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The founding charter of the Genomic Observatories Network

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Abstract

The co-authors of this paper hereby state their intention to work together to launch the *Genomic Observatories Network* (GOs Network) for which this document will serve as its *Founding Charter*. We define a Genomic Observatory as an ecosystem and/or site subject to long-term scientific research, including (but not limited to) the sustained study of genomic biodiversity from single-celled microbes to multicellular organisms.

An international group of 64 scientists first published the call for a global network of Genomic Observatories in January 2012. The vision for such a network was expanded in a subsequent paper and developed over a series of meetings in Bremen (Germany), Shenzhen (China), Moorea (French Polynesia), Oxford (UK), Pacific Grove (California, USA), Washington (DC, USA), and London (UK). While this community-building process continues, here we express our mutual intent to establish the GOs Network formally, and to describe our shared vision for its future. The views expressed here are ours alone as individual scientists, and do not necessarily represent those of the institutions with which we are affiliated.

Keywords: Biodiversity, Genomics, Biocode, Earth observations

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Background

Key outcomes of 21st century science include an Earth with its essential life support systems intact, and a planet where human society has achieved sustainable development. Achieving these challenges, however, requires a greatly improved understanding of human interactions with the natural environment. Towards that end, the GOs Network aims to observe DNA sequences – the biocode – across the principal levels of biological organization (cell, organism, ecosystem) up to the planetary genome [1,2]. Our approach is to apply genomic technologies to study the flux of genetic variation within these nested scales of biological function. We will inventory genomic biodiversity and map its distribution over time and space. To address the processes that generate and maintain this diversity, we will link the genomic information to physico-chemical, ecological, and socio-economic data. We will work with the broader scientific community to build models of how genomic biodiversity contributes to ecosystem services, evolutionary potential, and ecological resilience.

Main text

What is a Genomic Observatory?

Some of the terms we use here require definition (See Table 1), since not everyone in the community uses them in the same way. Helping to solidify a shared terminology in such a fast moving field is one contribution of the GOs Network. Our intention here, however, is merely to clarify what we mean in the limited context of this document. Only time will tell whether these terms, or our definitions of them, become broadly accepted. The definitions are deliberately concise and in some cases require fuller explanation, which we plan to provide in a future publication.

Most importantly, we define a 'Genomic Observatory' as an ecosystem, and/or a site within an ecosystem, that is the subject of long-term scientific research, including (but not limited to) the sustained study of genomic biodiversity. An *observatory* is the institutionalized act of observing, and so for a given ecosystem (and/or site) to be recognized as a Genomic Observatory, one or more institutions (e.g., field station, marine laboratory, museum, university, etc.) should express, and preferably have demonstrated, their long-term commitment to the scientific study of that system's genomic biodiversity. One important feature of this definition is that it allows the establishment of new genomic observatories, while recognizing the value of those that have existing time-series data already.

Mission and vision

The mission of the GOs Network is to work towards Biocoding the Earth; integrating DNA data into Earth observing systems and eventually building a global Genomic Observatory within the Global Earth Observation System of Systems (GEOSS) [3].

The vision of the GOs Network is to:

- Advance the science of biodiversity genomics through a global network of premier research organizations generating well-contextualized genomic biodiversity observations compliant with global data standards.

Table 1 Definitions

Biocode	The totality of DNA sequences in a given *unit of biological organization,* such as a: *cell* (e.g., the Yeast Biocode includes both its nuclear and mitochondrial genomes); *organism* (e.g., the Human Biocode includes both the Human Genome and the Human Microbiome); *ecosystem* (e.g., the Moorea Biocode includes all the genomes on the island); *planet* (e.g., the Earth Biocode includes all the genomes on the planet)
Biocoding the earth	The aspirational target of sequencing every genome on the planet. While a theoretical goal that is clearly unattainable in practice, strategic genome sequencing (e.g., as proposed by the Global Genome Initiative http://www.mnh.si.edu/ggi/) can cover the major variation found among genomes on Earth
Planetary genome	A special case of the biocode: the sum of all genomes that exist on Earth at a given time. (N.B. (nota bene): the existence of a planetary genome neither implies that natural selection acts at this level, nor that the phenotype of the planetary genome is adapted for its preservation and propagation)
Genomic biodiversity	The genetic variation found among genomes
Biodiversity genomics	The field of scientific study that maps genomic biodiversity over space and time, investigates the functional consequences of this variation, and seeks to explain how it is generated and maintained
Ecosystem	A biological community of interacting organisms in their physical and chemical environment
Genomic Observatory	An *ecosystem* and/or site subject to long-term scientific research, including (but not limited to) the sustained study of genomic biodiversity from single-celled microbes to multicellular organisms
Genomic Observatories (GOs) Network	A network (i) of *ecosystems* and *sites*, which are often already part of existing scientific networks, (ii) of *researchers*, who are intensively studying one or more GOs, and (iii) of *institutions*, *infrastructures*, and *initiatives*, whose work aligns with the GOs Network's mission
Future 'omics (futuromics)	The preservation of biological samples for eventual study of their nucleotide and protein sequences through the techniques of genomics, transcriptomics, proteomics, metabolomics, and other 'omics' analyses

- Coordinate a set of long-term DNA-centric research programs (actions) at local, regional, and global scales that help develop and implement common standards and best practices for quantifying genomic biodiversity and mapping biotic interactions over time.
- Partner with natural history museums, repositories, and bio-banks, (e.g., members of the Global Genome Biodiversity Network (GGBN) [4]) to preserve well-contextualized samples (environmental samples and organismal specimens) for future 'omics analysis, including whole genomes and metagenomes.
- Work with the broader scientific community to develop predictive models of biodiversity, ecosystem services and evolutionary potential [5] - especially with respect to global change.
- Provide training, technical assistance, resources, and best practice guides as a learning platform for individuals and organizations wishing to carry out genomic observations at genomic observatories and beyond.

Governance and membership

The GOs Network is a collaboration of the Genomic Standards Consortium (GSC) and the Group on Earth Observations (GEO) through its Biodiversity Observation Network (GEO BON) [6]. The GSC is incubating the GOs Network, and GEO BON has listed it as a key deliverable. Through this pathway, the GOs Network will also contribute to the new Future Earth program [7] for global sustainability research, thus promoting links to other scientific disciplines and helping forge partnerships with policy makers and other stakeholders.

Working under GEO reflects our mission of integrating genomic data into GEOSS, while working under GSC ensures that these data are fit for that purpose. Initially, a GOs Network Board, including representatives of key stakeholders, will administer the GOs Network and set its strategic objectives (this charter). One of the first tasks of the Board is to define criteria for membership of the GOs Network and to put in place a governance mechanism and operating procedures. All co-authors of this article are considered "founding individual members" of the GOs Network.

Research coordination activities

The GOs Network will focus on coordinating activities, such as (1) Organizing an annual meeting (GOs Network Conference) involving all network members and other interested parties worldwide; (2) Co-organizing regional and thematic meetings (GOs Network Workshops) in collaboration with partner organizations; (3) Maintaining a online registry of Genomic Observatories; (4) Participating in standards development efforts, for example, through the *Genomic Biodiversity Working Group* (GBWG) - a collaboration of the GSC and the Biodiversity Information Standards organization (TDWG.org); and (5) contributing to GEO and GEOSS, particularly through the cross-cutting Working Group 1 (Genetics) of GEO BON.

Actions

The GOs Network will support actions aiming to build a coordinated and well-contextualized set of genomic biodiversity observations and archived vouchers (specimens and environmental samples). In particular, the GOs Network aims to provide a roadmap for ecosystem-based Genomic Biodiversity Assessment Reports as one of its contributions to GEO BON. These reports might start with a simple checklist of species, building up to a DNA barcode library and eventually to metagenomic inventories. The former will contribute towards the International Barcode of Life (IBOL) initiative and work towards the latter is already underway through the GOs Network's first action, *Ocean Sampling Day* (OSD) [8], an initiative of the EU FP7 Project Micro B3 to carry out coordinated sampling of marine microbial communities on June 21, 2014. The GOs Network will help expand the scope of OSD to include new geographies, sampling approaches, taxa and environments, and to maintain this action beyond 2014. OSD represents the GOs Network's first attempt to aggregate participating sites into a global genomic observatory and to begin functioning as a distributed major research infrastructure. The GOs Network will build on OSD to support development of Marine Biodiversity Observation Networks [9], particularly through the coordinated actions of leading marine Genomic Observatories.

Biocode commons

The GOs Network intends to adopt the Biocode Commons as its informatics stack - a primary forum for sharing tools that support genomic observations from collection through analysis and publication, bringing together developers, scientists and standards (see: http://biocodecommons.org/). Eventually, the Biocode Commons might aim to provide a one-stop shop for genomic biodiversity data and scientific workflows from genomic observatories. We believe that wherever feasible these data should be fully compliant with global data standards, machine-readable, *and* (while respecting legitimate concerns for privacy and for the protection of endangered species) accessible without restriction to the scientific community [10].

Conclusions

Genomic biodiversity represents the foundational data layer for biological research. The Genomic Observatories (GOs) Network brings together premier research sites to develop 'systems-based' approaches that integrate genomics into ecological, evolutionary, and socio-environmental

studies. This paper outlines the network's mission and seeks broad community participation in this collaborative effort.

Abbreviations

GEO: Group on Earth Observations; GEO BON: Group on Earth Observation Biodiversity Observation Network; GEOSS: Global Earth Observation System of Systems; GGI: Global Genome Initiative; GGBN: Global Genome Biodiversity Network; GSC: Genomic Standards Consortium; IBOL: International Barcode of Life; OSD: Ocean Sampling Day.

Competing interests

The authors declare that they have no competing interests.

Authors' contributions

ND and DF drafted the original text with detailed input from GOs Steering Committee members (LAZ, MC, JD, AD, DPF, JG, JG, FOG, PH, JL, CM, MO, SP, CS, APV, VBL, RG, and RT) and broad consultation with all the co-authors. All authors read and approved the final manuscript.

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GOs-COS

Genomic Observatories Community of Scientists. http://genomicobservatories.org/, Oxford, England, UK; info@genomicobservatories.org.

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