

ASSEMBLE



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Abstract

Marine Genomics Observatories are networks of ecosystems, and/or sites within ecosystems, that are the subject of long-term scientific research, including (but not limited to) the sustained study of genomic biodiversity within its environmental context (Davies et al. *GigaScience* 2014, 3:2). At the Institutional, organizational level, a marine GOs network can be seen as a distributed infrastructure consisted of sustainable, dedicated and committed community of experts and marine stations working in a coordinated way, and capable to facilitate expansion to new stations to monitor biodiversity over time and space and across ecosystem types. Significant progress in such a holistic monitoring of marine biodiversity has been achieved mainly in the course of the last ten years. Nevertheless, that task is demanding, as it involves not only standardisation of a broad range of methods and data descriptions, but also requires that these methods will be adopted broadly and applied pertinently. While being part of a fast changing technological environment, reasonably emerges the need to test and benchmark new methods before making them broadly accessible under standardised ways. Progress for GOs has been significantly hampered by the fact that developments until now were dependent on research projects and therefore could not maintain communities in the long run. ASSEMBLE Plus, with JRA1 research joint activity, aims to address these challenges by the creation of strong GOs supporting community within a long term sustained research infrastructure, EMBRC ERIC, and with additional well established marine stations. Such a continuously evolving GOs community will develop by implementing real observation projects, by standardisation of observation of marine biological communities and habitats that have not been standardised yet and by establishing links and collaboration with relevant initiatives at the international level. Based on information captured with a Questionnaire (Appendix), on meetings and workshops and on two major sampling events, the Ocean Sampling Day and Autonomous Reef Monitoring Structures (ARMS), we have been building the first elements of a GOs roadmap, to consolidate standardized methods and expand it to a global community, while testing new methods, approaches and data types.



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1. Introduction

Observing the dynamics of earth's marine ecosystems by long term monitoring is a valuable data and knowledge resource and an urgent need. Indeed, in the so called "Anthropocene" that we are traversing, such an objective is a pressing need, as facing the impacts of climate change, pollution, overfishing, physical destruction of habitats, or other stressing factors on the marine environment. In addition to all the above, the need to address the demand for food of an ever increasing human population, requires high quality and long term data on the structure and function of marine ecosystems, combined with high quality environmental data.

Such a need may already be tractable in the case of environmental data assessment, where processes have been highly automated; even in this case the scale of observation needed raises several challenges. On the other hand, observing the biological component of marine ecosystems has been a slow process requiring a lot of time from experts that are less and less available. Until the era of Genomics, it was not conceivable to think of effective biological/ecological monitoring outside few well known big marine stations. Today, in order to reach meaningful assessment of the dynamics of marine ecosystems, intensive monitoring across space and time is essential, so that informed decisions based on solid knowledge can be made. Such an ambition has emerged with the advent of Genomics by means of Next Generation Sequencing, which is automatable to a great extent and boosted developments in Bioinformatics and computational biology. Genomics and metagenomics data offer access not only to marine community composition but also to the functional potential of marine organisms and its expression under given environmental conditions. Additional levels of data can be added as technologies evolve, so that today we talk about meta-proteomics and metabolomics and high-throughput bioimaging. As DNA is the most resistant biological macromolecule and at the same time the most informative one (identification of organisms, functional potential, history of populations and species, interactions between organisms, etc.), genomics is a priority in marine observation, when combined with high quality environmental data but also with more traditional marine biology approaches (e.g. taxonomy). Considering that broadly distributed observation can only make sense under appropriately standardised procedures, the challenges are very significant, especially in a period of continuous changes in technologies, raising the need not only to integrate new technologies but also to summon organisational and sociological expertise. In such a period of technological transitions in biological sciences, JRA1 is called to take advantage of previous developments on GOs, and to create a distributed community; such a community needs to be sufficiently big to be able to follow technological developments, standardise procedures, test and benchmark methods, coordinate operations, link with other international initiatives, discover gaps and call for solutions, while at the same time to be of size allowing cohesiveness in order to be effective. Ideally GOs within ASSEMBLE Plus, supported in the long term by EMBRC ERIC, will serve as a paradigm and a driver for global genomics observatories of the seas and oceans.



2. Objective

The objective of JRA1 is the foundation of a long-term operational Marine Genomics Observatories infrastructure serving as a paradigm and contributing to a holistic global monitoring of the seas and oceans.

A prerequisite for a GOs infrastructure is the creation of a standards-literate community that can introduce, develop and test methods and practices, communicate and help applying it globally in standardized ways, producing open data under the “FAIR data principle” and extracting knowledge. The ASSEMBLE Plus project, through the EMBRC ERIC infrastructure, which combines expertise in marine biology, ecology and genomics, with additional well established marine stations, including MARS stations, and in interaction with other communities and infrastructures (e.g. ELIXIR ERIC, LIFE Watch ERIC, Euro-BioImaging ERIC, Genomics Standards Consortium, etc.), offers a prolific ground for the establishment, operation and support of marine GOs.

After the first year of operation of JRA1, the present document (D7.1) constitutes a first version of a roadmap towards the establishment of GOs within ASSEMBLE Plus. This is a “living document” to evolve over the next years so that ASSEMBLE Plus, delivers not only a dedicated well-trained and operational community and established GOs infrastructure, but also an experience-based practical guide for marine GOs, advising on practical issues as well as on strategic aspects and supporting broad internationalization.

3. Community building

The ASSEMBLE Plus Marine Genomics Observatory (GOs) community has been formed following an open call to the actual ASSEMBLE Plus partners, during the preparation of ASSEMBLE Plus proposal, which brought about a warm and broad expression of interest and led to the actual shape of JRA1 partnership and stations network. It is taking form since the first year, by means of meetings, a workshop, by distance communication (e-mails, teleconferences) and has been evolving through two “hard actions”, namely the OSD18 event and the deployment of ARMS devices. It comprises 17 stations of 16 partners, which include most EMBRC (The European Marine Biological Resource Centre) partners and other stations known for their leading role in marine and oceanographic research, including MARS stations. These stations cover European seas of the Mediterranean and the Atlantic, the Red sea, the Arctic and the Antarctic.

3.1 Meetings

3.1.1 First meeting, hosted by UPMC (now Sorbonne Université) on October 20th 2017

This meeting took place aside of the kick off meeting of ASSEMBLE Plus in Paris. This has allowed partners to get to know each other, and to overview the WP, to address thoughts and concerns and to plan activities of the GOs community. A key issue has been the transfer of the experience and data related tools on Ocean Sampling Day (OSD) by MPI Bremen (who had established OSD during the FP7 project Micro B3), to the ASSEMBLE Plus community and to EMBRC, who was in process of becoming an ERIC (achieved in March 2018). The challenges and critical points have been addressed so that all

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partners became aware that distributed work among stations represented challenges even for the simplest tasks. The need and decision of a tight collaboration between NA2, that addresses the data challenges and JRA1 that produces data, has been also stressed; to this end, it is very convenient that VLIZ who coordinates the NA2 is partner in JRA1, so that information exchange is direct. It was evident that many JRA1 stations had experience in OSD, as they have participated during the FP7 Micro B3 project while others have had experience with Tara Oceans or with related national projects. Leaving this first meeting, it has been clear to all, that this is a mature enough community to work for the implementation of a network of a proper Genomics Observatory stations and community, and to serve as test bed and benchmarking machinery for established and new tools, methods and processes integrating the most pertinent ones into coherent workflows.

3.1.2 First workshop, hosted by CCMAR on March 13th - 14th 2018

This workshop, in Faro, Portugal, has been followed by a PIC meeting of ASSEMBLE Plus. Most partners have been physically present while the others have participated via a very effective teleconference. This has been a great event for knowing each other's history and activities related to GOs, since all partners have had the occasion to present their station. At that stage, a major decision has unanimously been taken and this was about materialization of an OSD event within 2018, something that has not been part of due deliverables of the project for its first year. This has shown the motivation of all partners to work towards having a first go and assess any possible flaws so that the OSD2019, scheduled for June 21st 2019 would be better prepared. The logistics of such an organization are not trivial and the schedule from March 13, to June 21st has been very tight.

3.1.3 Breakout meeting during ASSEMBLE Plus General Assembly 2, in NUIG, October 10th 2018

This meeting in Galway, Ireland, has allowed consolidating the community by building trust in JRA1 community, by reporting back a successful OSD2018 event that brought a lot of lessons to be taken into account for OSD2019. It also allowed hosting a workshop on the deployment of ARMS by teleconference and by physical presence, coordinated by Dr. Matthias Obst, (Göteborg University).

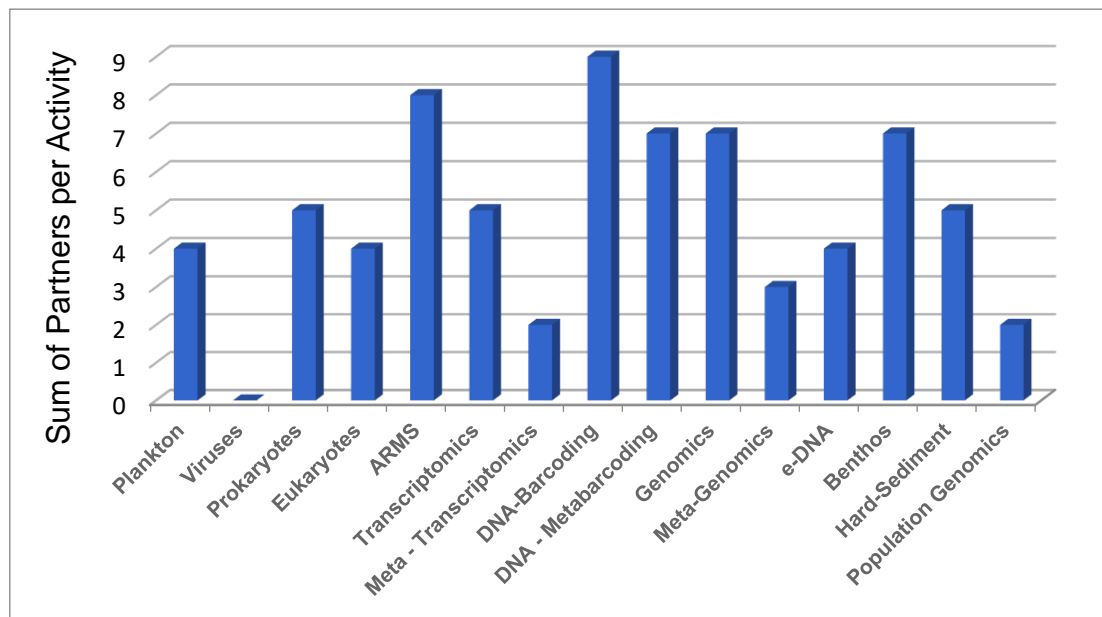


4. GOs Roadmap within ASSEMBLE Plus

Based on the above meetings, on the experience gained during two joint hard actions, and the output of the questionnaire (see available expertise in the figure and table below & the Questionnaire in the Appendix), the rough lines of a roadmap can be presented. We need to notice that in a field involving technologies with a high rate of change, this roadmap is a dynamic document to be regularly assessed and adapted by a dedicated community. The document will be discussed at the following GA meetings during dedicated JRA1 breakout sessions, while information of technical and policy nature may be exchanged regularly by distance. The planned creation of a dedicated portal should serve such purpose as well.

Partners (Institutes)	Activities														
	Plankton	Viruses	Prokaryotes	Eukaryotes	ARMS	Transcriptomics	Meta - Transcriptomics	DNA-Barcoding	DNA - Metabarcoding	Genomics	Meta-Genomics	e-DNA	Benthos	Hard-Sediment	Population Genomics
Stazione Zoologica di Napoli Anton Dohrn	*		*			*	*	*	*						
Ryan Institute, NUI, Galway				*				*		*					
Station Biologique Roscoff (CNRS & Sorbonne University)	*			*	*	*	*	*	*	*	*	*	*	*	*
Max Plank Institute for Marine Biology, Bremen			*					*	*	*	*				
University of Helsinki, Tvarminne Zoological Station					*								*		
Flanders Marine Institute (VLIZ)	*		*	*	*	*		*	*				*	*	*
University of Gothenburg, Sweden					*			*	*			*	*	*	
British Antarctic Survey (NERC-BAS)			*		*	*		*	*	*					
University of Gdansk					*			*		*		*	*		
Instytut Oceanologii Polskiej Akademii Nauk (PAN)					*					*			*	*	
HCMR, Heraklion, Crete	*		*	*	*	*		*	*	*	*	*	*	*	*
Total	4	0	5	4	8	5	2	9	7	7	3	4	7	5	2





5. Genomics Observatories (GOs)

Genomics Observatories (GOs) of marine ecosystems is about the development of a global distributed network of long-term observatories, developing and implementing standardized methods and procedures to assess, integrate and make publicly available genomics, environmental and other biological data that technologies allow capturing. Such data will follow the FAIR principle (Findable, Accessible, Interoperable and Reusable). Dynamic knowledge production by continuous integration of time series spatial data will inform a broad range of stakeholders, allowing ecosystem-based management and decision making on sectors affecting and/or being dependent on the marine environment (fisheries, aquaculture, biotechnology, bioremediation, etc.), advising spatial planning, informing policies and helping to better face the needs of a growing human population and the fast climate change.

GOs development is an ongoing endeavour. JRA1 will operate in several different levels:

(a) It will test, operate and expand observation procedures that have been tested and will internationalize as globally as feasible. This is the case for the Ocean Sampling Day (OSD). The operation of such an event prepared within 3 months only (in spring 2018), has allowed creating a network of more than 100 OSD-registered stations around the Globe. In the next years within ASSEMBLE Plus, effort will be made to expand the network with more stations. As the stations get experience and methods are being simplified, it will be possible to apply OSD at a seasonal or monthly basis. Also OSD can be implemented to address specific questions, e.g. connectivity between boundary zones, or assessment of invasive species. The core of GOs, that is the actual JRA1 stations, will serve as a driver of such a procedure. The main challenges to good operation of broadly distributed networks of stations are the long-distance communication, motivation and expertise.



JRA1 is already widely distributed across Europe and will be a test bed to evaluate those challenges, both within JRA1 and at the Global OSD network.

(b) It will optimize, apply and test, in non-tropical waters, the ARMS methodology, which assesses benthic biodiversity by means of the standardized methods. This involves interacting with the Smithsonian Institute of Natural History (USA), which has developed the method and has expanded it to tropical waters in the Pacific and Indian Ocean. The operation of ARMS has been planned as a two-stage process. The first stage (2018) is a standardisation/training procedure, which is now close to completion; ARMS devices have been deployed in late spring-early summer 2018, and then collected after a period of about three months. At present, the sampled by each station material has been sent to HCMR for DNA extraction and sequencing. The second phase of ARMS operation will start in late spring to early summer 2019, based on 2018 experience. In this phase, ARMS devices will be implemented to address a series of different scientific questions (e.g. percentage of known part of local community captured by ARMS, relation to plankton communities, assessment of invasive species, observed geographic patterns, etc).

(c) GOs initiative will be meaningful if over the years will be evolved to comprise observations of all different kinds of biological communities and ecosystem types. This will demand time and resources. Within JRA1 there is expertise and ongoing regional, national or international projects addressing different ecosystem types. To take advantage of the expertise and start addressing each component across stations, at least at the level to come up with a mature roadmap of how to further proceed or even to fully develop, we have created working groups where stations have been asked to subscribe and are in procedure within 2019 to make progress on that. Coordinators have been identified for some of them. Here is the list of activities and the working groups. Following the data produced by the questionnaire, the working groups may be better organized and a new round of assigning coordinators (named “champions”) will follow. Below is a table showing the working groups formed during the first JRA1 workshop on March 2018. In case of some “weak” availability of expertise, it will be addressed by inviting experts among collaborators of the JRA1 network. Occasions will be taken to fund experiments as for instance Meta-Transcriptomics experiment and viral metagenomics planned at HCMR in September 2019 funded by EMBRC-Greece and by the “Aquacosc” network (<https://www.aquacosc.eu/>). JRA1 will “scan” for such opportunities to improve its arsenal of standardized methods for observing the whole range of marine communities and ecosystem types.



Working groups addressing methods and ecosystems	Meta-T	ARMS	Plankton net	DNA Barcoding	eDNA
University of Gothenburg, Sweden		coordinator	participant	participant	participant
University of Helsinki, Finland		participant			
University of Gdansk, Poland		participant	participant		participant
HCMR, Greece	participant			participant	participant
IOPAN, Poland		participant	participant		
Marine Biological Association, Plymouth, England		participant	participant	participant	coordinator
NIB, Marine Biology Station Piran, Slovenia		participant	participant	participant	participant
NERC-BAS	maybe	participant		participant	maybe

6. Data

Concerning Data policy and management, it has been addressed within NA2 and as mentioned above, there is close collaboration between NA2 and JRA1. A Data Management Plan has been already issued by NA2, where FAIR data principle is adopted. Concerning JRA1 data, they will become publicly available for scientific use. A short moratorium (one year) usually applied on any such kind of data is justified, to give time to properly curate the data and test by first round of analysis.

Organization of a training workshop on DNA meta-barcoding and meta-genomics data analysis is encouraged for 2020. ASSEMBLE Plus has the means for this and it can be co-organized with ELIXIR ERIC. It will be addressed within the PIC.

The Nagoya protocol is taken into consideration not only within JRA1 but Globally within ASSEMBLE Plus and within EMBRC. This is a process in progress. Within JRA1, bilateral agreements have been signed between OSD registered Institutions sending samples to HCMR and HCMR following the requirements of the Nagoya Protocol and the national laws of the respective countries. Mutual transfer Agreement documents have been also signed. Concerning data management for OSD data, there has been a “configurator” demand to ELIXIR ERIC through the project EMBRIC and a report advising on processes for data management has been produced. This document will be seen within NA2 in order to make data management as easy as possible and to further inspire needed collaboration with EBI, ELIXIR, etc.



7. Outreach & Collaborations: Promoting ASSEMBLE Plus GOs community – looking into the future

GOs are a complex endeavour requiring joining forces between relevant initiatives, in order to improve processes, to standardize everything from sampling and sample processing to data management and to expand oceans' observation globally and to as many as possible community and ecosystem types. JRA1 has direct contact with the Genomics Standards Consortium (GSC) since 2010. GSC is an initiative that has introduced the idea of Genomics Observatories. Indeed, GOs have been established in the USA first as a GEOBON informed initiative of GSC but now it comprises partners on all continents. Therefore active collaboration with it brings a lot, including internationalization with seas and oceans far from Europe (Pacific & Indian Ocean). This collaboration between USA, Australia and Europe can now be further intensified thanks to the ASSEMBLE Plus GOs implementation; ASSEMBLE Plus being an EMBRIC ERIC coordinated project, it offers good perspective to long-term sustainability of GOs. Tara Oceans is also a community that has enormously inspired and contributed to the vision of GOs and some JRA1 partners are part of Tara Oceans community. Furthermore, within the ATLANTOS (H2020) project, there has been created a community (GLOMICON) to explicitly address and work towards GOs improvements. JRA1 is in contact with GLOMICON. We have been already addressing the need of a joint workshop in 2019 or 2020. Finally the effort is continuous to link with other communities to improve and expand GOs. Within such a perspective, EMBRIC has participated in the H2020 proposal "AtlantECO" which aims at linking drivers with ecosystem response in the Atlantic. In this project OSD is planned and will be funded for 2021 & 2022 with an effort to develop a denser network of OSD stations in Southern Atlantic. If successful, the project will back up JRA1's objectives and will offer sequencing of all samples including OSD2019 by GENOSCOPE, which has been the sequencing centre of Tara Oceans project, and therefore is very experienced. Even if not funded, the joint effort has created common understanding within a very strong research community. Finally, ASSEMBLE Plus GOs will be presented in a AGU Fall Meeting in Washington DC on 10-14/12/2018 within a GEOBON session entitled "The Group on Earth Observations Biodiversity Observation Network (GEO BON): Integrating in situ and remotely sensed observations to advance biodiversity monitoring, research, and applications". Abstract submitted under the title: "Genomic Observatories, Global Omics, and Ocean Avatars". In the abstract ASSEMBLE Plus GOs are presented jointly with GSC/ GEO Bon GOs and with GLOMICON. Finally JRA1 will be represented in the Genomics Standards Consortium meeting (GSC21) in Vienna in May 20-23, 2019, co-organising a special Genomics Observatories session (<https://press3.mcs.anl.gov/genosc/meetings/gsc21/>). By that occasion, will be also addressed the need of closer collaboration with initiatives of oceanographers who have been investing actively on automation of sampling and in using new types of sensors. Such an initiative should be done within a more general ASSEMBLE PLUS policy framework and JRA1 has the means to support it. Several JRA1 partners have been contributing anyway to such initiatives. Examples of networks and infrastructure producing data on the marine environment and ecosystems comprise LifeWatch ERIC, Euro-Argo ERIC, EMSO ERIC, EMODnet, SeaDataNet, EurOBIS, WORMS, ICES, , JERICO, etc.



8. Appendix

Deliverable D7.1

- Partners Profile -

Questionnaire

1. What is your full name?

2. What is your title? Mr Mrs Miss Dr. Prof.

3. Are you an official representative of GOs within ASSEMBLE Plus? Yes No

4. What is the name of your Institute/Affiliation/Department, you work at:

5. Activity/Community type you involved and what are your responsibilities? (*✓tick more than one, if applicable*)

Plankton → Community targeted: pico- nano- micro - zooplankton

Viruses

DNA Barcoding

Prokaryotes

e-DNA

Eukaryotes

Benthos

ARMS

Hard sediment

Meta-Transcriptomics

Responsibilities:

6. What is the Taxonomic expertise of the GO group you are involved in?

7. For which of the following categories do you have expertise? (*✓tick more than one, if applicable*)

DNA-barcoding DNA-metabarcoding Genomics Metagenomics

Transcriptomics Metatranscriptomics Other (*Please specify*)

8. Do you have a bioinformatics/data science team in your station? Yes No

If yes,

8.1. What is the size of the group?

8.2. What is the expertise of the group?

Deliverable D7.1
- Partners Profile -

Questionnaire

8.3. What is the composition of the personnel of the group in terms of employment? (staff members, engineers, post-docs, researchers) *✓tick more than one, if applicable*

- members of the staff self-employed under contract other

(example of answer: 2xresearchers, 3xPhD students, 1xengineer, 2xpost-docs etc.)

9. What data repositories do you use? Public In house *(✓tick more than one, if applicable)*

9.1. If in-house, please specify:

9.2. If Public, please specify:

10. Do you have easy access to the (meta)data needed for your analysis? Yes No

11. Do you annotate your Data? Yes No

If yes,

11.1. How often? every time sometimes rarely never

11.2. Do you store Data on a standardized format? Yes No *(If yes, please specify)*

12. Do you have a national level GO-like network? Yes No *(If yes, please specify)*

13. In which other GO-relevant initiatives are you involved? *(✓tick more than one, if applicable)*

- GSC Tara Oceans
 Atlantos / GLOMICON Other *(Please specify)*

14. Are you actually running projects that are within the broader scope of GOs? Yes No

If yes, please specify:

What aspects of it do they address? Are they short-term (up to 3 years) or long-term projects?

*There will be two levels of information access: 1. internal ASSEMBLE PLUS and 2. Open-access .
Please specify which (if any) information would you prefer to be withheld only within ASSEMBLE +, (e.g. Question 10)*

