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D9.14 Final Report on promoting the Marine Science Technology Synergies

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Introduction

This report aims to provide an overview of strategies and initiatives to promote synergies in Marine Science Technology by the Eurofleets+ Consortium in Period from February 2022 to October 2023. Previous activity has been reported in Deliverable 9.9 *Interim Report on promoting the Marine Science Technology Synergies*. During this period Eurofleets+ focused on building synergistic connections, associations and relationships with key partners pertinent to the development of a Eurofleets Research Infrastructure.

Eurofleets Research Vessels play a central role in provision of access to our Global Oceans and Seas. As a result, one of its key objectives is to ensure that it not only explores, develops but promotes Marine Science Synergies across all stakeholders to ensure that all vessels can respond to Users' needs.

The global landscape of marine technology has witnessed a remarkable surge in innovation, driven by the pressing need to address critical environmental, economic, and societal challenges. Eurofleets+ has sought to develop and grow synergies within marine technology, exploring the interconnectedness of various disciplines, industries, and methodologies.

Marine science and technology play a pivotal role in understanding, managing, and conserving our oceans and coastal environments. The integration of cutting-edge technologies has the potential to revolutionize research, exploration, and sustainable resource management in marine ecosystems. This report outlines key strategies to enhance synergies in this domain.

Recognising the critical importance of marine ecosystems and the potential for technology to drive advancements in this field, Eurofleets+ engaged with academia, industry, industrial partners and other initiatives to foster collaboration and innovation.

This report describes new synergies developed since February 2022 and on the further development of established collaborations with roadmaps for continued longer term fostering of partnerships until 2028 and beyond.

1 Establishment of Cross-Sectoral Partnerships

Eurofleets+ has focused on fostering collaboration between government agencies, academia, research institutions, and private industry to pool expertise, resources, and technologies to better advance Marine Technology and knowhow. This strategy has been developed with the intention to avoid duplication of efforts, delivering more significant impacts, facilitate platforms for knowledge exchange, joint projects, and shared infrastructure to accelerate technological advancements. Research Vessels (RVs) and their operators provide access to state-of-the-art mobile platforms to enable cutting edge research, testing and prototype development.

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Building toward a Eurofleets RI the key missions of the Infrastructure will be to provide easy access to up-to-date information on the European RV Fleet: maintaining and validating European RV and LEXI information in the EurOcean research infrastructure database, hosting technical groups and supporting R&D projects for low emissions RVs operation. Provision of education and training courses, activities, opportunities, programs, summer schools, etc. (both theoretical and practical). Additionally, building a European shared strategic vision and sharing that vision with funding agencies, key stakeholders and marine science communities as well as other relevant stakeholders to identify key funding needs.

Eurofleets+ developed a strategic plan focusing on key areas by which to further develop partnerships to deliver on the not only the Eurofleets+ vision to Provide single point open access to European funded activity of research vessels to deepen knowledge of our seas and oceans.

Investment in Research and Development:

To date Eurofleets+ funding for access to Research Vessels (RVs) and Large exchangeable equipment (LEXIs) and supporting activities since 2009 to 2023 has enabled 677 days at sea for hundreds of marine scientists and many more have also taken part in training provided by the projects. Although the Transnational Access (TA) offered in Eurofleets has been funded by the European Commission, the Vessels, Equipment, crew, technicians and support staff are predominantly funded by state or research intuitions. Without this continuous investment by national funders, programmes such as Eurofleets TA could not take place. Working in partnership with the European Commission, Eurofleets RI has an opportunity to further strengthen the European Research Area through the provision of TA to scientists to explore new ways of working together for better results. Two upcoming Horizon Europe projects outlined in section 2, AQUARIUS and AMRIT are examples of how such investment can be exploited for the betterment of marine research and paving the way towards new research pathways by combining the RI's in TA programmes.

Promoting Open Data and Standards:

Eurofleets+ facilitated open free of charge access to a unique fleet of state-of-the-art research vessels, Autonumous Operated Vehicles (AUVs) and Remotely Operated Vehicles (ROVs) from European and international partners. A Data Policy was adopted which aimed at making Eurofleets+ research data **f**indable, **a**ccessible, **i**nteroperable and **r**eusable (FAIR). Therefore, data management was an integral part of the Eurofleets+ workplan, and different contributing activities were deployed in multiple work packages, in particular WP3, WP4 and WP9.

A major objective of the Eurofleets+ data management strategy was to ensure that metadata and data of all TA cruises would become available for publishing and wider distribution through leading European infrastructures for marine and ocean data, such as SeaDataNet, and EMODnet.

To achieve this a number of activities were undertaken:

- Upgrading the Eurofleets Automatic Reporting System (EARS) software for administering metadata and data during cruises
- Arranging transfer of underway metadata and data during cruises to a data hub onshore

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- Deploying and configuring the EARS software onboard of Research Vessels
- Inclusion and publishing of received metadata and data streams at a dashboard on the EVIOR platform
- Follow-up of data management after cruises by National Oceanographic Data Centres (NODCs) with TA teams
- Inclusion of cruise metadata and data in SeaDataNet and feeding EMODnet thematics

Coordinated by UTM-CSIC, the 3 partners UTM-CSIC, RBINS, and IFREMER have upgraded the existing EARS (Eurofleets Automatic Reporting System), as earlier developed in previous Eurofleets project, and made it more robust. First an EARS V2 was released, later followed by EARS V3 around the middle of 2021. The EARS upgrading focused on several aspects from optimizing the data acquisition system to adoption of a new data model and web services to simulations and field trials to drafting full documentation and guidelines for installation and configurations. EARS, once installed on a Research Vessel, has been instrumental for gathering, partly automatically and partly manually, the full set of cruise data that is acquired during the operations of an Eurofleets+ TA cruise, namely metadata and data from:

- en-route (underway) data from fixed sensors, such as navigation, meteo sensors, and salinometer;
- human operations, such as CTD profiles, and also including samples (water, sediment, and biota) which are partly processed at the onboard laboratories and partly later at shore;
- long-term timeseries by sensors deployed on frames, ROVs, AUVs or floats.

For arranging the transfer of metadata and data from sailing RVs to the shore, a cooperation and synergy has been established with SeaDataNet and the EMODnet Ingestion project. In practice, the Sensor Web Enablement (SWE) toolkit, earlier developed as part of SeaDataNet, has been adopted and adapted by 52N, partner in EMODnet Ingestion, to give e-access to underway and operational information and data from sailing RVs. SWE allows Real Time en-route (navigation, meteo and thermosalinometer) data for each RV. As part of the toolkit a central data hub is provided that has been configured at CSIC together with a dashboard for displaying data from connected RVs. The access to the dashboard has been integrated in the Eurofleets+ **EVIOR - European Virtual Infrastructure in Ocean Research** platform, which is a component in the Eurofleets+ website.

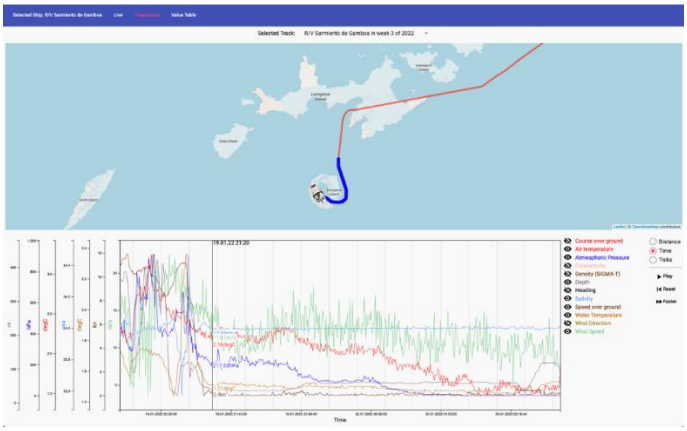

Figure 1- Trajectory Dashboard at CSIC and EVIOR platform for presenting Underway Data from research vessels, while sailing and in the port.

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Figure 2- Live Dashboard at CSIC and EVIOR platform for presenting Underway Data from research vessels, while sailing and in the port.

The central DataHub at UTM-CSIC (Spain) has been receiving underway data sets (navigation, meteo, and salinometer data) from the RVs, equipped with the EARS system, in Real-Time, and allowing underway data transfer.

RBINS and UTM-CSIC have organized workshops and bilateral webinars with RV operators for introducing the EARS software and how to install and configure it at RVs. In later version, a method of Docker containers has been introduced which has lowered the threshold. Furthermore, webinars were organized for informing and training TA scientific teams in using the EARS system and its User Interfaces, both on a laptop as by means of an app on their phones or tablets. As a result, the EARS software has been deployed at multiple RVs during the full Eurofleets+ project, namely EARS V2 at 4 RVs and EARS V3 at 10 RVs, in support of the data management during cruises. For other RVs it was not possible to equip them with EARS for technical, logistic, and policy reasons.
An overall workflow has been designed for the Eurofleets+ Data Management, illustrated in the following image from sailing vessel to the EVIOR platform.

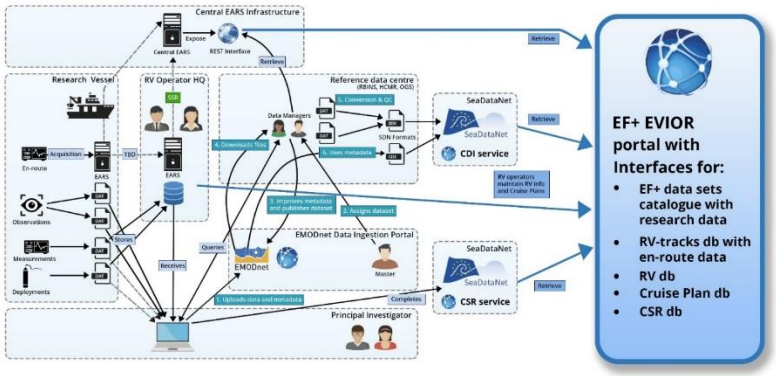

Figure 3- Eurofleets+ data management workflow

En-route metadata and data from the EARS system at research vessels is transferred to the dataHub managed by CSIC who ensures publishing of the received information by means of a **Dashboard** at the **EVIOR portal**.
Narratives about all scheduled TA cruises have been gathered from the TA cruise teams for publishingat the Eurofleets+ website and included in the **Eurofleets+ data sets catalogue** at the **EVIOR portal**.

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Cruise Summary Reports (CSR) are prepared by Principal Investigators of cruises with coaching by SeaDataNet NODCs and managed by IFREMER for publishing through the **SeaDataNet Cruise Summary Report catalogue** and included in the **EVIOR portal** and its **Eurofleets+ data sets catalogue**. A further cooperation and synergy was arranged from Eurofleets+ with **EMODnet Ingestion** and **SeaDataNet** for handling the actual metadata and data flows and elaborating received data sets to common standards for inclusion in SeaDataNet and EMODnet. TA scientific teams did not only acquire underway data sets, but also took various other observations, such as bathymetric surveys and collecting samples which require further processing afterwards with dedicated equipment and/or in laboratories. Therefore, three National Oceanographic Data Centres (NODCs), who are members and nodes of the pan-European SeaDataNet infrastructure for marine and ocean data management, and also partner in Eurofleets+, namely RBINS, HCMR, and OGS, were assigned to give a data management follow-up. They worked together with the TA cruise scientific teams in an early stage to prepare Data Management Plans (DMP).

As a next step, they coached the TA cruise scientific teams for deploying those DMPs, aiming at using EARS facilities during the cruises and at retrieving afterwards metadata and data sets for long term stewardship and publishing of the Eurofleets+ cruise results by these NODCs. As one means for transfer of metadata and data it was recommended to the TA scientific teams to make use of the **Data Submission Service of the EMODnet Ingestion portal,** which facilitates to submit data set packages together with some documentation. The received suibmissions are then assigned by EMODnet Ingestion to the three NODCs taking int account their division over Eurofleets+ TA cruises. The submissions are published in two stages, first 'as-is' and in a later stage, where possible, as elaborated, once the metadata and data have been converted to prevailing standards and included in SeaDataNet and EMODnet. As an other alternative, TA scientific teams were recommended to make use of the **SeaDataNet SEANOE service,** which facilitates to submit a (preliminary) paper on the cruise combined with associated data sets. This is then published at the SeaDataNet portal with a landing page, whereby the researchers also get an DOI for data citing purposes. There is an exchange in place between SEANOE and EMODnet Ingestion, arranging that all Eurofleets+ SEANOE submissions are also forwarded to EMODnet Ingestion for the following steps towards publishing in EMODnet and SeaDataNet.

These facilities are well used by the Eurofleets TA scientific teams and are resulting in a steady flow and progress of making the TA cruise results published and included in SeaDataNet and EMODnet, although it can be in selected cases with embargo's on access to the actual data. Eurofleets+ allowed for embargo's of maximum 2 years in order to give the researchers sufficient time for further processing of observations and samples and for preparing their scientific publications. However, the assigned NODCs are trying to get as much as possible already data sets, even if under embargo, just to live up to the Eurofleets+ agreements for cruises and to safeguard the data and metadata in an early stage.

To keep track of the progress with this data management follow-up a **Cruise Data Sets Catalogue service** was added to EVIOR, which gives information per TA cruise, including the various links to Cruise Summary Reports, publications in EMODnet Ingestion and SEANOE, and inclusions of elaborated data sets in SeaDataNet and EMODnet thematics.

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Overall, the strategy applied for the Cruise Data Management has been successful, and metadata and data for most of the TA cruises has been received so far, while there are also cruises for which this is still ongoing, partly due to late cruise dates and partly due to time needed for processing observations and samples by the TA scientific teams.

The DM methodology and also the use of EARS software have proven themselves as feasible and practical, and these will be promoted to new projects which include comparable TA activities. A good example is the forthcoming AQUARIUS project that will start in 2024 and which will encompass TA Calls for a range of Research Infrastructures, also including RVs. The approach as developed and tested in Eurofleets+ has been fully adopted in the AQUARIUS proposal and that project will give additional opportunity for refining the methodology, taking into account the lessons learned in Eurofleets+ as well as the new challenges in AQUARIUS with data streams from multiple types of RIs.

Capacity Development Through Collaboration

Joint Research Action 3.2 Equipment innovations for deep sea operations from vessels focuses on improved capability for regional vessels and improving sustainability. Exploration of the deep sea is a major challenge and opportunity in marine research. Rigs and related technologies are fundamental to the study of the sea as they are needed to deploy equipment. In collaboration wtih industrial partners Ferri SA Eurofleets+ developed a design for repurposing a Knuckle-type crane which are common on ships, especially those dedicated to oceanic and marine research. These cranes provide flexibility and versatility in cargo handling, as their articulated design allows for more complex and precise movements compared to fixed cranes. The project with Ferri SL involved obtaining detailed design with drawings, specifications, calculations, and plans. A conceptual design was created where Eurofleets+ vessel operators provided feedback to ensure that the design would meet their needs of increasing the capacity of their Research Vessels, especially smaller regional type vessels or older vessels in the fleet. This design should allow this type crane to be used for the deployment of other equipment, especially the operation of the piston corer. Collaborations such as these built through European Funded projects such as Eurofleets+ demonstrates to industry the benefits and opportunities available through working with the European Research Community.

Autonomous Underwater Vehicles (AUVs) and Remotely Operated Vehicles (ROVs):

JRA 3.3 Intelligent robot exploration explores innovative methods and strategies for intelligent exploration, mapping and control using cooperative navigation. New technologies for Autonomous Surface Vehicles (AUVs) and Autonomous Underwater Vehicles (ASVs) are being developed and the innovations will be validated prior to field testing during operational cruises. These activities involve researchers from academia and industry working closely together and interaction with innovation and exploitation activities, and remote access. Eurofleets+ developed synergies with EUMarineRobots (EUMR) on number of levels. Several surveys have been carried out within Eurofleets+ using the Sparus AUV owned by UdG to test the intelligent navigation strategy of JRA3.3 Intelligent robot exploration. Eurofleets+ JRA 3.3 innovations have paved the way towards a collaboration with DKFI Robotics Innovation Centre in Bremen (P.I. Thomas Vögele) for using the autonomous navigation capabilities of AUVs in the experiments that EU project DEEPERSENSE will carry out by the end of 2023 using a Girona-1000 AUV equipped with a side-scan sonar for seafloor mapping and characterization.

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Knowledge Transfer & Dissemination:

Recognized mechanisms to transfer technological know-how from within the marine science community have been exploited to the fullest by the Eurofleets+ beneficiaries throughout the lifetime of the project. Channels utilised include organizing and participation in workshops, conferences, and training programs to disseminate knowledge and skills related to all of the work carried out in the Eurofleets+ project. A full report on all Knowledge Transfer & Dissemination can be found in D9.16 Dissemination and communication impacts report, including case studies.

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2 Eurofleets+ Synergies with European Funded Projects

GROOMII	Gliders for Research, Ocean Observations and Management II
Lead Partner	ENSTA Paris
Website	https://www.groom-ri.eu/
Funder	H2020
Synergies	Best Practices on data interoperability and metadata standardization; Sharing experiences and skills in integrating data through a federated sustainable approach; Sharing relevant information and available materials for the implementation and the operation of core services to users; Discussing innovation in e-science and in IT systems development for the hosting and operation of core services; Optimizing planning and operations of MAS and research vessels; Developing calibration and other operational services for both Parties' members and users; Developing joint training activities based on the common requirements of the members and users of both Parties.
Established Collaboration Pathway	MOU signed between ENSTA Paris representing the GROOM consorita and MI representing Eurofleets+ consortia to facilitate cooperation. This MoU defines the roles and relationship between GROOM II and EUROFLEETS+ consortia. It will help provide clarity on the respective roles in contributing to the development of the European Ocean Observing System (EOOS). The MoU also provides the basis to increase collaboration between both groups and reduce the complexity in the EOOS landscape. It will be a tool for fostering contributions of both projects to the ENVRI cluster.

EuroGOSHIP	Euro GO-SHIP: developing a Research Infrastructure concept to support European hydrography
Lead Partner	NORCE
Website	https://eurogo-ship.eu/
Funder	HORIZON Europe
Synergies	Research vessels are essential platforms for the hydrographic community. EuroGOSHIP and Eurofleets+ have engaged through a stakeholder process and plan to develop collaborative working groups related to best practice, training, access to facilities and ship design to ensure that the European Research Vessel fleet can better meet the needs of the hydrographic community.
Established Collaboration Pathway	Linked with WP 5 RI Structure, Governance & Financial Model of the EuroGOSHIP project Eurofleets RI will continue to work with the hydrographic community in the development of a closer collaborative partnership.

MISSION Atlantic	Towards the Sustainable Development of the Atlantic Ocean: Mapping and Assessing the present and future status of Atlantic marine ecosystems under the influence of climate change and exploitation
Lead Partner	DTU

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Website	https://missionatlantic.eu/
Funder	HORIZON 2020
Synergies	Seeking to improve existing approaches to sustainably managing ocean resources. RV's seen as key stakeholders in delivering this mission.
Established Collaboration Pathway	Linked with WP4: Benthic Mapping: ecosystem resources and pressures to aid in the planning of RV's in the development of a cohesive strategic mapping approach to support IEA through multidisciplinary seafloor bathymetry and benthic habitat data acquisition and dissemination, particularly in data poor regions.

2.1 New Horizon Europe Projects 2024-2028

AQUARIUS	**Aqua Research Infrastructure Services for the health and protection of our unique, oceans, seas and freshwater ecosystems**
Lead Partner	Marine Institute
Partners	FMI, **CSIC, HCMR, IMR, GRNI**, SSBE, HEREON, **AWI**, UL, INCDM – NIMRD, **MARIS**, **SYKE, CNR**, CzechGlobal, NIVA, **RBINS, VILZ,** EMBRC, CCMAR, CCIMAR, MERCATOR, EMBL EBI, SMHI, IRD, ULIEGE, INGV, IH, NORCE, Plocan, **SOCIB**, VITO, **EMSO ERIC**, **GEOECOMAR, FMRI**, INPA, INKODE, **OGS, IFREMER, MFRI,** UPC, **NIOZ, Tubitak** and SLU. **Eurofleets+ partners in bold, with Eurofleets+ NODC's underlined*
Duration	2024-2028
Funder	HORIZON Europe
Synergies	For the first time, diverse research infrastructures will be combined to facilitate the work of researchers and key stakeholders focused on challenges and opportunities for both marine and freshwater systems. An impressive range of research infrastructure services will be made available to include research vessels, mobile marine observation platforms, aircraft, drones, satellite, sensors, fixed freshwater and marine observatories and test sites, experimental facilities, and sophisticated data infrastructures. The AQUARIUS project will build on the legacy of projects such as EuroFleets (1 and 2) and EuroFleets+; JERICO, JERICO-NEXT, JERICO S3, EUFAR, EUFAR2; DANUBIUS (DANCERS, DANUBIUS-PP, DANUBIUS-RI); EMSO-ERIC (EMSO-PP, FIXO3, EMSO-Link, EMSODEV).
Established Collaboration Pathway	Marine Institute as Co-Founder of Eurofleets RI and Coordinator of AQUARIUS will ensure that the logistics of integrating access to different types of research infrastructure can be addressed, and that users of the infrastructure are fully supported in implementing their research and innovation projects. Capacity building – Training.

AMRIT	**Advance Marine Research Infrastructures Together**
Lead Partner	ARMINES
Partners	Brings together partners from ICOS ERIC, EURO-ARGO ERIC, EMSO ERIC, established as European Research Infrastructure Consortium and projects such as JERICO RI, Eurofleets+, GROOM RI, and later EUMR2, MINKE and EuroGO-SHIP.
Duration	2024-2028
Funder	HORIZON Europe

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Synergies	The objective of the AMRIT Project is that a more synergistic functioning of MRIs for sea operations and data collection to build up the European Ocean Observing System thus benefiting the European Research Area, Copernicus Marine Service, and the Blue Economy. This includes both Research Vessels and many of the associated Large Marine Equipment and mobile platforms deployed from vessels.
Established Collaboration Pathway	The AMRIT work plan aims to • ensure seamless operation of marine observation platforms to guarantee a) the deployment of increased observing capacity and b) synergies across MRIs and an overall cost optimisation through federated tools and services. • ensure that a) the life cycle of observing platforms and sensors is properly managed at any stage, in particular for calibration, circular management when applicable, and b) the development of the next generation of sensors matching the scientific needs can be used without delay on all relevant types of platforms; • exploit the complementarity of the various platforms in order to tend towards coherent and relevant resolution for the observation of the EOVs; • ensure the overall coherence of the data value chain to guarantee operational and long-term data provision, in line with the needs of the ERICs, Copernicus Marine Service and other Copernicus Services, the development of EOOS and the ability to adapt to new needs

POLARIN	**POLAR RESEARCH INFRASTRUCTURE NETWORK**
Lead Partner	AWI
Partners	UOULU, INPA, ULUND, **CNR**, **OGS**, INKODE, AU, CNRS, UCPH, EPB, ETT, UIT/APECS, **CSIC**, SIOS, NILU, NASC, IGOTUL, FLPO, INACH, GFZ, **DTU**, IPEV, PONANT, **MFRI**, **GINR**, MCIN, SPRS, SSLC, DMI, ULAVAL, UTU, NPI, UGRAZ, SAVN, RIF, SU, AMU, ARI, IGFPAS, UMK, UAF, **MI**, UKRI, UH, **FMI**, BAI, UICS, CAFF & TARA. **Eurofleets+ partners in bold, with Eurofleets+ NODC's underlined*.
Duration	2024-2028
Funder	HORIZON Europe
Synergies	POLARIN's overall aim is to provide efficient and customised research infrastructure (RI) services to address the scientific challenges of the polar regions, including access to a wide portfolio of complementary and interdisciplinary top level RIs including Research Vessels.
Established Collaboration Pathway	Many Eurofleets+ Research Vessels included in the POLARIN project, will provide key access to services to enable access to Polar regions. This project enables the continuation of the collaborations established in Eurofleets II, expanded in ARICE project. Additionally, a system developed for automation of Transnational Access provision for INTERACT Access project will be adapted and updated an implemented by both POLARIN and AQUARIUS thus further developing the tool leveraging previous funded development by the European Commission.

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3 Research Infrastructures, Key Networks and Organisations

SeaDataNet	Marine Data Infrastructure
Members	**AWI**, DELTARES, ENEA, ETT, FMI, **HCMR, IFREMER**, IHPT, IMB-MNE, **IMR**, INGV, INSTM, IO-BAS, IOF, IOLR, **IOPAN**, LHEI, **MARIS**, **MFRI, MI**, MSI-TALTECH, NIB, NIMRD, **NIOZ,** NOC-BODC, **OGS,** ORION, **RBINS,** RIHMI-WDC, SMHI, TSU DNA, UM, **UTM CSIC** and **VLIZ**. **Eurofleets+ partners in bold, with Eurofleets+ NODC's underlined*
Website	https://www.seadatanet.org/
Sector	Data Processing, visualisation and management.
Status	AISBL
Synergies	Eurofleets+ Research vessels and SeaDataNet are both crucial components of marine research and data management. They work together to enhance our understanding of the oceans and their ecosystems.
Established Collaboration Pathway	Eurofleets+ data management aims to publish the metadata and data sets collected by scientific teams during all the Eurofleets+ TA cruises through inclusion in SeaDataNet portals and in a F.A.I.R. way. This has been achieved through three selected NODC's within Eurofleets+ project that has established the pathway which can be exploited for future funded TA programmes. It ensures data quality, accessibility and interoperability to support policy making decisions.

EMODnet	European Marine Observation and Data Network (EMODnet)
Members	A full list of EMODnet partners, data providers and associated partners can be found here: https://emodnet.ec.europa.eu/en/partners-list
Website	https://emodnet.ec.europa.eu/en
Sector	Marine and environmental data management
Status	Partnership
Synergies	Eurofleets+ and EMODnet work together to ensure that marine data is collected, managed, and disseminated effectively. Their collaboration enhances our collective ability to understand, protect, and sustainably manage marine environments.
Established Collaboration Pathway	Eurofleets+ data management aims to publish the metadata and data sets collected by scientific teams during all the Eurofleets+ TA cruises through inclusion in EMODnet portals and in a F.A.I.R. way. The majority of RV operator organisations are EMODnet partners. This will continue to ensure that all data collected through funded TA is submitted to EMODnet.

EURAF	EUropean Facility for Airborne Research
Members	Belgium, Canada, Denmark, Estonia, Finland, France, Germany, Iceland, Ireland, Latvia, Lithuania, The Netherlands, Norway, Poland, Portugal, Russian Federation, Spain, Sweden, United Kingdom, United States of America
Website	https://www.eufar.net/

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Sector	Pan-European Portal and Network For Airborne Research Infrastructures Dedicated To Environmental Sciences.
Status	Research Infrastructure - AISBL
Synergies	Research vessels and research aircraft play crucial roles in advancing environmental science by providing unique capabilities for data collection in different environments. When used in tandem, they can offer complementary advantages, enhancing our understanding of various natural systems
Established Collaboration Pathway	Established cooperation with EUFAR and Eurofleets+, with Aodhán Fitzgerald sitting on the EUFAR Advisory Board provided the connection with the community when the AQUARIUS concept was developed. The AQUARIUS project includes several aircraft and drones (EUFAR partners) which will be offered alongside other infrastructures such as Research vessels to further develop collaborative research such as Spatial Coverage, Vertical Profiling, Ocean-Atmosphere Interactions, Remote Sensing Calibration and Validation, Habitat mapping etc.

ICES	**The International Council for the Exploration of the Sea (ICES)**
Members	Belgium, Canada, Denmark, Estonia, Finland, France, Germany, Iceland, Ireland, Latvia, Lithuania, The Netherlands, Norway, Poland, Portugal, Russian Federation, Spain, Sweden, United Kingdom, United States of America
Sector	Intergovernmental marine science organization, meeting societal needs for impartial evidence on the state and sustainable use of our seas and oceans.
Status	Global Organisation
Synergies	The Data Science and Technology Steering Group look at New methods, systems and devices that are transforming human interactions with the sea and our capacity to collect, quality assure and analyse the data needed to assess and understand ecosystems and the effects of human activities and pressures. Research Vessels are a key access point to our seas and oceans and ICES have a number of Working Groups dedicated to activities on vessels and how they operate
Established Collaboration Pathway	Working Group on Greening the Research Fleet (WGGRF) Co-Chaired by Aodan Fitzgerald, Eurofleets+ Coordinator Consolidates and distributes knowledge and best practice regarding environmentally sustainable design, build, and operation of research vessels. The group reviews and reports on emissions of selected international operating research vessels (case studies) and their environmental impact. They also review the renewal profile of the fleet, as well as relevant International Maritime Organization (IMO) and other regulations. Further, WGGRF identifies and publishes best practice and general recommendation for new builds/refit and low-emission operation of research vessels. Their work will support the ambition of ICES on developing science that informs and support the scientific community to reduce its environmental impact, with emphasis on emissions.

ERVO	**European Research Vessels Operators group**
Members	AFBI, AWI, CEFAS, CNR, CSIC, DTU, ECPI, FMRI, GDA, GEOECOMAR, GEOMAR, HCMR IFREMER, IMR, INFOMAR, IPMA, MAPYA, Marine Scotland, MFRI, MI, NCL, NERC,

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	NIOZ, OGS, RBINS, SLU, SOCIB, SYKE, TUBITAK, UA, UGOT, Uni Malta, and VLIZ
Sector	Marine Research
Status	European Network
Synergies	ERVO meetings address common issues/problems that affect research vessel operators for the purpose of identifying solutions for improving services to the scientific community and developing best practice in the operation of Research Vessels. Members present their National Reports on activities, including any future plans for acquisitions/upgrades. ERVO meetings also facilitate invited guests from industry to present new developments and technologies of key interest to Research vessels. Many challenges identified through ERVO working groups have been addressed across the Eurofleets projects.
Established Collaboration Pathway	Eurofleets+ and its beneficiaries have long established relationships within the ERVO community, with an update on the project provided at each general meeting. Participation in working groups on Spare Capacity and hosting webinars to inform members of the status and progress towards a Eurofleets RI have also taken place. Additionally, it is proposed that the Eurofleets RI would become the ERVO Secretariat when established.

IRSO	**International Research Ship Operators group**
Members	IRSO members include national research organizations, from Argentina, Australia, Belgium, Brazil, Bulgaria, Canada, Chile, China, Denmark, Finland, France, Germany, Greece, Iceland, India, Indonesia, Ireland, Israel, Italy, Japan, Kenya, Korea, Netherlands, New Zealand, Norway, Portugal, Romania, Russia, South Africa, Spain, Sweden, United Kingdom, and USA. Intergovernmental Organizations include JCOMMOPS and International Hydrographic Organization. Companies and Commercial participants are also invited to meetings on an adhoc basis.
Sector	Marine Research
Status	International Network
Synergies	IRSO promotes the safe, efficient and environmentally responsible operation of research ships in support of the global marine scientific research community. The annual meeting provides a forum to share professional information and best practice regarding design, management and operation of research ships and associated scientific equipment; explore and develop opportunities for sharing and/or exchanging ship time, personnel, instruments and equipment and benchmark their research ship and associated equipment operations with other comparable operators.
Established Collaboration Pathway	Eurofleets has actively participated and been showcased at each of the last four IRSO meetings. In addition, the ICES Working Group on Greening the Research Fleet (WGGRF) Co-Chaired by Aodan Fitzgerald was recently held at the annual meeting in October 2023. The announcement of the establishment of a Eurofleets RI was also made and an update on progress will be made at the meeting in 2024.

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EUROGOOS	European Global Ocean Observing System
Members	EuroGOOS is an association of national governmental agencies, research organizations, and private companies, committed to oceanography within the context of the intergovernmental Global Ocean Observing System (GOOS).
Sector	Ocean Observing
Status	AISBL
Synergies	EuroGOOS also maintains a number of operational Task Teams which oversee the technical networks of ocean observation platforms throughout Europe. Eurofleets+ RVs both operate, own, deploy, service and maintain many of these fixed and mobile platforms across Europe.
Established Collaboration Pathway	The EuroGOOS Task Team is Co-chaired by WP 8 leader from CNR and WP 5 Leader EMSO ERIC. The link to this task team is significant as it is important operational components of the EOOS framework setting out a vision and coordination mechanisms for a truly integrated ocean observing in Europe, for the benefit of society, science and innovation. Work with the task force will be continued through the Eurofleets RI once established in 2024.

BEERI	Board of European Environmental Research Infrastructures
Members	ACTRIX, ARISE, EISCAT 3D, EUFAR, HEMERA RI, IAGOS, ANAEE, DISSCO, EMPHASIS, INTERACT, EIRO-ARGO, EUROFLEETS+, GROOM RI, JERICO RI, SEADATANET, SPOS, EuroGOOS, ICOS RI, IS-ENES, SIOS, AQUACOSM, DANUBIUS-RI, eLTER RI, EMBRC, LifeWatch ERIC and EMSO ERIC
Sector	Environmental Research Infrastructures
Status	Network
Synergies	The Board of European Environmental Research Infrastructures (BEERI) acts as a coordinating body for the cluster of environmental RIs. It delivers a range of benefits for the participating RIs that includes sharing of perspectives across the different domains, adopting common strategies for engaging with selected activities and opportunities, and acting as a unified voice for environmental research infrastructures in Europe. The BEERI as the European Commission's main partner for a dialogue with the environmental cluster.
Established Collaboration Pathway	Marine Institute will continue to represent the Eurofleets community until 2024 at which point it will pass to the Eurofleets RI. The BEERi provides opportunity for collaboration with both and projects that have been funded under Horizon Europe to strengthen the ERA and in particular the Environmental Research landscape.

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4 Training Partnerships

POGO	Partnership for Observation for the Global Ocean
Members	POGO has 55 members across 30 countries
Sector	Ocean Observation
Status	Partnership
Synergies	POGO has three main activity pillars, one of which is Capacity development that includes Ship Board Training. Eurofleets+ Partnered with POGO utilizing spare berths onboard both Eurofleets+ research vessels during the lifetime of the project. This partnership has built a robust pathway for access to Eurofleets+ vessels for POGO Shipboard Training Fellowships.
Established Collaboration Pathway	The partnership established will be further developed with the inauguration of the Eurofleets RI, where spare capacity onboard vessels will be logged and made available to POGO to match with the existing database of selected candidates.

EURO ARGO	EURO ARGO ERIC
Members	12 members across Europe, Bulgaria, Finland, France, Germany, Greece, Ireland, Italy, Netherlands, Poland, Uk and Spain
Sector	Ocean Observation
Status	European Research Infrastructure Consortium
Synergies	Collaboration between vessel operators and Argo float operators can enhance the efficiency and effectiveness of oceanographic research and data collection efforts, leading to a better understanding of our oceans and their role in the global climate system. Areas such as deployment expertise, maintenance and recovery operations and training and capacity building being particularly relevant.
Established Collaboration Pathway	A pilot training module took place during the RV Dallaporta Floating University in September 2022 where a representative from EURO ARGO ERIC joined lectures from CNR to provide both classroom based teachings and Euro-ARGO floats programming, deployment, and recovery. This highly successful collaboration will be further developed through Eurofleets RI with a vision for a floating university dedicated to mobile platform deployments.

AAFUN	All Atlantic Floating University Network
Members	Canada, Cape Verde, COTE D'IVOIRE, Egypt, Germany, Ireland, Morocco, Namibia, Portugal, Spain, South Africa, UK and Uruguay. Projects/partnership members POGO, Eurofleets+ and AIR Centre.
Sector	Joint Pilot Action on Capacity Development (AA-TP)
Status	Project
Synergies	Training at sea is critical for preparing the new generations of Early Career Ocean Professionals. Multiple training at sea opportunities and programs are in operation globally that target different needs and requirements for different academic and industrial sectors. To strengthen and develop further training at sea in the Atlantic region, greater exchange and collaboration between new and existing programs is essential, including sharing of best practices.

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Established Collaboration Pathway	Eurofleets has a long established Floating University programme, and will share the knowledge developed over the last 13 years with AAFUN to enable capacity building across other research vessels and countries. Additionally, through Eurofleets RI space on future Eurofleets RI Training initiatives will be offered through AAFUN in order to reach participants from less developed countries of countries will less capacity.

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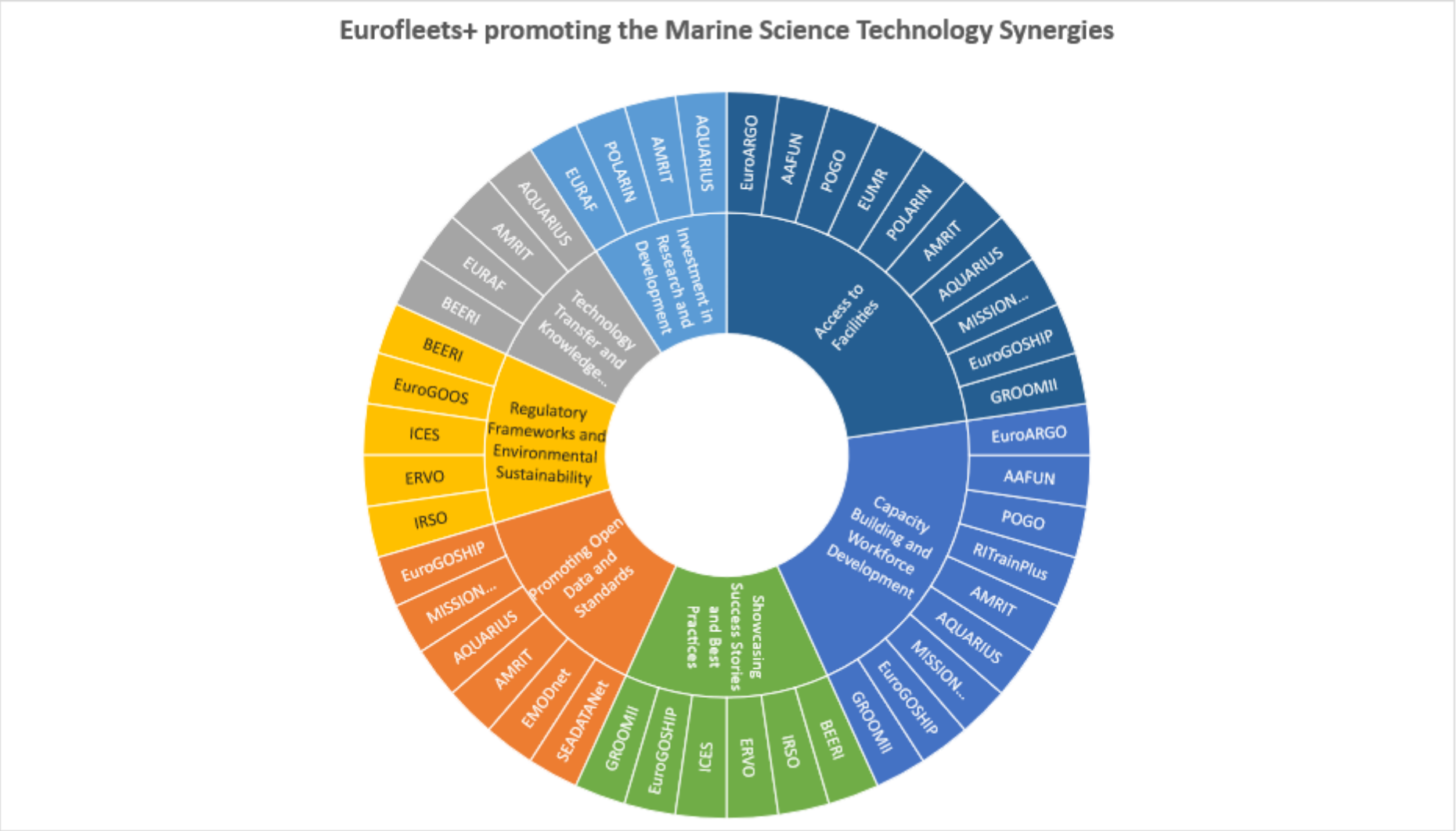

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5 Conclusion

In conclusion, Eurofleets+ has demonstrated an unwavering commitment to advancing Marine Technology and knowledge through a holistic and collaborative approach. By fostering partnerships between government agencies, academia, research institutions, and private industry, the initiative has harnessed collective expertise, resources, and technologies to drive meaningful progress in the field. This strategy, designed to prevent redundancy and maximize impact, has paved the way for extensive knowledge exchange, joint projects, and shared infrastructure, accelerating technological advancements in Marine Science.

The establishment of a Eurofleets Research Infrastructure (RI) is poised to be a pivotal milestone, dedicated to providing seamless access to vital information about the European Research Vessel Fleet. This infrastructure will not only maintain and validate crucial data but also serve as a hub for technical groups and R&D projects, particularly in the realm of low emissions RV operation. Furthermore, the provision of educational programs and training opportunities, both theoretical and practical, underscores the commitment to nurturing the next generation of marine scientists.

Eurofleets+ has demonstrated a clear vision for the future, emphasizing the importance of a united European approach in the realm of Marine Science. By sharing this vision with funding agencies, stakeholders, and marine science communities, the initiative seeks to identify and address critical funding needs, ensuring sustained progress in the field.

The substantial investment in Research and Development by the European Commission across all three Eurofleets project (2009-2023) has been instrumental in enabling hundreds of marine scientists to conduct cutting-edge research at sea. This support has not only facilitated access to Research Vessels and essential equipment but has also provided invaluable training opportunities. Recognising the pivotal role played by state and research institutions in funding vessels, equipment, and personnel, Eurofleets+ acknowledges the necessity of this sustained investment.

Promoting Open Data and Standards has been a cornerstone of Eurofleets+'s approach. By facilitating free access to a diverse array of advanced research vessels and equipment, and adopting a robust Data Policy, the initiative has prioritized the principles of findability, accessibility, interoperability, and reusability (FAIR) for research data. The commitment to making metadata and data from TA cruises widely available through leading European data infrastructures further underscores the dedication to transparency and collaboration in the pursuit of advancing marine knowledge.

In sum, Eurofleets+ stands as a beacon of collaboration, innovation, and commitment to advancing Marine Technology and Science. Through strategic partnerships, targeted investment, and an unwavering dedication to open data principles, Eurofleets+ has not only realised its own vision but has significantly enriched the broader Marine Science ecosystem. The establishment of the Eurofleets RI and the forthcoming projects like AQUARIUS and AMRIT are representative of the continued promise and potential that this initiative holds for the future of marine research.

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