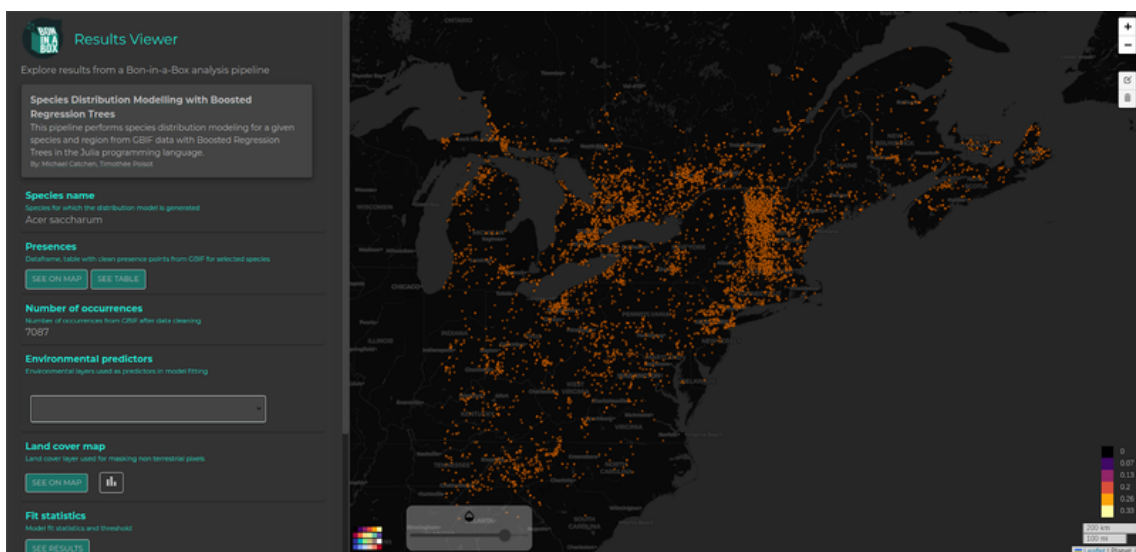
The results viewer show the final results, but also key steps to obtain it. Here, the occurrences of Acer saccherum *supporting a Boosted Regression Tree (BRT) species distribution pipeline.*

These developments were possible thanks to the 1M$ grant from Microsoft, and the collaboration of McGill University, Instituto Alexander von Humboldt, Université de Sherbrooke, Université de Montréal and Université Concordia.

This new tool provides the link to transform the data into variables valuable for decision-making in an open and transparent way. In that regard, it was submitted to the CBD as an existing tool that can support the implementation of the Kunming-Montreal Global Biodiversity Framework. See submission and call.

We sincerely hope that BON in a Box will enhance open collaboration, transparent science and evidence-based decision-making we need to reach the GBF targets faster all together. But this initiative needs you! Feel free to contribute projects and tools to BON in a Box by logging in with your GEO BON member account, and reach out to us if you wish to contribute EBV or indicator pipelines.

GEO BON

Group on Earth Observations
Biodiversity Observation Network

MBON
Marine Biodiversity
Observation Network

FWBON
Freshwater Biodiversity Observation Network

Soil BON

OmicBON

Colombia
BON

China
BON

French
BON

Arctic
BON

EUROPABON

APBON
Asia Pacific Biodiversity
Observation Network

EcoCode
K2A Hub
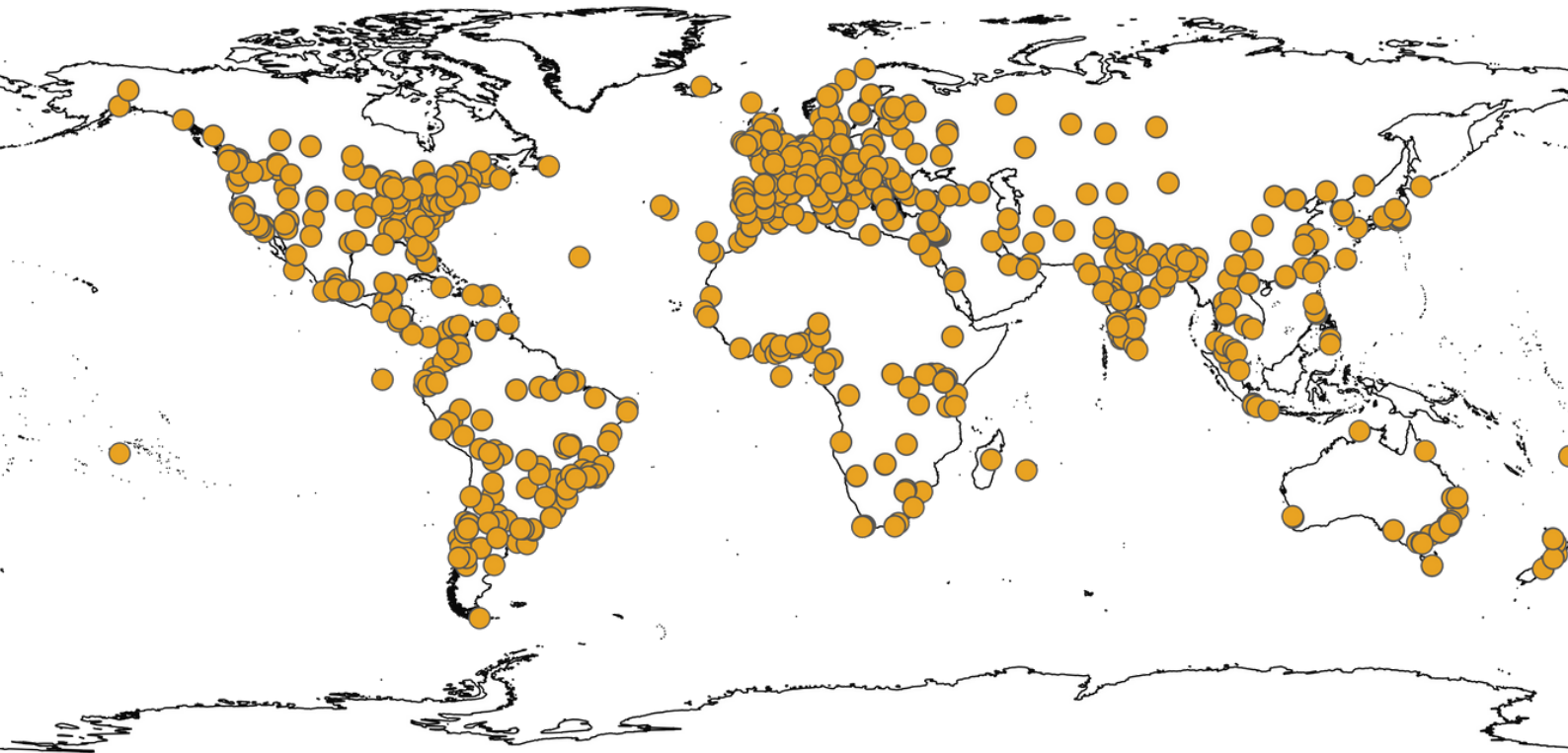
Indicator
K2A Hub

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 Function WG	Ecosystem Services WG
						BON Development WG

Genetic Composition WG

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

In December 2022, the United Nations Convention on Biological Diversity (CBD) adopted the Kunming-Montreal Global Biodiversity Framework (KMGBF), in which 196 Parties, for the first time, committed to report on the status of genetic diversity for all species. Prior to the KMGBF, genetic diversity was only marginally considered for economically relevant species, and their relatives. To prepare for COP15, the GCWG worked with dozens of volunteers from numerous conservation genetic working groups, like G-BiKE, IUCN, SCB and the umbrella group the Coalition for the Conservation of Genetics, to hold a side event, host a booth and conduct extensive outreach activities including manuscripts, webinars and policy briefs. Therefore the Genetic Composition Working Group entered 2023 with a mandate and commitment to support the implementation of the GBF as one of our main projects going forward. As explained in the publication below, published by the GCWG with colleagues, the wording of the Goal A and Target 4 specifies conservation and if possible restoration of genetic diversity and adaptive capacity, within and among populations. Goal A reads: "The genetic diversity within populations of wild and domesticated species, is maintained, safeguarding their adaptive potential." Target 4 is: "Ensure urgent management actions … to maintain and restore the genetic diversity within and between populations of native, wild and domesticated species to maintain their adaptive potential, including through in situ and ex situ conservation and sustainable management practices, and …" There are also numerous genetic indicators included in the agreed Framework- several complementary indicators and one Headline Indicator, "the proportion of populations with an effective size above 500" also known as the "population effective size indicator". The GCWG is committed to providing support to countries in implementation including providing advice, webinars, inputs to future SBSTTA etc. This is all explained in the publication:

- Hoban, S., et al., 2023. **Genetic diversity goals and targets have improved, but remain insufficient for clear implementation of the post-2020 global biodiversity framework.** Conservation genetics, 24(2), pp.181-191.

In spring 2023, one of our GCWG founding members, as well as long time leader in GEO BON efforts and in many areas of genetics and ecology, Michael Bruford of Cardiff University, passed away. Dr. Bruford was a collaborative, supportive, inspiring, and highly productive scientist working in conservation, agriculture, and evolutionary biology. Several members of the GCWG and colleagues wrote an obituary for Mike.

- Hoban, S., Segelbacher, G., Vernesi, C. and Russo, I.R.M., 2023. **Michael W. Bruford** (1963–2023). Nature Ecology & Evolution, pp.1-2.

Genetic Composition WG

In July a number of members of the GCWG participated in a final meeting of the group G-BiKE, an EU funded project from 2019-2023. It focused on genetic diversity and the CBD. The conference was hosted by Christiano Vernesi in San Michele d'Adige. The overarching goal of G-BiKE was twofold: to help establish genomic data usage as standard tool for monitoring and managing wild and ex-situ plant and animal populations; to put genetic diversity at the forefront of EU regulations such the Biodiversity Strategy, for 2030, Natura 2000 and the Habitats Directive. Thanks to this COST Action, we established a solid and thriving European network of scientists and practitioners across 39 countries. G-BiKE will now be establishing a Joint Research Unit which will ensure long term collaboration between G-BiKE and GEO BON.

In summer, the GCWG completed a major project demonstrating the indicators are feasible, affordable, inclusive, and can be calculated fairly quickly using available data and knowledge. The indicators are flexible and can be applied to plants, vertebrates and invertebrates. This project was undertaken because it was important to demonstrate the feasibility of this approach to Parties for their national reporting. The project addressed methodological challenges of using empirical data gathered from diverse sources, across diverse taxonomic groups and for countries of varying socio-economic status and biodiversity levels. The genetic indicators were assessed for 919 taxa, representing 5,271 populations across nine countries, including megadiverse and developing economies. Data were available to calculate indicators for 83% of taxa for at least one indicator. The results of analyzing the indicators show that although most species retain the vast majority of their populations, many have lost at least one-tenth of their populations (complementary indicator [populations maintained] value < 0.9). In addition, 58% of taxa (n=568) have all populations too small to sustain genetic diversity (headline indicator [Ne 500] value = 0). By comparing taxon indicator values to their global Red List status, range size, and other factors, we found the loss of genetic diversity shown by these indicators would go unnoticed by other biodiversity assessments, highlighting the critical importance of monitoring and conserving genetic diversity using these indicators. Many populations of many species are already losing genetic diversity and may be at a critical threshold of further loss of genetic diversity unless urgent policy and action to support genetic diversity are implemented. This is summarized in several publications:

- Mastretta-Yanes, A., da Silva, J., Grueber, C.E., Castillo-Reina, L., et al., 2023. **Multinational evaluation of genetic diversity indicators for the Kunming-Montreal Global Biodiversity Monitoring framework.** EcoEvoArxiv.

- Hoban, S., da Silva, J.M., Mastretta-Yanes, A., Grueber, C.E., Heuertz, M., Hunter, M.E., Mergeay, J., Paz-Vinas, I., Fukaya, K., Ishihama, F, Jordan, R., V Köppä, MC Latorre-Cárdenas, AJ. MacDonald, V Rincon-Parra, P Sjögren-Gulve, N Tani, H Thurfjell, L Laikre, 2023. **Monitoring status and trends in genetic diversity for the Convention on Biological Diversity: An ongoing assessment of genetic indicators in nine countries.** Conservation Letters, 16(3), p.e12953.

- Hoban, S., da Silva, J., Hughes, A., Hunter, M., Stroil, B.K., Laikre, L., Yanes, A.M., Millette, K., Paz-Vinas, I., Ruiz, L, Shaw, R., Vernesi, C, 2023. **Too simple, too complex, or just right? Advantages, challenges and resolutions for indicators of genetic diversity.** BioScience, biae006

Numerous members of the GCWG worked together with the Coalition for Conservation Genetics to create support materials for policy makers at a recent scientific and technical meeting of the Parties to the Convention on Biological Diversity, held in Nairobi Kenya in October. The team created a policy brief translated in four languages, a short video, a flyer, and a post for an online CBD discussion forum. The materials were presented on an easy to read website. This builds on the engagement and support the team provided at the Kunming-Montreal Global Biodiversity meetings in December 2022. The goal of the materials was to explain the recent implementation of genetic diversity indicators in a fast, affordable manner in nine countries, including four megadiverse countries. One message highlighted was that many populations worldwide may be on the precipice of large losses of genetic diversity, and that this status of biodiversity can be monitored in all countries, without the need for DNA sequencing data.

- "Genetic diversity at the SBSTTA25". Coalition for Conservation Genetics.

The group also attended the GEO BON Conference and was able to interact with members of the Ad Hoc Technical Expert Group (AHTEG) before the GEO BON Conference. The group helped organize and participated in a symposium at the GEO BON Conference, organized by Dr. Moisés

Expósito-Alonso. Six speakers presented on a diversity of topics relating to monitoring genetic biodiversity: genetic indicators based on proxies, macrogenetics, an area-based relationship, analysis of adaptive genes, satellites, climate records, and simulations. Co-Chair, Maggie Hunter, hosted a session titled, "Biomolecular Approaches for Global Biodiversity Observation" and moderated the panel opening the biomolecular and eDNA sessions, announcing the launch of the new GEO BON network - Omic BON.

Genetic Composition WG

In November the group gave an online presentation to many members of the AHTEG about the progress on the genetic diversity indicators, to review the findings from the study noted above, and to explain upcoming initiatives to create easy to use tools and guidance so countries can calculate the indicators.

Other publications from members of the group:

- Carroll, C., Hoban, S. and Ray, J.C., 2023. **Lessons from COP15 on effective scientific engagement in biodiversity policy processes.** Conservation Biology.
    - This publication provides a perspective and review of the advancement of science-based policy in the Convention on Biological Diversity. The authors write about the challenges and opportunities of expanding the idea of conservation beyond just conserving species to conserving both genes and ecosystems. The article use examples of efforts to conserve 30 percent of ecosystems by 2030, and efforts to measure and manage genetic diversity affordably and quickly. Challenges included explanation of definitions, the speed and complexity of policy negotiations, science communication, and incentives and guidance for scientists to engage.

- Schmidt, C., Hoban, S. and Jetz, W., 2023. **Conservation macrogenetics: harnessing genetic data to meet conservation commitments.** Trends in Genetics.
    - Genetic biodiversity is rapidly gaining attention in global conservation policy. However, for almost all species, conservation relevant, population-level genetic data are lacking, limiting the extent to which genetic diversity can be used for conservation policy and decision-making. Macrogenetics is an emerging discipline that explores the processes underlying population genetic composition at broad scales by aggregating and reanalyzing thousands of published genetic datasets. Here we argue that focusing macrogenetic tools on conservation needs will enhance decision-making for conservation practice and fill key data gaps for global policy.

- Robuchon, M., da Silva, J., Dubois, G., Gumbs, R., Hoban, S., Laikre, L., Owen, N.R. and Perino, A., 2023. **Conserving species' evolutionary potential and history: Opportunities under the Kunming–Montreal Global Biodiversity Framework.** Conservation Science and Practice, p.e12929.
    - Genetic diversity (GD) and phylogenetic diversity (PD) represent species' evolutionary potential and history, and support biodiversity benefits to humanity. Yet, these two biodiversity facets have been overlooked in previous biodiversity policies. As the Parties to the Convention on Biological Diversity adopted the Kunming–Montreal Global BiodiversityFramework in December 2022, we analyze how GD and PD are considered in this framework and discuss how their incorporation in the GBF could strengthen conservation. This represents a significant improvement compared to the CBD strategic plan 2011–2020 and an opportunity to bring species' evolutionary potential and history to the core of public biodiversity policies.

Species Population WG

Leads: Walter Jetz, Melodie McGeoch

In 2023 the IPBES Plenary approved the Summary for Policymakers of the Thematic Assessment of Invasive Alien Species and their Control, based on the full Assessment Report.

This first global assessment of invasive alien species drew significantly on work from the GEO BON Species Population Working Group (SPWG). This included WG products supporting the assessment of status and trends of invasive alien species (Seebens et al. 2023), in particular the Country Compendium of the Global Register of Introduced and Invasive Species (Pagad et al. 2022).

One of the seven key governance and policy options identified by the Report for the management of biological invasions (McGeoch et al. 2023) is informed by Essential Biodiversity Variables for Species Populations and by broader work by the SPWG (Jetz et al. 2019, McGeoch & Jetz 2019, Vicente et al. 2022). This key action is to have information systems and open data sharing on invasive alien species, so that information is up to date, and readily and rapidly accessible for managers, researchers and members of the public.

Supported by the work of the WG, it recognises that "open and interoperable information systems, supported by international cooperation, play a critical role in tackling biological invasions", and that "open information systems can ...[facilitate] the evaluation of the effectiveness of policy instruments using indicators, including the 'rate of invasive alien species establishment' headline indicator adopted for monitoring progress towards Target 6 of the Kunming-Montreal Global Biodiversity Framework provides opportunities to build on existing indicators of biological invasions" (IPBES 2023, McGeoch et al. 2023).

Ecosystem Structure WG

Leads: Gary Geller, Susana Rodriguez-Buritica, Rubén Valbuena
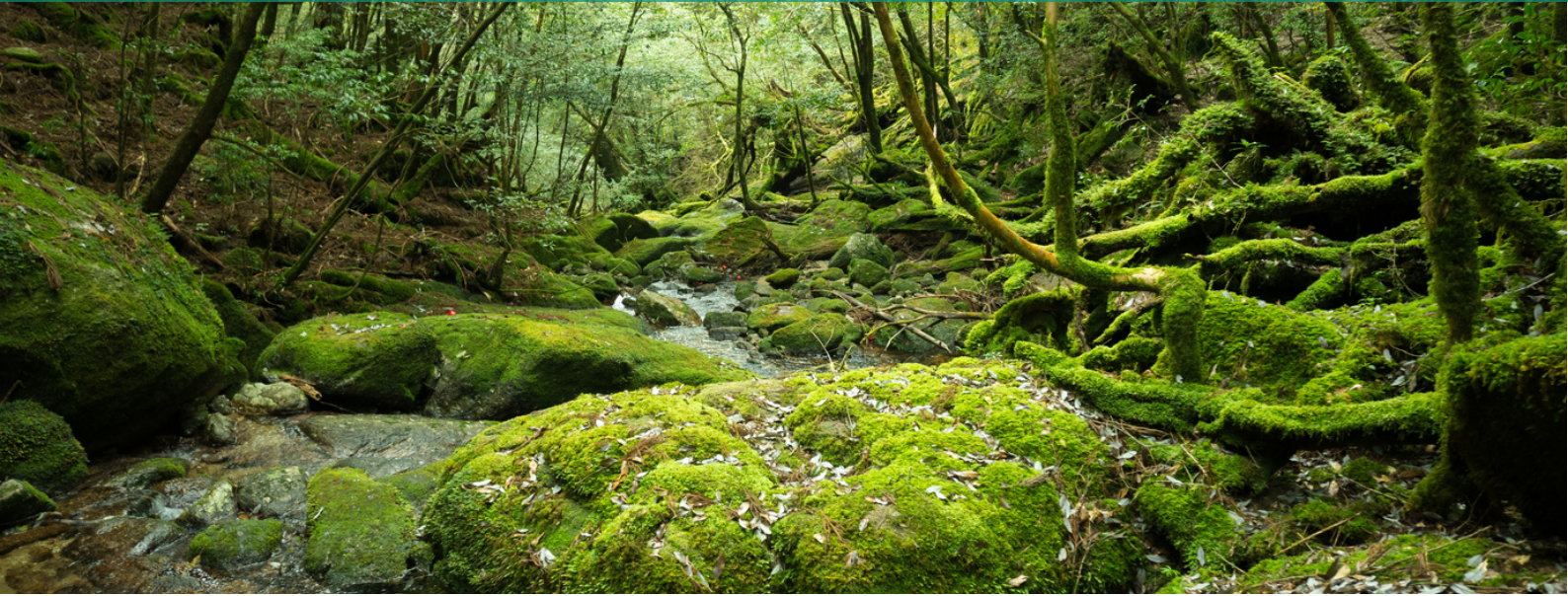
The focus of the Ecosystem Structure Working Group in 2023 has been on developing a journal paper summarizing the EBVs. The purpose of the paper is to:

- Put the "final" Eco Structure EBVs into the literature for easy accessibility
- Provide justification and explanation on the EBV selections (e.g., how they meet the EBV criteria)
- Explain each of the Eco Structure EBVs
- Show conceptual workflows from observations to EBVs
- Discuss tradeoffs and challenges, including technical, scientific, and those to global implementation

A draft outline was developed by the co-leads and distributed to potential authors within the working group to help assess who might be interested and able to participate as an author. The co-leads then had a virtual call with interested authors to discuss the goals and scope of the paper and go over the outline section by section to facilitate writing assignments. These are now in progress despite several delays and submission to the journal (still under discussion) is expected in 2024.

Ecosystem Function WG

Leads: Ghada El Serafy, Pedro J. Leitão

Shifting from frameworks to workflow, the provisioning of tools represents a strategic evolution in operational efficiency. While frameworks offer a structural foundation, workflows introduce a dynamic and streamlined approach to tool provisioning by delineating the sequential steps involved in the tool provisioning process. A modular approach to tool provisioning, ensuring that each step aligns seamlessly with the overarching objectives of the group is envisioned by the group. Activities aimed at exploring the opportunities for current and future satellite remote sensing data, including the production of workflow and their effective utilization, have started and will continue to run over the next years. Activities have mainly focused on the Primary Production (or productivity) and Disturbance regime and ecosystem disturbance EBV. The workflow developed for the monitoring of gross primary productivity has been made available via the Virtual Laboratory Platform (VLab), a software framework for the orchestration of data access and model invocation services that leverages the capability of existing cloud platforms. The model and the generated products will be further refined and made available via the GEOSS infrastructure in 2024.

Ecosystem Function Working Group targets different types of users including the science community, industry, environmental managers, regulators, and policy makers. While the group has begun engaging the user community, engaging with local bodies and Protected Area managers for the co-design of the tools and products developed within the group, an increase effort in this direction will take place involving more users. Connection have been already established with eLTER, and several protected area managers in Europe.

The WG has reviewed and update the implementation plan based on new research, and activities on the current research landscape. Interconnection with bio-, geo- and eco-diversity will be at the core of the group activities. For that, we are working in close collaboration with other GEO initiatives, and particularly with GEO AquaWatch for forecasting of water quality.

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, Nuria Pistón

Achievements:

ESWG implementation plan

The ESWG established, through a participatory approach with its members, the implementation plan for 2023 - 2026 in line with the new GEO BON strategic plan. The ESWG plan is dedicated to developing different outputs to achieve three key and complementary goals:

1 Conceptualization define and expand the conceptual basis of Essential Ecosystem Services Variables (EESVs), and their links with Essential Biodiversity Variables (EBVs) as well as with social, cultural, economic and knowledge-based systems;

2 Implementation - operationalize and promote the use of EESVs in monitoring schemes from local to global scales, and

3 Engagement - create and promote synergies with other initiatives, projects, and networks focused on ES, such as in business, government, civil society, education, and research.

By doing so, the ESWG aims to continue contributing to advancing a scalable observation and monitoring system that enables or facilitates status and trend assessments of multiple ecosystem services across temporal and spatial scales. You can find the implementation plan here.

Reinforced coordination

The ESWG appointed Nuria Pistón as co-chair of the ESWG at the beginning of 2023 and defined the WG structure and the roles of key coordinator positions. The ESWG nominated Agnes Vari, Flavio Affinito and Ana Sofia Vaz as leading coordinators of the three main goals of the implementation plan: Conceptualization, Implementation and Engagement, respectively. The ESWG have received additional support by active group members, an examples is Jamie Kass which started an ESWG Google Group. The Google Group serves as a forum for the ESWG members to exchange information and ideas. You can find more detailed information about the ESWG at the webpage.

Ecosystem Services WG

Key initiatives

Surveys and Follow-ups
The ESWG kicked off the implementation plan - Goal 1 (Conceptualization) with a group survey to gather information on existing assessment frameworks that provide sets of indicators for ES (such as EBVs, economic accounting, anthropogenic use) that can be used to inform and measure EESVs (both ecological and human dimensions). The ESWG compiled information regarding group members' own experience on ES indicator frameworks and modelling. Results were presented by the leading coordinator of Goal 1, Agnes Vari, at the GEO BON Global Conference with the presentation "Advancing Essential Ecosystem Service Variables (EESV)".

GEO BON Global Conference
The Ecosystem Services Working Group session, "Monitoring Ecosystem Services: Where Do We Stand and How Do We Move Forward?", took place in October 12th, 2023. It covered a wide range of topics like the role of earth observations in ES mapping, the positive impact of indigenous led conservation in promoting ES, how a One Health approach can protect ES and human health, a complete data driven project focused on monitoring mountain ES and the potential for using standardised EESVs to report on ES change from local to national scales. These exciting talks then led on to a workshop session where participants discussed the current frameworks for studying ES and what dimensions of ES are missing from them. These table conversations resulted in valuable insights for the working group going forward and we expect they will contribute to upcoming collaborations across the network. You can find the report of the Conference here.

Webinars
The ESWG, with support from the GEO BON Secretariat, organised two webinars:
1) *"Opportunities of eDNA in biodiversity and ecosystem services"* (February 3rd, 2023) that addressed the opportunities and caveats of this emergent technique. Details can be found here.
2) *"Status of the world's soil biodiversity metrics, methods and initiates"* (November 17th, 2023) that presented the results of a global survey and proposed metrics and methods for the Global Soil Biodiversity Observatory (GLOSOB). Details can be found here.

Publications

A set of publications aligned with the ESWG topics and strategic plan were developed and are to be soon published. The following paper already comes from the ESWG members:
Pinto, T., Machado, T., Nicolau, D., Oliveira, N. G., & Vaz, A. S. (2024). **Accounting for nature contributions to people in corporate sustainability: The case of a waste management company in Portugal.** Corporate Social Responsibility and Environmental Management, 1–10.

Collaborations

The webinar on "Status of the world's soil biodiversity metrics, methods and initiates" was a joint initiative, organised by FAO and the International Network on Soil Biodiversity, NETSOB, of which Carlos Guerra (co-chair of SoilBON) and George Brown are co-chairs of WG1.

Future Plans

Hands on the ESWG implementation plan
2024 will be a year dedicated to the activities and initiatives foreseen in the ESWG plan, mainly on how to define and expand the conceptual basis of Essential Ecosystem Services Variables (EESVs), and their links with Essential Biodiversity Variables (EBVs). Several surveys are already being planned to get the ESWG members involved in the process. Also, a series of webinars are also planned, including on how ES and nature-related issues are moving from the scientific and governmental spheres, to take a solid ground in businesses and economy!
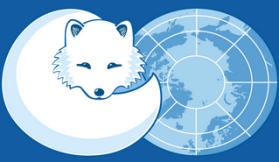
Arctic BON

Leads: Tom Christensen, Cathy Coon

In 2023, the Circumpolar Biodiversity Monitoring Program (CBMP)-the Arctic BON-produced a 20-year retrospective article, published in *Frontiers in Conservation Science*. This paper describes the process and approach taken in the last two decades to develop and implement the CBMP. It documents challenges encountered, lessons learnt and solutions, and considers how it has been a model for national, regional, and global monitoring programmes; explores how it has impacted Arctic biodiversity monitoring, assessment, and policy and concludes with observations on key issues and next steps.

Further, the CBMP was represented at the GEO BON Conference in October 2023 and is exploring opportunities to further link its work to Essential Biodiversity Variables to support implementation and reporting to the Kunming-Montreal Global Biodiversity Framework.

In 2024, the CBMP will be represented at the World Biodiversity Forum and looks forward to further working with circumpolar partners on actions to implement its existing Strategic Plan and respective ecosystem-based implementation plans.

![PNDB Pôle National de Données de Biodiversité]

Leads: Yvan Le Bras, Jean-Denis Vigne

Key Initiatives:

1 Our Essential Biodiversity Variables Open Science Cloud project - EBVOSC - has been accepted as a case study by the Global Open Science Cloud international organization. The EBVOSC case study aims to demonstrate that a better mobilization of biodiversity data & metadata can readily generate EBVs and associated biodiversity indicators through automated and regular updating thanks to a high level of FAIR {meta}data and code source.

2 The Gallantries project (2020-2023) has been a great success. It was a collaboration between five European universities, members of Software Carpentry, and members of the Galaxy Project, with the aim to increase ecoinformatics & bioinformatics and core data analysis skills in the field of life sciences across Europe. During the project, The French BON team has developed and proposed 16 trainings and FAIR workflows on biodiversity analysis through the Galaxy ecology platform.
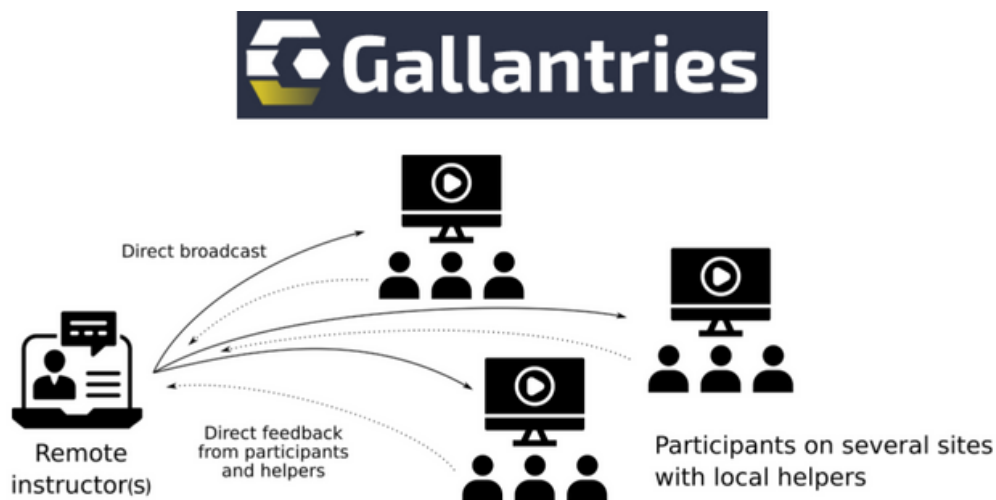
3 Under the lead of the French biodiversity agency (OFB), the French BON gathered the biodiversity monitoring community for a 2-day governance workshop in August 2023. Representatives of various institutions over the 3 realms (terrestrial, marine and freshwater biodiversity) shared their visions and discussed a common framework centered around the use of EBVs.

Collaborations

- The French Biodiversity Data Hub ("Pôle National de Données de Biodiversité" - PNDB) and the French nodal point of the GBIF have continued to collaborate by accompanying communities on data sharing through data papers publication and secondly by producing flux from raw data to standardized occurrence data (in DarwinCore standard) thanks to the Ecological Metadata Language - EML
- The French BON (PNDB) has participated to the French Barcode of Life workshop on October at the CESAB Centre for the Synthesis and Analysis of Biodiversity (Montpellier, France)
- The French BON, through the involvement of the OFB, is part of the European biodiversity partnership Biodiversa+. Biodiversa+ brings together 80 partners from 40 countries to improve monitoring and governance of biodiversity and ecosystem services across Europe.

Achievements

Articles, guides, conference abstracts, interview

- Hiltemann S. et al.. 2023. **Galaxy Training: A powerful framework for teaching!** PLOS Computational Biology.
- Gonzalez A. et al., 2023. **A global biodiversity observing system to unite monitoring and guide action.** Nature in Ecology and Evolution.
- Lacoeuilhe A, et al.. 2023. **An Overview of the French eDNA Data Landscape: Focus on a national technical repository of reference genetic sequences.** Biodiversity Information Science and Standards 7: e110103.
- Yvan Le Bras. 2023. **Galaxy for Ecology: Elevating FAIRness of Biodiversity Science Source Codes.** EOSC in practice story. md5:90204c98180bae55d09f415b270c5895
- Michelle Silva del Pozo, Guillaume Body, Gaby Rerig, Mathieu Basille. (2023). **Guide on harmonising biodiversity monitoring protocols across scales.** Biodiversa+ report. 60 pp.
- Lipsanen A., Riera L.,Skov F., Lestina D. (2024). Final report Biodiversa+ Governance pilot: Towards national biodiversity monitoring coordination centres: comparison of governance, data interoperability and standards. 25pp. (to come)

GEO BON Conference

- From EBV operationalization pilot to GBiOS, a French BON point of view [talk]
- From raw heterogeneous biodiversity data to operational indicators based on essential variables: an exploratory session thanks to Galaxy-Ecology [workshop]
- Enhancing collaboration and data accessibility in Earth and environmental sciences: a gateway approach of the FAIR-EASE project [talk]
- The EBV grammar allows application to real-world monitoring programs [talk]
- Influence of the EBV framework on biodiversity monitoring systems and services [talk]
- EBVs facilitate international cooperation & harmonization [talk]

Future plans:

- The French BON, led by the PNDB, the Biodiversity Information System on Public Policies ("Système d'Information sur la Biodiversité" - SIB), and the OFB, wishes to organize in 2024 the "French BON communities days". These collaboratives days could help to:
  - engage more people from public policy, expertise and research for a local and national biodiversity monitoring
  - develop and test new analytical workflows from raw data to indicators with different biodiversity data and metadata
- Under the lead of the French biodiversity agency (OFB) and the Biodiversa+ partnership, the French BON will continue to explore the current situation of biodiversity monitoring governance in France and contribute to the development of a cross-realm and cross-scale monitoring community.

Lead: Helena Olaya

Responding to the global need to support the establishment and design of Biodiversity Observation Networks (BONs) at national and regional levels, as well as to efficiently assess progress under the Kunming-Montreal Global Biodiversity Monitoring Framework, we focused on the creation of a monitoring project portal in the development of BON in a Box 2.0. and the creation of workflows (pipelines) for the replicable calculation of Essential Biodiversity Variables (EBVs) and indicators.

This integrated biodiversity information system was designed to support the creation of BONs to improve monitoring and reduce data uncertainty, to strengthen researcher networks, and to support regional and national decision making to halt biodiversity loss.

The implementation of BON in a Box has optimized the capacity to respond to complex research questions, allowing us to more effectively address territorial mission challenges associated with sustainability. This tool is based on the automation of workflows through pipelines, sequentially structured sets of code steps. This feature allows for standardization in data management, which will facilitate analysis in the long run. In the context of biodiversity, where research questions can vary widely, the ability to identify and apply the same methods is fundamental for transparent information management. In addition, this allows for greater replicability and traceability of results for subsequent discussion and updating. Significant progress was made in the estimation of landscape-scale indicators, which will be introduced in the BioTablero platform and proposes a new method for the integration of spatial data in the geographic query module, which is evident, for example, in the workflows for the calculation of the indicators connectivity of protected areas, forest loss and persistence, and the persistence of the human footprint. Additionally, in order to identify and strengthen the knowledge of monitoring project networks, and facilitate the discovery of the best available data, tools, expertise and partnerships, a global monitoring project search portal was created, allowing users to find out who is doing what and where, in terms of biodiversity monitoring projects.

Also, a dedicated page was provided for all projects that enter this database, thus giving web presence to those that did not have it, as being found is a first step to improve networking. This also strengthened the network of GEO BON members, the only prerequisite for adding new projects and editing them, unifying the community under the same project metadata structure (which they themselves update) and also joining with the ocean network by sharing the same indexer that ODIS and the Ocean InfoHub use.

After having identified almost 700 monitoring projects in Colombia, the pilot country, 174 were finally selected and incorporated into the database, ensuring the accuracy of this metadata through direct communication with the project owners. The development reached its final version with a user-friendly interface and advanced search capabilities, a map visualization function and multilingual translation options, just in time to be successfully presented at the GEO BON 2023 Global Conference in Montreal, October 10-13, where it generated interest from new members and contributed to the expansion of the platform, and held the "BON in a Box (INTRO SESSION)" session to encourage the participation of GEO BON network members in this project. The topics discussed at the conference had a direct impact on the work of the BON Colombia by strengthening the capacity for monitoring and evaluation of biodiversity in Colombia. The BON in a Box platform and the tools presented allow us to improve conservation work, identify critical areas of biodiversity and learn from international experiences, which enriches the approach to the national context. The conference highlighted the experiences using BON in a Box as a key component in strengthening the development of automated workflows that facilitate the calculation of spatial indicators for the estimation of biodiversity indicators in Colombia.

Lead: Haigen Xu
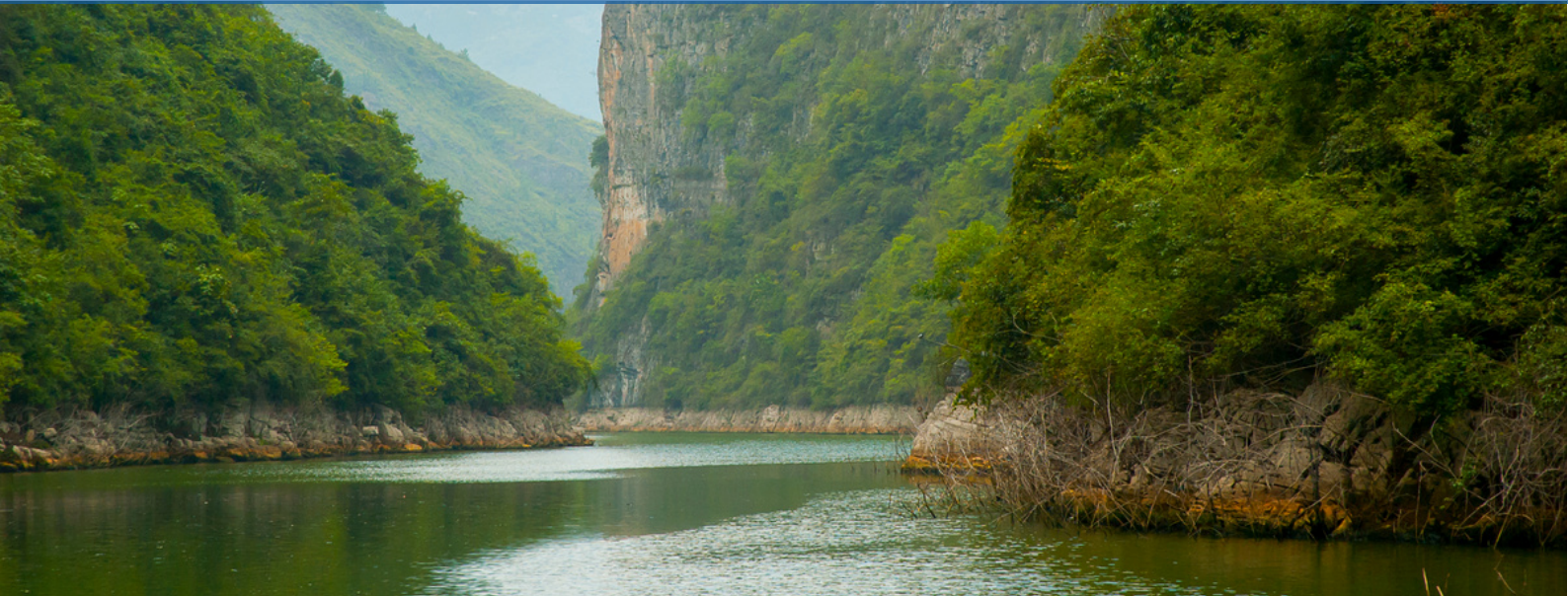
In 2023, China BON carried out bird diversity observations in 22 sample areas, 164 transects and 93 sample points in 18 provincial-level administrative regions, covering the main bird breeding areas and wintering areas in China. The data collected by China BON is important for analysing regional bird dynamics and the effectiveness of management policies. We analyzed the spatial–temporal trends of the optimized Living Planet Index (LPIO) based on bird monitoring from 2011 to 2020 in 536 sites in the Yangtze River Basin (YRB), the third largest river in the world. We found that the LPIO of all birds in the upper and middle reaches of the YRB increased by 7.80% and 7.64%, respectively, and terrestrial bird diversity showed an increasing trend in the whole watershed. Increasing functional diversity of birds in the YRB and forest was indicative of enhanced ecosystem functioning and abundant resource. Almost 75% of the national key protected birds of China in the YRB are protected. However, waterbird diversity mostly declined, notably by 14.40% in the lower reaches, likely because of the change of wetlands and insufficient conservation measures. **The significant improvements in terrestrial bird diversity could indicate the regional success of global targets, while the decline of waterbird diversity highlights the urgent need for further biodiversity protection for the world's third largest river.**

The project "Key Technologies and Applications of Efficient Sensing and Conservation of Endangered Animals" led by China BON won the second prize of Jiangsu Province Science and Technology Award. The project aimed at the diversity conservation of rare and endangered animals, and solved the problem of efficient identification of endangered animals and population dynamic monitoring through the establishment of efficient perception technology composed of infrared camera multi-terminal cascade communication network and DNA macro barcode detection and identification. Through the establishment of the wild Père David's Deer (*Elaphurus davidianus*) population restoration technology in the South Yellow Sea wetland and the Big-headed Turtle (*Platysternon megacephalum*) artificial breeding technology, the extinction risk of the two animals has been significantly reduced, providing a new perspective for the artificial breeding of endangered animals and the restoration of wild populations. By establishing the

demarcation of priority areas for biodiversity conservation and proposing a multi-scale conservation target system, it provides refined management techniques for the in-situ conservation and assessment of wild animals.

Furthermore, **the "Key Technologies and a Standard System of Biodiversity Observation Network and its Application" led by China BON won the first prize of China Environmental Protection Science and Technology Award.** The award further affirmed China BON's contribution in developing a biodiversity observation technology standard system, developing a biodiversity observation database system and information management platform, and taking the lead in creating Asia's largest biodiversity observation network.

In the future, China BON will further strengthen communication and exchanges with various stakeholders to ensure the long-term and sustainable operation of China BON.

Leads: Hiroyuki Muraoka, Runi Sylvester Pungga, Yongyut Trisurat

APBON (est. 2009) is a network for observations and assessment of biodiversity, and a platform for science-policy engagement to contribute to effective biodiversity conservation, management, and sustainable use of biodiversity at the national, regional and global scales. APBON has developed networks, advocated biodiversity science, facilitated communication for sharing knowledge, and built the capacity of researchers and stakeholders through workshops, webinars, and publications.

APBON and its members made various activities in 2023 including the following:

APBON Webinar Series
- The 15th seminar (February, onsite) with APBON members and students of Kyushu University, Japan. This seminar highlighted research activities of university students and interactions with international scientists of APBON.
- The 16th seminar (April) was held when the GEO BON co-chairs, Dr. Maria Cecilia Londono and Professor Andrew Gonzalez, were invited to discuss about the GEO BON strategy and Global Biodiversity Observing System (GBiOS). They highlighted the importance of GBiOS, and the need to strengthen biodiversity observation across the globe. APBON's importance and contribution were also highlighted.
- The 17th seminar (July) introduced the "super-site" concept for combined observations and integrated studies on biodiversity and ecosystem functions in a changing environment. Brainstorming discussion on biodiversity data availability and gaps in AP region was also made by the participants.
- The 18th seminar (September) highlighted advances in species distribution modeling and applications for predicting ecosystem functions and services. The paper by Dr. Jamie Kass is published on Trends in Ecology & Evolution.
- The 19th seminar (December) was held to learn the data and knowledge needed in CBD Kunming-Montreal Global Biodiversity Framework and IPBES assessment for considering concrete action plans of APBON for its collaborative observations and data sharing in 2024.

The 14th APBON Workshop

APBON has been organizing annual workshops from the beginning of its establishment for sharing information on biodiversity observations, data and knowledge, and capacity building. The workshop is a forum of the network to develop the community of practice. On 1st February 2023, twenty-one members from seven countries (in-person) and four members from two countries (online) convened at Fukuoka, Japan, to share the recent status of observations and knowledge sharing, after three-years of pandemic. We also discussed the role of APBON and its development to strengthen biodiversity observation and sharing of knowledge to contribute to the Kunming-Montreal Global Biodiversity Framework (GBF). Participants shared the necessity of fostering biodiversity observations by applying various methods to achieve societal goals of biodiversity conservation and sustainable development through strengthening the cooperation of APBON.

All presentation materials in the webinars and workshop are available on APBON website. Webinars here.
Workshop summary here.

Contributions to the Group on Earth Observations (GEO), GEO BON, CBD and relevant organizations

In 2023, APBON participated in the following meetings of GEO, GEO BON and other relevant organizations to share its activity highlights and knowledge, and to discuss regional and global cooperation.

- GEO Symposium 2023 (June 2023, Geneva)
- GEO Open Data and Open Knowledge Workshop (June 2023, Geneva)
- GEO BON Global Conference 2023 (October 2023, Montreal)
- CBD Secretariat Knowledge Management for Biodiversity webinar series (October 2023, online)
- SBSTTA meeting 2023 (October 2023, Nairobi)
- GEO Week 2023 (November 2023, Cape Town)
- 10th Anniversary of the National Institute for Ecology (November 2023, Republic of Korea)

APBON's advancement in biodiversity and ecosystem observations

Research groups and national BONs (Sino BON, JBON) utilize advanced technologies and equipment such as monitoring towers, in-situ and satellite remote sensing, eDNA, automated cameras, and artificial intelligence analysis to achieve continuous monitoring of biodiversity such as plants, birds, amphibians and reptiles, mammals, fish, insects, and ecosystem functions including phenology and carbon cycle.

Publications from the network activities

- Chaudhary S. et al. (2023). **Effects of a changing cryosphere on biodiversity and ecosystem services, and response options in the Hindu Kush Himalaya.** In ICIMOD (P. Wester, et al. [Eds.]), Water, ice, society, and ecosystems in the Hindu Kush Himalaya: An outlook (pp. 123–163). ICIMOD.
- Kass J. et al. (2023) **Biodiversity modeling advances will improve predictions of nature's contributions to people.** Trends in Ecology & Evolution.

- Hughes A.C. (2023) **The Post-2020 Global Biodiversity Framework: How did we get here, and where do we go next?** Integrative Conservation 2(1) 1-9.
- Hughes A.C. and Grumbine R.E. (2023) **The Kunming-Montreal Global Biodiversity Framework: what it does and does not do, and how to improve it.** Frontiers in Environmental Science, 11.
- Mori A.S. et al. (2023) **Sustainability challenges, opportunities, and solutions for long-term ecosystem observations.** Philosophical Transactions of the Royal Society B: Biological Sciences 378: 20220192.
- Muraoka H. et al. (2023) **Review: Long-term and multidisciplinary research networks on biodiversity and terrestrial ecosystems – findings and insights from Takayama super-site, central Japan.** Journal of Ecology and Environment (in press)
- Shin N. et al. (2023) **Mining plant phenology records from Kanazawa, Japan in the 1807–1838 Kakuson Diary.** International Journal of Biometeorology.
- Trisurat Y. et al. (2023) **Climate change impacts on species composition and floristic regions in Thailand.** Diversity 15, 1087.
- Special issues by Sino BON:
  - *Biodiversity Science* **special issue**, 2023. 12. Online.
  - *Life World* **special issue**, 2023. 08.

Plans for 2024

APBON will further develop the network for addressing local, national and regional biodiversity issues with particular attention to the impacts of changes in climate and society. Following from a survey we developed in 2023 with the AP region we aim to analyze the data needs and gaps for the region and use this to develop a plan to help reconcile the gaps and enable countries to access the data needed to develop NBSAPs and better monitor regional biodiversity. The planned activities include, conceptualizing 'super-sites' for long-term and multiple monitoring; promoting interdisciplinary research and problem-solving approaches with filling observational and knowledge gaps by integrating technologies and platforms; promoting data sharing and data accessibility by networking the observation networks and collaboration with partner organizations; delivering information and knowledge through stakeholder engagement at local, national, and regional scales. We will also publish at least one paper as a group and may organize a Special issue for AP Regional biodiversity.

Leads: Henrique Pereira, Jessica Junker

Being the final year for EuropaBON, 2023 has been a busy, yet very fruitful one for the project. A promising start for the year was the online workshop on Essential Biodiversity Variable workflows, which brought together more than 520 people from 47 countries to share their knowledge and expertise in the terrestrial, freshwater, marine and coastal ecosystems. As a result of this event and the active involvement of the EuropaBON network, the project's EBVs list was refined later in the year. More than 170 comments were addressed and allowed for fine-tuning of the EBVs list, which is now available in our GitHub repository.

In April we published the first EuropaBON policy brief, The Future of Biodiversity Monitoring in Europe. Brought to life by the project's team at IIASA, the brief provides a comprehensive overview of the current state of biodiversity monitoring and offers recommendations for improving it.

During the same month, we hosted a Showcases and Co-design workshop in Troi, Portugal. Between 16 and 20 April 2023, more than 60 experts gathered to discuss the policy showcases on workflows of selected Essential Biodiversity Variables (EBVs) and ways towards the implementation of a European Biodiversity Observation Network. Participants included experts in biodiversity conservation, sampling design, research, monitoring and IT infrastructure, remote sensing, modelling and novel technologies.

2023 was a productive year in terms of scientific contributions, as we released three research articles, all available in the EuropaBON RIO collection.

Our members attended a handful of events, amongst which were the Wildlife Research and Conservation conference in Berlin, the 52nd GfO meeting, where EuropaBON took the stage prominently by organising a dedicated session on the Future of Biodiversity. This session saw active participation from EuropaBON's coordinator, Henrique Pereira (iDiv), and project partners amongst whom Aletta Bonn (UfZ), W. Daniel Kissling (UvA), and Cesar Capinha (IGOT UL). We also made a stop at the GEO BON Conference in Montreal, Canada, where along with actively

participating in the discussions within the discourse of best practices and innovative technologies for biodiversity observations and monitoring, a collaboration between EuropaBON and B-Cubed project was highlighted.

Amongst our most prominent achievements during 2023, EuropaBON is happy to mention that in collaboration with its stakeholder, the project organised an open consultation on the Terms of Reference for the European Biodiversity Monitoring Coordination Centre (BMCC).

In November we hosted the final EuropaBON scientific workshop in the presence of consortium and Advisory Board members, alongside key stakeholders from across Europe. A pivotal aspect of the discussions centred around finalising the EBV workflows, the co-design of the system, the cost-benefit analysis of a EuropaBON, the cross-cutting policy assessments of biodiversity, and the European Biodiversity Monitoring Coordination Centre (BMCC).

We ended the year with the achievement of a major milestone as we crossed the 1500-member mark in the EuropaBON members network. We are proud to share that we have grown into one of Europe's largest and most influential biodiversity communities, boasting a diverse membership that includes representatives from academia, NGOs, governmental organisations, citizen scientists and the private sector.

If you're not part of our amazing network yet, there's no better time to join us on this remarkable journey. Be a part of the change and help us shape a greener future for Europe. Register now here!

Leads: Eren Turak, Andreas Bruder, Jennifer Lento

Supporting the mobilization of freshwater biodiversity data

In 2022, the Global Biodiversity Information Facility (GBIF) provided a small amount of funding to FWBON to develop improvements to the mobilization of freshwater biodiversity data. This funding was used for two projects, one with the goal to **identify impediments to the mobilization of freshwater biodiversity data** through GBIF and other portals and the other to **develop a guide for publishing freshwater data**. The first project involved contributions from FWBON members or close associates (respondents were 151 data creators, researchers, and practitioners from 56 countries) followed by data analysis (189 datasets provided) to (i) identify and rank impediments to mobilization and (ii) an assessment of the suitability of availability data for supporting the implementation of the Kunming-Montreal Global Biodiversity Framework (KMGBF). This analysis allowed us to identify critical characteristics that influence data mobilization and to develop a predictive model that shows the effect of managing the different characteristics of datasets and monitoring programs to improve their mobilization. The analysis showed that data currently being collected by FWBON members, their associates and their institutions are able to support headline indicators of the KMGBF. However, urgent action is needed to remove critical impediments of mobilization. The predictive models developed through this project can be used to optimise the outcomes of these actions. The results of this analysis will be submitted in early 2024 for publication in a peer-reviewed scientific journal.

The second project developed a guide, which is intended to facilitate more effective use of freshwater biodiversity data in large-scale assessments by promoting greater harmonization of published freshwater data. The guide outlines the aspects of freshwater biodiversity data that must be captured in the data and metadata to improve comparability, including information about the biomes, lake zones, and river mesohabitats in which observations took place, the organism group and life stage of the observed individual, and the sampling equipment (e.g., mesh size where applicable), and sampling effort used for data collection. The guide also contains explanations of which fields from Darwin Core should be used to enter all relevant freshwater data and metadata. Examples specific to freshwater data are provided to help the user. The guide will be launched on the GBIF website in 2024, and it is our hope that it will be a valuable resource that encourages more effective freshwater data publishing in the future.

Special sessions at the GEO BON Conference in Montreal, October 2023

FWBON organized two special sessions at the GEO BON conference help in Montreal, Canada in October 2023. One session was titled "Innovative Approaches to Monitoring, Documenting, and Communicating Change in Freshwater Biodiversity" and featured 17 short presentations in four different themes: indicators and community composition; mapping, monitoring, and assessing ecosystems and processes; eDNA as a monitoring tool; and developing and applying new monitoring technologies. Interactive discussion periods offered the opportunity to poll the presenters and audience about their thoughts on challenges to implementing freshwater monitoring, developing and maintaining freshwater biodiversity datasets, and implementing new technologies and AI in freshwater monitoring. Organizers of the session are developing a proposal for a special issue of a freshwater journal following from this session.

The second special session was jointly organised with MBON and titled: "Biodiversity Monitoring in Aquatic Ecosystems to Support a Whole Society Approach to Transformative Change". This session brought together members of the two thematic BONs to explore how biodiversity monitoring capabilities and approaches in marine and inland waters can be aligned with terrestrial approaches to track biodiversity change. Topics discussed included the role of thematic biodiversity observation networks (FWBON and MBON) and existing programs (GBIF, OBIS, etc.) in building the Global Biodiversity Observation System (GBiOS) and measuring ecosystem services. This session included rich and diverse presentations and discussions in terms of geography, themes and the types of marine and inland ecosystems covered. There were examples at local to global scale, of the use of different monitoring techniques. The session also highlighted the need for wider collaboration and coordination especially between those who are striving to apply the Essential Biodiversity Variables concept in aquatic environments while also working with Essential Ocean Variables and Essential Climate Variables. These thoughts and initiatives provide a path forward and an opportunity for FWBON and MBON to coordinate approaches to building the aquatic components of the GBIOS.

Another impression of the conference was given by FWBON member Jonathan Ready after participating in the session "Unlocking eDNA as a Biodiversity Monitoring and Conservation Tool in Tropical Landscapes". After the conference, he reached out to leaders in other thematic BONs and the EcoCode working group of GEO BON to assess existing and potential additional links, especially with the aim of stimulating greater participation of colleagues in the tropics and global south and addressing the challenges faced in these regions. This initiative reflects a continuation and extension of the topics discussed during the session. Jonathan specifically invites GEO BON members to contact him if they would like to help developing these connections or to raise other specific demands and challenges in this context. He's affiliated with CEABIO and UFPA in Guamà, Belém, Brazil and can be contacted on jonathan.ready@gmail.com.

MBON
Marine Biodiversity Observation Network

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

Key Achievements

MBON joins the UN Ocean Decade Vision 2030 process

The MBON co-chair, Frank Muller-Karger (University of South Florida), together with Aileen Tan (CEMACS, Universiti Sains Malaysia), are co-leads of the new United Nations Decade of Ocean Science for Sustainable Development's "Ocean Decade Vision 2030 Expert Working Group #2". This Working Group includes over 20 members, from the private, government, and academic sectors to write a White Paper on how to make progress to address Challenge 2 of the Ocean Decade - "Protect and Restore Ecosystems and Biodiversity." To ensure the Ocean Decade accomplishes its objectives, it needs to evolve and implement practical solutions. Through a participatory and iterative process, working group #2 is defining a strategic ambition and milestones for the Ocean Decade to address Challenge 2. The collaborative effort will foster the exchange of ideas, best practices, and the development of impactful initiatives to address the Ocean Decade Challenge 2. Further, this will allow the Decade Coordination Unit of the Intergovernmental Oceanographic Commission of UNESCO and partners to work with other groups to meet the Ocean Decade goals. The draft White Paper on Challenge 2 will be presented and discussed at the 2024 Ocean Decade Conference in Barcelona (10 – 12 April 2024).
https://oceandecade.org/news/vision-2030-ocean-decade-launches-new-global-ambition-setting-process/

MBON Europe

The Marine Biodiversity Observation Network for Europe (MBON Europe) was established as a EuroMarine LTSWG aiming to spearhead the coordination of active monitoring of marine biodiversity by organizations in Europe.

Long-term time series are essential to recognize and understand trends that may be due to natural or human activities, especially climate change. MBON Europe formalizes coordination between organizations through Memoranda of Understanding (MoU), collates information on what monitoring is being done and how, discusses how to harmonize methods, facilitate data publication, synthesize the current situation, and develop a strategy for improved coordination.

So far, 15 organizations have signed the MoU committing to long-term annual monitoring of marine biodiversity in Europe. A first survey of members needs identified 13 unpublished time-series datasets. The next steps involve publishing the data. In 2024 MBON Europe will begin synthesis of the data to identify trends and gaps. These founding members promise that "(1) Our organization will collect data on marine biodiversity on at least an annual basis; (2) Our sampling or observation methods will be standardized to aid comparability of data over the years and may be adjusted to aid comparability with datasets internationally; (3) Our data will be published into the Ocean Biodiversity Information System (OBIS) as one or more datasets each year." The signed MoU and a blank copy can be downloaded from the MBON Europe webpage. Any organization, be they a university, company, institute or NGO, is welcome to sign and join the movement.

Key Initiatives

MBON and FWBON joint session at the GEO BON Global Conference: Monitoring Biodiversity for Action 2023
On October 12th, 2023, a joint session on "Biodiversity Monitoring in Aquatic Ecosystems to Support a Whole Society Approach to Transformative Change", organized by the Marine Biodiversity Observation Network (MBON) and the Fresh Water Biodiversity Observation Network (FWBON), took place during the GEO BON Global Conference in Montreal.

This session explored how biodiversity monitoring capabilities and approaches in marine and inland waters can be aligned with terrestrial approaches to track biodiversity change.
There is an urgency to synergize aquatic approaches to biodiversity monitoring and data collection and to better connect the community globally and across freshwater and marine domains. Key challenges still encompass limited awareness and understanding, restricted access to advanced technologies, capacity-building gaps, and financial constraints.

Measuring the extent of inland, coastal, and marine biodiversity to characterize habitats and biodiversity is a management priority for nations around the world. Nations are faced with addressing the goals and targets of the Kunming-Montreal Global Biodiversity Framework, and this requires baselines and measuring progress against them. Still, nationally and regionally accepted protocols for freshwater biodiversity monitoring and ecological status assessment are rare. Yet the structure provided by the GEO BON to link different national and thematic BONs helps to address requirements for biodiversity information in the land-ocean-atmosphere continuum to address multiple societal needs. There is a recognition that habitats such as drainage ditches, estuaries of all sizes, and wetlands play important roles in delivering ecosystem services and need to be integrated into these observing frameworks. Many of these areas are important for food, human health, and developing and managing Blue Carbon.

Learn more about the session here.

Contributing and Publishing Datasets to OBIS

On October 2, 2023, the Contributing and Publishing Datasets to OBIS training course was launched on the OceanTeacher Global Academy platform. This free course is self-guided and designed to teach skills to structure datasets to contribute to the Ocean Biodiversity Information System (OBIS). The comprehensive course will lead participants through the entire OBIS data life cycle, offering step-by-step guidance. Attendees will learn how to identify the right data structure, apply Darwin Core Archive formatting, carry out quality control checks, publish data, and effortlessly access data from OBIS. Additionally, the course includes a dedicated module specifically tailored for preparing DNA-derived data. This special DNA module is packed with the latest standards and practical examples illustrating how to map DNA data to Darwin Core. OBIS certification is obtained by completing the entire course, containing around 32 hours of content, including engaging assignments and quizzes that assess learning. The course instructor follows attendees' progress and provides feedback on all assignments, ensuring support during learning. This training course has been developed with financial support from NORAD and LifeWatch ERIC. The course will be delivered online between October 2, 2023, and February 16, 2024.

Second Marine Biodiversity Data Mobilization Workshop

Recently, a group of experts in marine data science standards and data management hosted a virtual eight-hour workshop spread over two days, to help scientists educate themselves on how to leverage data standards for rapidly mobilizing their data to global biodiversity databases.

The group of experts who organized and ran the workshop represent several organizations (Marine Biodiversity Observation Network (MBON), Caribbean Ocean Biodiversity Information System node, Canadian Integrated Ocean Observing System, Hakai Institute, U.S. Integrated Ocean Observing System, Ocean Biodiversity Information System, Ocean Biodiversity Information System-USA, and Ocean Tracking Network) and collectively represent over 55 years of experience implementing the relevant standards and practices.

This second annual Marine Biodiversity Data Mobilization Workshop aimed to be a small hands-on, interactive virtual workshop focused on mobilizing marine biological observation datasets to the Ocean Biodiversity Information System (OBIS). The primary objective was to help data

providers standardize their data according to Darwin Core. This included species observations from any type of sampling methodologies (e.g., visual surveys, net tows, microscopy, fish trawls, imaging, omics, acoustics, telemetry). Building upon the successes of last year, some attendees returned with more data and jumpstarted the mobilization of dozens of datasets. The curriculum for this workshop was modelled using The Carpentries evidence-based best practices of teaching, reusing materials from existing lessons, and similar workshops. Materials are openly available through GitHub and thus free for re-use or adaptation.

Equally important, we strengthened our community of practice by facilitating the interactions of scientists from 4 continents and 17 countries. The second Marine Biodiversity Data mobilization workshop was also a contribution to the UN Decade of Ocean Science for Sustainable Development and the Marine Life 2030 Ocean Decade programme. Another edition is being planned for 2024 spring.
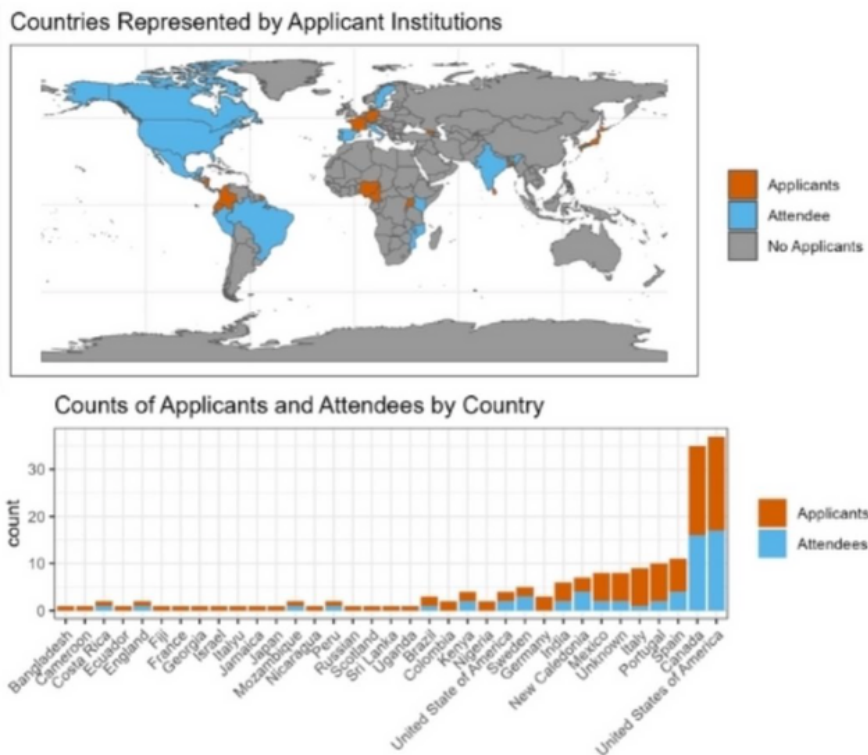

Figure X. Geographic distribution of participants.

FISHGLOB – an integrated dataset of fish biodiversity sampled with scientific bottom-trawl surveys
FISHGLOB is an international consortium open to all interested in the collection, curation, sharing, and use of data from scientific bottom-trawl surveys. New members can join here. The consortium completed and published its first data compilation of publicly available bottom trawl surveys for fish around the world (Maureaud et al. 2024). This follows on the heels of its recent designation as a UN Decade of Ocean Science project. These scientific surveys record demersal species abundance, biomass, and occurrence across space and time, often at annual and continental scales, and offer a unique opportunity to support research, marine conservation, and management in the context of global change. This initial integrated dataset contains 29 surveys from 18 countries, covering 2,170 sampled fish taxa and 216,548

hauls collected from 1963 to 2021. Going forward, the consortium, in particular, seeks input from collaborators interested in contributing data, improved analytical methods, community-building events, training, or connections to related marine data efforts.

Maureaud, A. A., Palacios-Abrantes, J., Kitchel, Z., Mannocci, L., Pinsky, M., Fredston, A., Beukhof, E., Forrest, D., Frelat, R., Palomares, M. L. D., Pecuchet, L., Thorson, J., van Denderen, P. D., and Merigot, B. 2024. **FishGlob_data: an integrated database of fish biodiversity sampled with scientific bottom-trawl surveys**. Scientific Data 11(24)
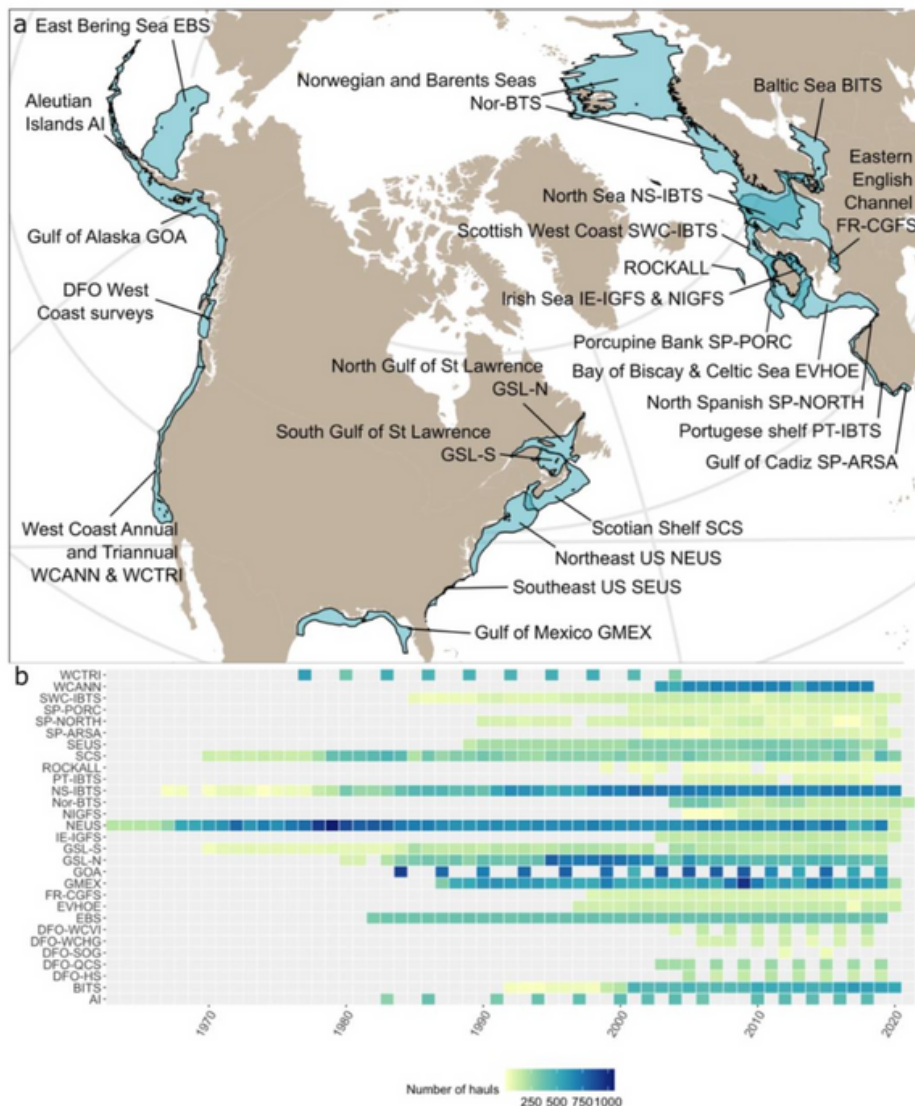

Figure Y. Spatio-temporal coverage of the FISHGLOB_data including 29 bottom-trawl surveys. **(a)** Survey spatial convex hull extracted from Maureaud *et al.* 2024 for publicly available surveys included in the dataset. **(b)** Survey-specific sampling effort time series.

MBON Europe news
MBON Europe held an online seminar about how to publish biodiversity data on 18th December 2023. It was attended by 35 Researchers interested in publishing their data, and 11 staff from LifeWatch ERIC, VLIZ (LifeWatch Belgium) and HCMR (LifeWatchGreece). Participants learned about tools for publishing biodiversity data on OBIS, GBIF and LifeWatch ERIC websites, FAIR

principles, and how to publish data as papers in the Biodiversity Data Journal (for which Lifewatch ERIC pays the open-access fees). The next step will be an in-person workshop in Bologna Italy on 12th February 2023 immediately preceding the EuroMarine Open Science Day (on the 13th) and Annual Meeting. Participants would be encouraged to stay for the EuroMarine meeting. By the end of this MBON Europe workshop, we expect participants will have their data ready and prepared for publication. Financial support for a limited number of participants to attend will be available. So far, 16 organizations have signed the MBON Europe MoU https://euromarinenetwork.eu/activities/mbon-europe

Collaborations

MBON International Collaborations
In 2023, the Marine Biodiversity Observation Network (MBON) signed two international collaborations to share the capacity to observe marine life for ocean conservation and sustainability.

The MBON and the ProtectedSeas recognized the need for globally coordinated and sustained ocean and biodiversity observing and data collection systems. The signed agreement between MBON and the ProtectedSeas recognized ongoing cooperation to reinforce ocean biodiversity observing capacity and use the best available resources and expertise. By collaborating on data, biodiversity, and levels of fishing protection interpretive needs, we can improve data and information sharing. This will result in more robust data that can be used for evaluating and assessing existing and future MPAs. Partnering will potentially facilitate more informed marine spatial planning needs for 30x30, and other future assessments.

The agreement signed between MBON, Marine Life 2030, and Seabed 2030 recognized the need for cooperation to map both the bathymetry and biodiversity of the global ocean, collaborating with different stakeholders, building their capacity and providing them with the best available resources and expertise. Through collaboration, these international networks, will advance understanding and contribute to the UN Decade of Ocean Science for Sustainable Development.

Future Plans

Biodiversity is changing and is thought to be in crisis. But to understand those changes we need data. We need data that is openly shared, easily accessed, and interoperable for aggregating at broad spatial and temporal scales. We need to integrate data from diverse types of biological observations, generated by the myriad projects, groups, and organizations that make up our scientific community, and to do this we need to work together. During 2024, the MBON aims to facilitate more marine biodiversity data mobilization workshops supporting people to organize the data they collect and how to put it into open databases.

MBON will also pursue its effort to foster the development of thematic, regional and international MBON, to cover the existing taxonomic and geographical gaps in marine biodiversity monitoring and data.

Meetings:
MBON will have a presence and participate in discussions at the UN Ocean Decade Conference planned for April 2024 in Barcelona.

MBON will join GEO BON, the Global Ocean Observing System (GOOS), the Ocean Biodiversity Information System (OBIS) and others in planning activities for the next Conference of the Parties (COP16) to the Convention on Biological Diversity, planned for Colombia from 21 October to 1 November 2024.

MBON looks forward to working with GEO BON for the next GEO BON all-hands meeting also planned for Colombia in 2025.

Leads: Raïssa Meyer, Pier Luigi Buttigieg, Neil Davies
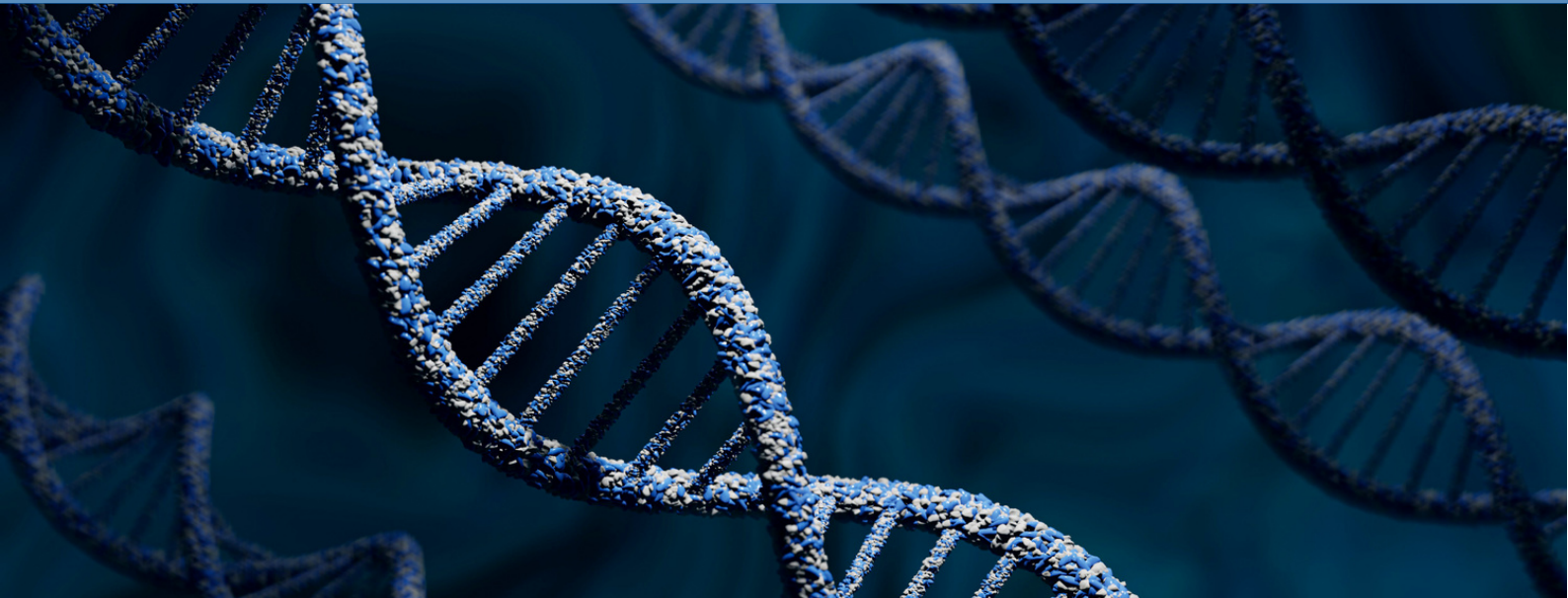
Omic BON: As a thematic Biodiversity Observation Network under GEO BON, Omic BON focuses on biomolecular observations in organisms and environments. It's designed to streamline omics observing strategies, methods, and data flows, aiming at a global omics meta-observatory.

2023 was a landmark year for Omic BON, marked by the publishing of our founding charter and an official introduction of Omic BON at the GEO BON global conference.

Omic BON Founding Charter Publication

Omic BON's 2023 journey began with the publishing of its founding charter. The charter united Omic BON's 32 founding partners and advisory committee members, representing 19 different organizations and initiatives from national, regional, and global observing systems, ethical and social bodies, standards and best practices organizations, and data and sample management infrastructures.

As part of exploring responsibilities in omic biodiversity observation in the founding charter and in Omic BON as a whole, we established a new partnership with Local Contexts, a global initiative that supports Indigenous communities with tools that can reassert cultural authority in heritage collections and data.

The founding charter is a place to learn about Omic BON's vision, mission, and overall goals (please also consult our website for more on our short- to mid-term activities), the positioning of Omic BON in the global context of programs, as well as Omic BON's governance and membership structure.

Omic BON at the GEO BON Global Conference

2023 marked the first time Omic BON joined the GEO BON Global Conference, this year with the theme of Monitoring Biodiversity for Action. Here, Omic BON was officially introduced to the broader GEO BON community. The network's goals and vision were presented, highlighting its

unique position in the GEO BON community and we explored how Omic BON can support omics observations across BONs. Our conference contributions were also defined by a strong coordination with the Genetic Composition WG.

We kicked off the biomolecular/eDNA sessions with a short Omic BON panel discussion on Thursday and closed it off on Friday with a joint mini-symposium on Biomolecular Approaches with the GenComp WG.

Omic BON Panel Discussion

The Omic BON panel discussion brought together representatives from the BON's observatory partners (EMBRC, AAFC, MarineGEO), global observing networks (OBON), data and sample infrastructures (GBIF, BOLD), and standards organizations (GSC, TDWG).

The panel explored the landscape around Omic BON, discussing the respective roles of each represented partner, and addressing the challenges faced by the omics observing community. The discussion focused on key aspects such as omics data integration and interoperability, streamlining data management practices, the concept of a representative sampling regime, the need for accessible, standardized protocols, and sample archiving and permitting for reuse. The importance of building a trusted and inclusive network ensuring easy entry and use of future products, including data, information, and knowledge products, was underscored.

As the Omic BON community evolves, the panelists expressed a commitment to addressing challenges and capitalizing on opportunities for collaboration and innovation in the realm of omics observations. The discussion set the stage for the subsequent eDNA/biomolecular sessions, continuing the dialogue and exploration of omics observing within GEO BON and beyond.

Mini-Symposium on Biomolecular Approaches for Global Biodiversity Observation

The symposium, co-hosted with the Genetic Compositions WG, delved into the integration of biomolecular tools in global biodiversity monitoring across space and time. Biomolecular approaches include the observation of DNA, environmental DNA (eDNA), proteins, lipids and other metabolites. The talks in this session presented the significant advancements for broadscale regional and global coordination efforts using eDNA networks, as well as case studies in biomolecular observing

Upcoming: Omic BON meeting 2024

We are looking forward to inviting Omic BON members and associates to our upcoming meeting on the theme of "Sampling Nature for 'Omic Observatories in an AI World". This event will be a collaborative meeting in conjunction with the NSF RCN 'Sampling Nature' and will take place from the 29th to 31st of May 2024 at the Smithsonian in Washington, D.C., USA, just prior to the 3rd National Marine eDNA Workshop.

Policy Task Force

Leads: Cornelia Krug, Laetitia Navarro

The GEO BON Policy Task force was established in 2017 with the aim to create a bridge between the GEO BON members and policy and decision makers concerned with global biodiversity change and conservation. This concretizes as transferring the outputs and knowledge generated within the different working groups of the network at the science policy interface, by solidifying collaborations with the CBD, with IPBES, with the IUCN to name a few partners, and by communicating back to the network the needs of those that rely on up-to-date open and high-quality data on all dimensions of biodiversity, across all realms. By design, the work of the task force, and its members, are closely linked with the GEO BON Secretariat.

Achievements

In 2023, the Policy Task Force and its members, together with the GEO BON Secretariat have been actively engaging with the Ad-Hoc Technical Expert Group on Indicators (AHTEG) of the CBD. María Cecilia Londoño has been nominated co-chair of the AHTEG, and a number of GEO BON members have been selected as members of the AHTEG. GEO BON is also an observer at the AHTEG. GEO BON can play a role in supporting the methodological development and data mobilization for headline indicators.

The GEO BON Global Conference in the fall of 2023 was a great occasion to discuss the interplay between biodiversity monitoring and policy and engagement. This was illustrated by 13 contributions presented within two sessions shared by the task force "Mainstreaming Biodiversity Monitoring into Policy and Practice" and "Mainstreaming and Communicating Biodiversity Monitoring Across Society".

Another highlight of the year was the renewed interest in engaging with the activities of IPBES which was illustrated by the nomination of a total of 15 experts and 2 fellows for the different calls on the Scenarios and Models Task Force, the scoping of the 2nd Global Assessment and the Monitoring Assessment. Whether those experts are selected by IPBES or not, this shows a keen interest from the GEO BON members to continue this engagement which will be supported by the Policy Task Force.

Collaborations

Key collaborators of the policy task force are the CBD and IPBES, but also ESA and NASA, as well as networks within Future Earth.

In November 2023, the Policy Task force, together with the GEO BON Secretariat, organized a GEO BON Information Webinar on the Open calls for experts and fellows and the different ways to engage with IPBES. The one-hour long seminar, notably introduced by David Obura, long term GEO BON member and recently appointed IPBES Chair, was very well attended mostly by Thematic BONs and Working Groups members. The seminar is also made available online and has since been watched 150 times.

This call was also the occasion for the Policy Task Force and the Secretariat to revise the criteria for endorsement of GEO BON experts for IBPES nomination.

- To be a GEO BON Member (essential) with knowledge of GEO BON and engagement in GEO BON (asset)
- Subject area expertise (essential)
- Experience formulating advice for governments, public and/or international bodies
- IPBES experience (asset)
- Career stage (early to mid-career favored; with separate criteria for the nomination of fellows)
- Geographic and gender representation
- Overall representation and balance of different scientific disciplines and/or interdisciplinarity of the profile
- Not seeking endorsement by a country (favored, but double nominations are allowed)

Future Plans

A key event in 2024 for the Policy Task Force will take place during the World Biodiversity Forum to be held in Davos in June. GEO BON members are organising a number of sessions dedicated to biodiversity monitoring. GEO BON is also one of the conveners of a workshop on GBiOS, which will explore how entities such as national and regional BONs can be connected to form an operational Global Biodiversity Observation System and what support structures would be needed to achieve this.

The task force will also reinforce its engagement with IPBES, even more so with the launch of the methodological assessment on monitoring biodiversity and nature's contributions to people ("monitoring assessment").

Over the course of the year, the Policy Task Force will also start a discussion with its members and the Secretariat in order to review its objectives and action plan as well as its strategy to engage with key partners such as IPBES, GEO, the CBD.

Modeling Hub

Leads: Mark Urban, Greta Bocedi, Damaris Zurell, Santiago J. E. Velazco

Global biodiversity monitoring networks are rapidly improving our ability to observe and understand patterns of biodiversity change worldwide. Preventing biodiversity loss requires theoretical and conceptual tools that synthesize incoming data, estimate uncertainties, improve data collection, detect trends, attribute trends to drivers, project future changes under differing socioeconomic scenarios, compare results, and design efficient mitigation strategies. EcoCode is a new working group and knowledge-to-action launched within GEO BON to address these needs.

EcoCode Expression of Interest Survey

At the beginning of 2023, the EcoCode team conducted a worldwide survey to reach students, researchers, and professors using or developing models who are interested in participating with the EcoCode working group. We had 324 responses from more than 70 countries. USA, Germany, and Canada had the most participants. Most people were willing to participate actively in sub-working groups. "Forecasting", "Spatial planning" and "Trend detection and attribution" were the main purposes that respondents listed for building and using models. Most respondents used or developed models are species distribution models and biodiversity indices models, although other models, including process-based ones, were also frequently listed.

Symposium at GEO BON Conference

At the GEO BON Conference, we organized and officially introduced the EcoCode group through the symposium "Advances in Biodiversity Modeling from Monitoring to Mitigation". Through two oral sessions and posters, this symposium explored recent advances in biodiversity modeling, including challenges and opportunities for integration and expansion, incorporation of mechanisms, accurate error propagation, scaling across space, time, and diversity, and new opportunities through artificial intelligence. Based on the accepted abstracts, we observed three general trends in these advancements: 1. Improvements of models for sampling, indices, and detection and attribution; 2. Inclusion of more mechanistic information into models; and 3. The application of artificial intelligence.

Discussion at GEO BON Conference

We organized a discussion section ("a fireside chat") titled "What is the best way to predict the future of biodiversity?" We discussed the best ways to perform modeling and the various tradeoffs involved. We also discussed how the modeling community could best serve the global monitoring and conservation community, which included activities that ranged from building better models to providing support to countries and to the development of the Convention on Biological Diversity. When asked how hypothetical financial support for modeling could be spent, the audience was split on whether it should be spent on better monitoring and validation data (including personnel) versus improving models.

First EcoCode working group workshop

After the GEO BON Conference, we organized the first EcoCode working group workshop at the Gault Natural Reserve (Canada). Sixteen scientists participated from eight countries. We worked over four days on two topics: (1) Reviewing and setting an agenda for the global modeling needs of biodiversity monitoring, detection, attribution, and forecasting; and (2) Developing a biodiversity modeling inter-comparison project that spans modeling philosophies, types, and mechanisms. This workshop was essential to establishing the first working group of the Biodiversity Model Intercomparison Project (BMIP).

Future plans

We are scoping a GEO BON Science Brief that summarizes how modeling can play a role in assisting countries in meeting the targets of the Convention on Biological Diversity. Also, we are organizing the second EcoCode working group workshop, which will be held in Germany next year. Another next step is to host an all-hands online workshop to organize additional EcoCode sub-working groups and define our broader mission.

Indicator K2A Hub

Leads: TBD

GEO BON's Knowledge to Action (K2A) hubs link the user community (strategic partners, local communities) with the knowledge production groups within GEO BON (e.g. Working Groups, BONs, Task Forces). Since its first online consultation meeting at the end of 2022, the Monitoring Framework for the Kunming-Montreal Global Biodiversity Framework was adopted, and the K2A Hub on Indicators has been engaged in **supporting the work of the CBD's AHTEG for the Indicators of the Monitoring Framework**. Members have been helping to support gaps in indicator needs for GBF goals and targets (Goal A, targets 4, 6, and 21 in particular). There are rich areas for capacity building and giving guidance on how to use and improve biodiversity indicators. Members responsible for supporting select indicators have been busy supporting the AHTEG's needs and providing meta-data updates.

The hub also hosted a session on Biodiversity Change Indicators during the GEO BON Conference, which focused on new indicators being developed and used for biodiversity assessments.

Future work of this hub will be to continue supporting the monitoring framework and integrate community-based monitoring initiatives. **In order to have a greater impact, the K2A Hub on Indicators is seeking co-leads.**

Looking forward to 2024

Going forward, this year will continue to be active and exciting for GEO BON members and our network.

Expect dynamic and rich opportunities for biodiversity policy in 2024:

- The Biodiversity Indicators Partnership is reinvigorating its mandate with its technical partners, indicator providers and users. Expect new initiatives to relate indicators to other multilateral environmental agreements, partnerships, networks and processes beyond the Convention on Biological Diversity.
- The mandate of the Ad Hoc Technical Expert Group (AHTEG) on indicators will come to an end, marking the completion of an intense evaluation of indicators and gaps in the Monitoring Framework of the Kunming-Montreal Global Biodiversity Framework.
- In May, with advice provided by the AHTEG, indicators in the monitoring framework will continue to be negotiated and put into policy during the scientific and implementation meetings of the Bureaus of the Convention on Biological Diversity (26th meeting of the Subsidiary Body on Scientific, Technical and Technological Advice, SBSTTA-26; 4th meeting of the Subsidiary Body on Implementation, SBI-04).
- This fall, we are looking forward to another biodiversity Conference of the Parties: COP 16 in Cali, Colombia (21 October to 1 November).

Members can expect to engage in all these discussions and more with each other and across groups, as we have started rolling out our **new communication platform on Discourse**!

As always, please get in touch with the GEO BON Secretariat (info@geobon.org) with your ideas and questions.

GEO BON Secretariat

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