



The Ocean Biomolecular Observing Network (OBON)

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ABSTRACT

Ocean life—from viruses to whales—is built from “biomolecules.” Biomolecules such as DNA infuse each drop of ocean water, grain of sediment, and breath of ocean air. The Ocean Biomolecular Observing Network (OBON) is developing a global collaboration that will allow science and society to understand ocean life like never before. The program will transform how we sense, harvest, protect, and manage ocean life using molecular techniques, as it faces multiple stresses including pollution, habitat loss, and climate change. It will also help communities detect biological hazards such as harmful algal blooms and pathogens, and be a key component of next-generation ocean observing systems. OBON will encourage continuous standardization and intercalibration of methods and data interoperability to help enhance and future-proof capabilities. OBON’s objectives are: 1) to build a coastal-to-open ocean multi-omics biodiversity observing system; 2) to develop and transfer capacity between partners; 3) to enhance marine ecosystem digitization and modelling and 4) to coordinate action on pressing scientific, management, and policy questions.

Vision and Potential Transformative Impact

OBON’s vision is that all ocean observing systems are capable of observing the molecular signatures of ocean life, opening up new horizons for understanding, managing, and conserving the living ocean. The program will utilize biomolecular technologies to research, understand, and monitor life in the sea at every trophic level and scale. It will transform and deepen how we observe and understand how marine life and human society are responding to climate change and more local impacts of human activity. OBON aims to build an improved recognition that life is at the heart of the ocean, and intimately connected to the ocean-atmosphere-land system. Further, OBON will contribute collaboratively developed and context-sensitive molecular methods for the Global Ocean Observing System’s (GOOS) biological and ecosystem Essential Ocean Variables (EOVs), as well as contribute to other Essential Variables where relevant.

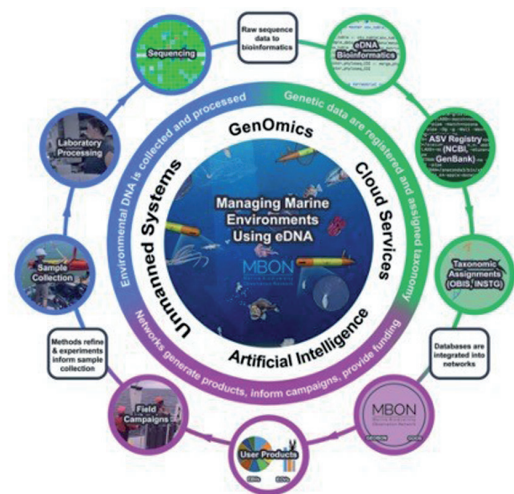


FIGURE 1. The Marine Biodiversity Observation Network (MBON) will act as a Community of Practice and will help to integrate all the aspects of the eDNA wheel and use a similar process for other biomolecular analyses. (Image: Chavez et al., 2021. Observing Life in the Sea Using Environmental DNA. *Oceanography*, 34(2):102–119. <https://doi.org/10.5670/oceanog.2021.218>.)

How Is the Project Realizable, With Connections to Existing Scientific Infrastructure, Technology Development, and Public-Private Partnerships

OBON aims to build a collaborative network that will jointly operate a multi-omics biodiversity observing system, which will be implemented over the Ocean Decade and continue beyond, and will range from coastal areas to open ocean, using a variety of techniques and consolidating data.

The program will:

- develop capability through the collection, analysis, and archival of biomolecules (e.g., nucleic acids) and reference samples using both autonomous and manual collections from fixed locations or grids where measurements of biological, biogeochemical, and other parameters are also collected.

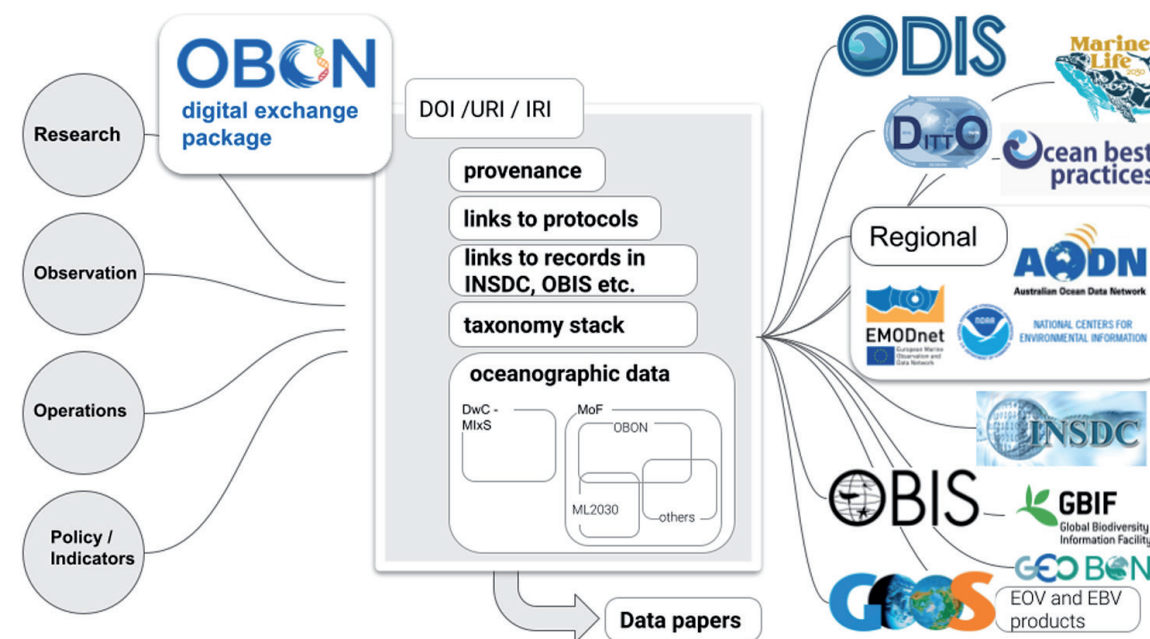


FIGURE 2. A visual representation of OBON’s strategy for handling biomolecular (meta)data.

- OBON will adapt sequencing and biomolecular technology originally developed for the medical diagnostics industry and eventually deploy a global network of autonomous platforms with biomolecular sensing capability that will greatly expand the footprint of the fixed locations. This autonomous platform network will provide persistent synoptic observations of the biology of the ocean analogous to the physical measurements of the Argo network. Our aim is to sustainably interface our observations with other international, multi-disciplinary ocean observation and data management efforts, and specifically target the IOC-UNESCO GOOS EOVs and Group on Earth Observation Biodiversity Observing Network (GEO BON) Essential Biodiversity Variables. Our activities will adhere to IOC open data requirements.

Scientific/Technological Sectors Engaged Outside of Traditional Ocean Sciences

As a fundamental signature of life, DNA, RNA, and other biomolecules unite all the biological and ecosystem EOVs with a closely related set of observing techniques. Our program will develop a coordinated and interoperating network of regional biomolecular observing efforts to bridge scientific innovation to the operational activities within and beyond the GOOS. OBON will work with GOOS in its efforts to integrate DNA sensing (and eventually that of other biomolecules) into its EOVS Specification Sheets by coordinating global intercalibration efforts, co-development of standards and methodologies (in collaboration with the Ocean Practices for the UN Ocean Decade Program; from observational plans to data synthesis), and co-design of stakeholder-specific interfaces to the data, information, and knowledge products generated throughout the program (see Figure 1).

OBON also aims to improve the assimilation of biomolecular data into artificial intelligence and modelling efforts. Naturally, OBON will also seek to leverage modelling efforts initiated by other scientific and user communities to complement its activities. The program will ensure that data flows are standardized and harmonized to support

model development, as well as to secure a FAIR (Findability, Accessibility, Interoperability, and Reuse) digital legacy and prepare for the implementation of the CARE (Collective Benefit, Authority to Control, Responsibility, and Ethics) principles.

Opportunities for International Participation and Collaboration

OBON will promote international participation and collaboration in a number of ways. Some of these are highlighted below:

- Scientific, operational, and strategic collaboration across OBON partners (spanning 41 different countries and including sampling in all continents and ocean basins) and UN Ocean Decade- and OBON-endorsed projects and activities
- Intercalibration exercises and coordination between partners with geographic, methodological, or thematic overlaps
- Co-design of OBON’s digital strategy (see Figure 2) and co-development and maturation of biomolecular (meta) data standards—contributing to the development of an OBON digital best practice guide for enhanced data sharing in support of global biomolecular observation

Develops Global Capacity and Encourages the Development of the Next Generation of Ocean Scientists, Engineers, and Technologists

OBON aims to develop and share capacity across communities, regions, and generations so as to initiate additional marine biomolecular observation activities. This will be supported through training programs combined with funded equipment programs supported by development/aid agencies and philanthropy. These programs will be developed in collaboration with the nations involved and will focus on sampling/analysis programs that address issues outlined in the UN Ocean Decade goals and UN Sustainable Development Goals (e.g., predicting biological hazards, managing protected ecosystems, etc.). Activities will include tools to enable access to and analysis of data by non-specialists, increasing the impact and reach of observations.