



Topic	H2020 – INFRAIA-2018-2020
Short Title	EUROFLEETS+
Title	An alliance of European marine research infrastructures to meet the evolving requirements of the research and industrial communities
Project Number	824077
Delivery Date	
Deliverable No	D 9.13
Lead Beneficiary	EurOcean
Dissemination Level	Public

Summary achievements and recommendations for policymakers



Document information	
Document Name	Summary achievements and recommendations for policymakers
Document ID	EurofleetsPlus D.9.13 Summary for policy makers V3
Revision	V3
Revision Date	11/11/2022
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Security	Public

Approvals			
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History			
Revision	Date	Modification	Author
V1	30/09/2022	1 st Draft	Sandra Sá
V2	07/11/2022	2 nd Draft	Sandra Sá, Niamh Flavin, Giuseppe Magnifico, Lorenza Evangelista
V3	11/11/2022	Final Version	Sandra Sá, Niamh Flavin, Giuseppe Magnifico, Lorenza Evangelista

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1 List of Acronyms and Abbreviations

Abbreviation	Definition
AISBL	Association Internationale Sans But Lucratif
AUV	Autonomous Underwater Vehicles
DM	Data Management
EVIOR	European Virtual Infrastructure in Ocean Research
EMODnet	European Marine Observation and Data Network
EMSO	European Multidisciplinary Seafloor and water-column Observatory
ERIC	European Research Infrastructure Consortium
EuroArgo	European contribution to Argo programme
F.A.I.R.	Findable, Accessible, Interoperable, and Reusable
GROOM	Gliders for Research, Ocean Observation and Management Infrastructure and Innovation
JRA	Joint Research Activities
NODCs	National Oceanographic Data Centres
RI	Research Infrastructure
ROV	Remotely Operated underwater Vehicle
RV	Research Vessel
SDG	Sustainable Development Goals
SDN	SeaDataNet
SeaDataNet	Pan-european infrastructure for marine and ocean data management
TNA	Trans-National Access
UN	United Nations

2 Introduction

The overall goal for EUROFLEETS+, which commenced in 2019, was to facilitate open free of charge access to an integrated and advanced research vessel fleet, designed to meet the evolving and challenging needs of the user community. This was a huge undertaking with ambitions to enable access to a unique fleet of 27 state-of-the-art research vessels from European and international partners. Through competitive Calls, researchers were able to access the entire North Atlantic, Mediterranean, Black Sea, North Sea, Baltic Sea, Pacific Southern Ocean and Ross Sea.

Built on the achievements of the EUROFLEETS projects, there is a common understanding among the consortium that it is necessary to bring the coordination and utilisation of the European funded activity of the RV fleet up to a new and more sustainable level beyond the project lifetime. The approach, under discussion within the consortium, to achieve this goal is to establish a legal entity, in particular an AISBL (Association Internationale Sans But Lucratif) (see EUROFLEETS+ Deliverable 8.1), named EUROFLEETS Research Infrastructure, that provides a formal structure for cooperating on a pan-European level.

The goal of EUROFLEETS RI will be to facilitate access to unique marine infrastructures to enable excellent research in order to sustainably support healthy oceans, increased cooperation in technical development, and sharing of knowledge in RV operations & management as well as increasing ocean literacy and provide a clear roadmap for the continued integration and advancement of the European RV fleet.

EUROFLEETS RI will play a central role in delivering the European Union Missions by the provision of access to our Seas and Oceans through facilitation of multidisciplinary science teams tackling changing climate, supporting bio-medical research, ocean monitoring, sustainable fisheries and advancing the European Green Deal.

The EUROFLEETS RI design phase will be closed at the end of the EUROFLEETS+ project (October 2023) with the aim of being operational and launching the first EUROFLEETS RI Transnational Access call programme by January 2025.

EUROFLEETS RI wish to continue providing vital necessary Transnational Access programmes utilizing its member's infrastructures to researchers and scientists into the future through funding programmes such as Horizon Europe. EUROFLEETS RI will work together with the European Commission in developing other long term sustainable funding support programmes to facilitate planned access to our Seas and Oceans through access, training and data provision.

3 Contribution of EUROFLEETS+ on Key policy areas:

3.1 Coordination of Ocean observing resources across scientific disciplines

An overarching objective of EUROFLEETS+ was to facilitate interdisciplinary research groups to access European and global seas and oceans to conduct excellent research, with priority given to new users, early-stage researchers, women scientists and researchers from less equipped countries.

The European research fleet is a key research infrastructure, essential for collecting in-situ marine data sets from global oceans, regional seas and coastal waters. Research vessels carry and operate shipborne observation equipment and facilitate deployment and handling of a large range of observing and sampling instruments. Without them, it would not be possible to deploy or service a wide range of observing systems, including moorings, buoys, seafloor observatories, and highly innovative AUVs and ROVs. The fleet thus provides a major platform for important data collection, increasingly functioning as intelligent data and information hubs, interacting with scientists onshore.

Moreover, Research vessels are the primary method of oceanographic observation, through direct observation and via autonomous vehicles.

Recommendations on making better use of existing observation systems and databases:

- Advance cooperation between data providers and data managers to facilitate for data sharing, through web platform/systems like the EUROFLEETS+ developed EVIOR portal
- Support the establishment of transnational and global teams that will enable ocean research making use of the research vessels as a unifying observing platform.
- Establish funding mechanisms for sustained observation systems, including access to research vessels, that are not dependent on short term research projects.

Contribution to UN SDGs:

13 Climate action; 14 Life below water; and 17 Partnerships for the goals.

3.2 Filling critical data gaps in the Ocean observing systems

EUROFLEETS+ has contributed to filling the gaps on marine observations. The development of a range of interoperable and portable tools for deep water research will allow regional vessels to support new developments and efforts in deep water observation and deep-water research.

The open data policy also allows data resulting from the analyses of observations and samples taken by the scientists on board the research vessels is available to others.

Recommendations for filling gaps in ocean observation:

- Implement ship-based observations for ocean and atmosphere data, e.g., Ferrybox systems.
- Improve power sources and broadband services to enable long-term operation and near real-time data transfer.
- Develop a Ship-Time Shop Window for the better visibility and coordination of vessels Schedules for the facilitation of observational data gathering

Contribution to UN SDGs:

13 Climate action; 14 Life below water; and 17 Partnerships for the goals.

3.3 Make available value of data through assimilation into EVIOR

EUROFLEETS+ developed and implemented the EVIOR system where the metadata and data sets, as collected by scientific teams during all the EUROFLEETS+ TNA cruises, are published. This system is integrated with the EUROFLEETS+ website and made available towards the larger community through inclusion in SeaDataNet and EMODnet portals and in a F.A.I.R. way. Therefore, the data management (DM) is deployed in synergy with SeaDataNet and its European network of NODCs.

Scientific cruise teams formulate cruise DM plans for review by SDN NODCs (HCMR, OGS, and RBINS), who coach each scientific team before, during, and after TA cruises. They arrange later validation and archival of cruise data sets by NODCs for long term steward-ship, and publishing. Scientific teams can make use of EMODnet Ingestion for transfer of processed cruise data sets to the NODCs.

Recommendations for ensuring access to multidisciplinary data

- Facilitate for integration of national and international data repositories holding multidisciplinary ocean data.
- Improve protocols for discovery of data, and harmonization of metadata and data formats.
- Provide long-term storage in data repositories with standard interfaces to enable interoperability between the repositories.
- Develop indicators based on data from multidisciplinary data sets.

Contribution to UN SDGs:

13 Climate action; 14 Life below water; 9 Industry, innovation and infrastructure; and 17 Partnerships for the goals.

3.4 Capacity building through skill development and education

Comprehensive training and education activities are taking place in EUROFLEETS+ to: 1. support early-stage researcher's careers and train the next generation of 'blue staff'; 2. increase the participation of less equipped countries and attract women to science; 3. encourage young people to consider science

careers; 4. spread good scientific practices and facilitate exchange of personnel; and 5. attract new users to using the fleet and infrastructure.

Multiple interesting training and education activities were planned, including events on-board vessels and e-learning. By using state of the art communication tools and digital technology, EUROFLEETS+ is enhancing ocean literacy, through engaging with and educating audiences ranging from young children to professionals and the public at large.

Recommendations for improving capacity building and education:

- Support for interdisciplinary projects with training of scientists in Ocean field work and data collection.
- Provide training and education across multi-disciplinary fields as a key to understanding complex ocean systems.
- Investment in a long-term education digital resources hub, building up on the EUROFLEETS+ Ocean Classroom portal

Contribution to UN SDGs:

4 Quality education; 5 Gender equality; 8 Decent work and economic growth; 9 Industry, innovation and infrastructure; 10 reduced inequalities; 13 Climate action; 14 Life below water; and 16 Peace, justice and strong institutions

3.5 International cooperation

Broadening of international cooperation has been achieved through the inclusion of many international partners providing access to infrastructures including New Zealand, Canada and the United States of America. This, coupled with Transnational Access Teams including no less than three different international partners, have ensured that EUROFLEETS+ has fostered and consolidated research partnerships both at a European level and globally. Across all calls in EUROFLEETS+ 33 different nationalities are represented including many international researchers from Algeria, Brazil, Canada, China, Israel, Korea, Morocco, New Zealand, and United States of America with each cruise having an average of five different nationalities working together.

In addition, EUROFLEETS+ has conducted wide stakeholder engagement activities including with pan-EU Research Infrastructures (i.e., GROOM, EuroArgo ERIC, EMSO ERIC), international organisations such as the International Research Ship Operators, and All Atlantic Cooperation for Ocean Research and Innovation.

Recommendations on international cooperation:

- Access to Ocean areas where observations are needed. This means that infrastructure, transport and logistical services must exist to deploy and operate the observing systems in remote areas.

- The full data delivery chain, including research vessels, observing system, processing, dissemination, and management of the data must be established to ensure that data are available for the users.
- Interoperability between different data systems must be improved to establish an integrated Ocean System thus supporting the development of the Ocean Digital Twin.
- Collaboration between countries and institutions should be improved to make best possible use of resources, personnel, and secure continuity of the systems.
- Funding mechanisms to support both development and operation of the research vessels.

Contribution to UN SDGs

9 Industry, innovation and infrastructure; 10 Reduced inequalities; 13 Climate action; 14 Life below water; and 16 Peace, justice and strong institutions.

3.6 Blue Economy

Our oceans are critically important to sustaining the planet. The European research fleet is a key research infrastructure, essential for collecting in-situ marine data sets from global oceans, regional seas and coastal waters. Research vessels carry and operate shipborne observation equipment and facilitate deployment and handling of a large range of observing and sampling instruments. The fleet thus provides a major platform for important data collection, increasingly functioning as intelligent data and information hubs, interacting with scientists onshore. This data and research is essential in supporting the Blue Economy across established sector's such as fishing and aquaculture and emerging sectors such as offshore energy and biotechnology.

Joint Research Activities (JRA), developed with industry partners have focused on data management tools to provide easy access to cruise data expanded satellite communications options for wider dissemination of science, investigate and develop equipment innovations for deep sea operations from research vessels and advance intelligent robot exploration to improve Autonomous Underwater Vehicle technologies.

Recommendations for contributing to the Blue Economy:

- Support and facilitate excellent Marine Science at European and global level
- Collaborate with industry to accelerate new innovations to address current challenges
- Educate the next generation of marine scientists and marine technicians

Contribution to UN SDGs

9 Industry, innovation and infrastructure; 10 Reduced inequalities; 13 Climate action; 14 Life below water;

4 Key Messages for policy Makers

4.1 Providing European researchers and their partners with access to cruises on board high performing RVs must go on

Research vessels are the primary method of oceanographic observation, through direct observation and via autonomous vehicles. Research vessels across Europe, and internationally, provide support for complex, multidisciplinary, multi-investigator research, and include state of the art technology and instruments to serve research and innovation needs for a large number of different end user communities.

Call for Action: Ongoing and better support for integrated and transnational access to research vessels through funding, and a supporting policy allowing the creation of a permanent EUROFLEETS RI.

The new RI will address the users-needs, providing researchers with TNA to RVs and associated equipment/instruments that are not available in their home countries, or that are not supported by national funding already available to the researcher.

4.2 Integration is essential for A European shared strategic vision of the European RV fleets

Ocean science has strongly benefitted from investment in research and innovation, but there is still a lot of scope for better and more efficient use of the existing resources. To better exploit previous efforts and to improve sharing of knowledge for mutual benefits, there is a need for greater integration of existing resources and infrastructure and for integration to be part of the planning for new initiatives. Data integration also requires long-term financial and political support for data repositories in all earth system disciplines.

Call for Action: Greater support for cooperation and collaboration between Infrastructures, data providers, data managers, across regional, national and international scales, to ensure interoperability and standardized methodologies for data gathering, transfer, treatment, storage and retrieval. The proposed EUROFLEETS RI will also play a key role to ensure the coordination of cruise planning and to reduce duplication of efforts, increase the sharing of data, thus broadening the impact of each cruise.

4.3 Ocean exploration must strive for excellent data (EVIOR)

Through the implementation of an active open data management strategy and associated procedures including adoption of SeaDataNet standards. EUROFLEETS+ is ensuring the capture, transmission, and publishing of information about the cruises, their data collection, and involved researchers, and data collected underway and processed later in time.

Call for Action: Greater support for cooperation and collaboration between data providers, data managers, across regional, national, and international scales, to ensure interoperability and

standardized methodologies for data gathering, transfer, treatment, storage and retrieval. The proposed EUROFLEETS RI will also play a key role to maintain the legacy of the web-system EVIOR.

4.4 Capacity building is essential in achieving participatory action and community involvement in observing, in policy development and in implementation

Continuity and longevity in Ocean research require that someone assumes ownership for the system and for the environment. Through its training activities EUROFLEETS+ supports the empowerment of early-stage researcher's careers and is training the next generation of 'blue professionals

Call for Action: Greater support for education programmes developed and implemented by an experienced selection of technical and scientific staff, thereby maximising capacity and adding value. The proposed EUROFLEETS RI will contribute to improving scientific expertise in the field of marine science/research. It will facilitate education and training courses, activities, opportunities, programs, summer schools (both theoretical and practical), not only for young scientists from countries where such facilities are lacking but also for vessel crews, marine instrument technicians, RV operators and other shore-based staff who are vital to planning and executing RV cruise activities.

4.5 Greener and more sustainable RV and underwater vehicle operations and design must be supported

EUROFLEETS+ has contributed to a better understanding of potential environmental impacts of RV operations, both for the RV operators, the vessel crews and the scientific parties on board, and what could be done to minimize or even eliminate such potential negative consequences. The guidelines which have been developed shows to the RV owners and operators several ways they can reduce the environmental impact of the operation of their existing RVs and also with regards to designing new RVs as "green" as possible.

Call for action: Endorse and support the adoption of the EUROFLEETS+ guidelines and recommendations on the new built thus contributing positively to the necessary environmental protection and climate preservation. Support research and development projects for eco-designed and eco-responsible European RV fleets of the 21st century.

5 Conclusions

Dialogues on the political level and at the science-policy interface have started to turn towards the actions required to deal with our ocean rather than the knowledge needed to understand it. This is a positive step in the right direction, but one step cannot replace the other. It is not unusual to hear statements claiming we have enough scientific knowledge, and now it is time to act, but the science must go hand in hand ...

Science, and ocean observation and monitoring, are dynamic. Data represents a point in time. Excellent data sets allow for the extraction of knowledge of the geographical and temporal scope of trends and patterns in the environment, but excellent datasets are not the norm.

For the foreseeable future, research vessels will be the primary infrastructure of oceanographic observation, through direct observation and via autonomous vehicles. Research vessels across Europe, and internationally, provide support for complex, multidisciplinary, multi-investigator research, and include state of the art technology and instruments to serve research and innovation needs for a large number of different end user communities.

Now is not the time to slow down Ocean observation efforts, not only because of their critical implications for understanding climate change, but also given the momentum of Ocean advocacy and cooperation.

The key messages for policy makers from the EUROFLEETS+ project are as follows:

- Providing European researchers and their partners with access to scientific cruises on board high performing RVs must go on
- Integration is essential for A European shared strategic vision of the European RV fleets
- Ocean exploration must strive for excellent data (EVIOR)
- Capacity building is essential in achieving participatory action and community involvement in observing, in policy development and in implementation
- Greener and more sustainable RV and underwater vehicle operations and design must be supported