A global biodiversity observing system to unite monitoring and guide action

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A Global Biodiversity Observation System for a nature-positive world

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The Global Biodiversity Framework (GBF) will be agreed at the UN Convention on Biological Diversity's (CBD) upcoming 15th Conference of the Parties. The GBF is a nature-positive vision for the state of the world's biodiversity by 2050. Attaining this vision will require a rapid reversal of the human impacts driving the global biodiversity crisis. An essential part of the GBF is a monitoring framework (described in CBD/SBSTTA/24/3[1]), which ensures that we monitor progress toward the targets and goals. In support of this new framework, we propose a global biodiversity observation system (GBiOS), that will monitor how, where, and why biodiversity is changing. This knowledge is critical if we are to avoid the enormous social costs of biodiversity loss we are witnessing (1).

Currently, the rate of global biodiversity loss, which exceeds that of any time in human history (2), is outpacing our capacity to monitor its changes across vast areas of the globe. Despite the growth in biodiversity data, very large geographic and taxonomic gaps in our knowledge of biodiversity change, especially for invertebrates (3). Furthermore, while there may be as many as 15,000 monitoring schemes worldwide efforts are generally unharmonized and uncoordinated (4). This situation impedes our understanding of biodiversity change across countries and regions and our ability to assess the success of conservation policy and action. A GBiOS will require major intergovernmental support and funding, here we propose a path to assembling it from existing initiatives, networks, and new technologies.

A Global Biodiversity Observation System

The GBiOS concept, which has been around for over a decade (5), envisions a comprehensive and integrated observation system operating from subnational to the global scale for the purpose of protecting and improving biodiversity and thus human well-being (6). A GBiOS must track changes over time of different biodiversity facets—from genetic through species to ecosystem diversity—because the GBF identifies indicators for each facet. Additionally, there is a need to collect this information on land, in freshwaters and in the oceans and to link it to information on human drivers and pressures to understand the threats and risks arising from biodiversity change.

1

We propose that a GBiOS be assembled as an international network of biodiversity observation networks (figure 1), encompassing coordinated biodiversity monitoring across a geographic area with services for supporting data use and sharing. Many biodiversity observation monitoring networks exist today with their own array of observation sites, methods, and data standards. Biodiversity information is produced by government agencies, research organizations, non-governmental organizations, companies, and civil society groups. Vital sources of information about the changing ecological conditions in land, freshwater, and ocean systems, also exist among Indigenous Peoples and Local Communities (7), which are recognized as important contributors to biodiversity knowledge (8).

An effective GBiOS will coordinate existing monitoring efforts and interlink groups from Indigenous Peoples to corporations, civil society, and governments to undertake this work (9). This major objective will ensure that these groups can contribute, access, and use comprehensive information on the changing state of biodiversity and the pressure it faces that are required by all users and stakeholders.

Biodiversity Observation Networks

In a first phase, GBiOS could be founded as a globally coordinated network of biodiversity observation networks. However, it is crucial to fill the large geographic gaps among these by investing in new infrastructure and observation networks worldwide. Over the last decade, the Group on Earth Observations Biodiversity Observation Network (geobon.org, 10), has coalesced to support the establishment of biodiversity observation networks that aim to fill the gaps. Guidelines for network establishment are publicly available (https://geobon.org/bons/bon-development/) and describe how to create an 'enabling environment' that assembles the partnerships, human capacity and scientific infrastructure needed to build a monitoring network.

There are currently 23 national, regional, and thematic networks endorsed by GEO BON covering aquatic and terrestrial systems (e.g. for Marine BON, Freshwater BON and Soil BON). For example, the Arctic Biodiversity Observation Network (the Circumpolar Biodiversity Monitoring Program) is a regional network coordinated by Conservation of Arctic Flora and Fauna Working Group (CAFF) represented by the governments of Arctic Council member States. Arctic BON functions as a pan-Arctic biodiversity monitoring network that coordinates data collection, analytics and assessments across the Arctic. The Arctic BON combines scientific data following FAIR principles, and local and traditional ecological knowledge following the CARE Principles for Indigenous Data Governance, to provide timely assessments of trends in arctic wildlife and key food or cultural species.

Other agencies and partnerships committed to biodiversity monitoring worldwide would also contribute to this first phase in the establishment of GBiOS. These include the UNEP World Conservation Monitoring Centre, the Global Biodiversity Information Facility (GBIF; https://www.gbif.org), the Ocean Biodiversity Information System, the World Resources Institute, and the IUCN SSC Species Monitoring Specialist Group (www.speciesmonitoring.org).

Key to the development of GBiOS will be the uptake of universally accepted data types and metadata standards. A major but solvable technical challenge is the coordination and integration of biodiversity observations within and across biodiversity observation networks. This interoperability can be maximized using harmonizable observation methods, and data sharing and exchange protocols (e.g., Darwin core) and agreements (10). Existing biodiversity information repositories, such as the IUCN Red List of Threatened Species, GBIF and OBIS, can store and curate the data GBiOS generates.

The growth of GBiOS will also facilitate the establishment of new networks. To build GBiOS, the CBD's GBF should include clear commitments for the establishment of national and regional networks as part of Target 19 (Information and knowledge) of the CBD's GBF. The national, regional, and thematic networks within GBiOS must be supported by and closely tied to the national bodies responsible for implementing the CBD.

Turning the data into actionable knowledge should happen at several scales. The establishment of regional and global knowledge synthesis centers to support the CBD is under discussion within the GBF negotiations (CBD SBI-3 item 7). Under this arrangement, (sub)national networks could build capacity for monitoring systems and data provisioning by stakeholders, whereas regional and thematic networks would focus on developing harmonized methods and protocols. Synthesis centers would work with national observation networks to distill and deliver locally tailored knowledge products that serve stakeholder needs.

A GBiOS will require constant engagement with the full set of stakeholders, Indigenous People and Local Communities, citizen scientists, NGOs and others that collect and use biodiversity knowledge (9). This will also enable a feedback cycle whereby data collectors are more likely to promote the use and collection of additional data and act on the decisions it supports.

Linking monitoring technologies

A GBiOS will leverage ongoing revolutions in biodiversity observation and processing technologies (11). Past biodiversity observations can now be combined with current observations streaming from a host of ground-based, in-water, airborne, and spaceborne platforms. Rapid developments in hand-held technologies have democratized the capacity to make biodiversity observations and boosted the contribution of citizen observations to global knowledge in the form of species images, videos, recordings, and genetic samples.

Remote sensing observations can now be integrated in near real time to accelerate our capacity to undertake rapid surveys and assessments at a range of spatial scales over time. Ground-based imaging, bioacoustic devices, eDNA and other "-omics" approaches are transforming the pace of biodiversity detection and discovery. New generations of satellites from both governments and private companies, provide unparalleled coverage of facets ecosystems at increasingly finer spatial and temporal scales (12). There is a pressing need to integrate these new technologies to form a comprehensive GBiOS.

Cloud computing and data science are accelerating the pace of inferences made from data. Machine learning with visual and audio recognition technology can be applied now to identify many species and their interactions with high accuracy, greatly shortening the previously long lag-times between observation and species identifications. By harnessing and coordinating this array of information, GBiOS would enable integration of knowledge from terrestrial, marine, and freshwater environments.

Detecting and attributing biodiversity change

Biodiversity observations made by GBiOS would feed data-to-knowledge workflows undertaken by synthesis centers. An alignment of observations and data principles would allow the application of the Essential Variable framework for biodiversity, ecosystems, and associated ecosystem services (13). Essential Variables are a compact set of metrics describing the state of species, populations, or ecosystems that provide a common foundation for indicators tracking progress toward the targets set by the CBDs GBF.

Information from across the GBiOS would feed models designed to detect trends in Essential Variables for biodiversity and ecosystems and identify their drivers at multiple scales. Such models can provide estimates of trends in data-poor areas to support action where in situ observations are limited. Multi-scale models can provide estimates of uncertainty about trends from subnational to global scales and link these trends to the ecological, social and economic risks and benefits. Spatially explicit maps of trends in key biodiversity facets and their causes can guide the location of new observations, to iteratively reduce uncertainty, and enhance the ability of GBiOS to reliably identify change and attribute causes to inform conservation action at different scales.

A GBiOS working with synthesis centres will support frequent updates of global biodiversity forecasts and scenarios. Scenarios for global biodiversity are highly uncertain but are essential to biodiversity projections needed to guide action over the coming decade (14). Systematic biodiversity observations can also inform models making short to medium term forecasts needed to assess the likelihood of success of alternative policies for conservation and restoration action.

An extraordinary return on investment

A GBiOS is vital for providing actionable biodiversity knowledge to stakeholders throughout the world, and therefore to the success of the Global Biodiversity Framework. A GBiOS would transform the way biodiversity information is used and shared to detect and assess biodiversity change so that it can guide policy and action for conservation. It is critical to build our capacity to avoid the enormous social costs of biodiversity loss we are witnessing (1).

Currently, there is no formal international financial commitment to a GBiOS. Achieving goals of Global Biodiversity Framework will be impossible without new and sustained funding. To enable and fund GBiOS there is an urgent need for coordinated global action based on a formal co-sponsorship among governments, international research organizations, the private sector, and civil society. The cost of a comprehensive GBiOS has not been assessed but the High-Level Panel on the Global Assessment of the Resources for Implementing the Strategic Plan for Biodiversity 2011-2020 (15) estimated the costs of global monitoring to be ~10% of the US$150 to US$ 440 billion per year required to reach the twenty Aichi Biodiversity Targets. This estimate should be updated as soon as possible.

A significant investment in biodiversity observations is already made annually via existing monitoring schemes, research networks, data repositories and observation technologies. A GBiOS can leverage these investments, supporting the coordination and capacity needed to fill the gaps in our knowledge of biodiversity change.

A formal estimate of the economic value (i.e., option value) of GBiOS is a critical priority for investment. The economic value will stem from the creation of jobs and the worldwide deployment of new technologies needed to operate the GBiOS, as well as the enhancement of capacity among numerous governmental and civil society stakeholders. Governments and businesses stand to make huge financial savings—indeed gains—by investing in a GBiOS because it will further the understanding of their impacts, investment risks, and dependence on biodiversity and ecosystems services, and reduce uncertainty in operations and markets.

Conclusion

We need transformative societal change to mitigate and indeed reverse the human impacts driving the global biodiversity crisis (1). Investment in a GBiOS will allow nations to assess their progress towards the goals of the Global Biodiversity Framework, but more importantly it will pay for itself many times over by allowing them to minimize and remedy ecological crises, including pest and disease outbreaks, ecosystem tipping points, food shortages and instabilities, and identify the measures needed to prevent their occurrence or mitigate their impacts. A GBiOS will deliver the capacity for society to guide the implementation of the policies needed to reverse biodiversity loss and attain a Global Goal for Nature that envisages an “equitable, carbon-neutral, nature-positive world” by 2050.

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Figure 1. This version will be revised to show monitoring in the oceans as well. I think the map could also include national boundaries to that Parties can see themselves in it (see map in Appendix). Other suggestions for improvement are welcome.