

Initial Scope of New Services and Access opportunities for EuroGO-SHIP

Deliverable 2.1



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1. Summary of Deliverable 2.1

Shared facilities, including new services and access opportunities, are cornerstones of the concept for a European Research Infrastructure for hydrography, EuroGO-SHIP. This document outlines the initial scope for these shared facilities. This initial scope for shared facilities is mostly what was outlined in the proposal, with some development and additions over the first months of the EuroGO-SHIP project. This document outlines the departure point for the work that will take place in Task 2.1 of the EuroGO-SHIP project. Over the next 19 months Task 2.1 will determine requirements, cost and possible supply models for the proposed shared facilities that will result in a complete description of the refined scope of these shared facilities (Deliverable 2.2, Due month 24). The work in Task 2.1 will be informed by consultation undertaken in WP4 (with a focus on the hydrography community) and through the demonstration activities undertaken in WP3.

The work from Task 2.1 (ultimately detailed in Deliverable 2.2) will feed into the synthesis work in Task 2.4. This synthesis work will take the outputs from WPs 2, 3 and 4 and produce a statement of requirement for EuroGO-SHIP, an element of which will be shared facilities. The final work of the EuroGO-SHIP project will be in WP5, where Structure, Governance and Finance models for the EuroGO-SHIP RI will be developed. These models will satisfy the statement of requirement developed earlier in the project and also explore the added value of collaboration with the existing marine RI landscape.

2. Introduction

The motivation for a European infrastructure for hydrography was born out of the experience of existing international structures that coordinate hydrographic observations including International GO-SHIP and the ICES Working Group on Hydrography. Both International GO-SHIP and ICES, as well as those involved in the Black Sea observing system, have written white papers describing their activities (Sloyan et al., 2019, González-Pola et al., 2019, Palazov et al., 2019). These white papers identify several areas that we will improve and move beyond the state of the art within the EuroGO-SHIP initiative.

3. Initial concept for EuroGO-SHIP

EuroGO-SHIP's project implementation methodology begins with an initial concept or scope for the research infrastructure (visualised in Figure 1 and described in more detail in Table 1), which addresses the recommendations and issues from existing networks of hydrographers. Within EuroGO-SHIP we will refine this concept through demonstration (WP3), consultation (WP4), and co-design (WP2).

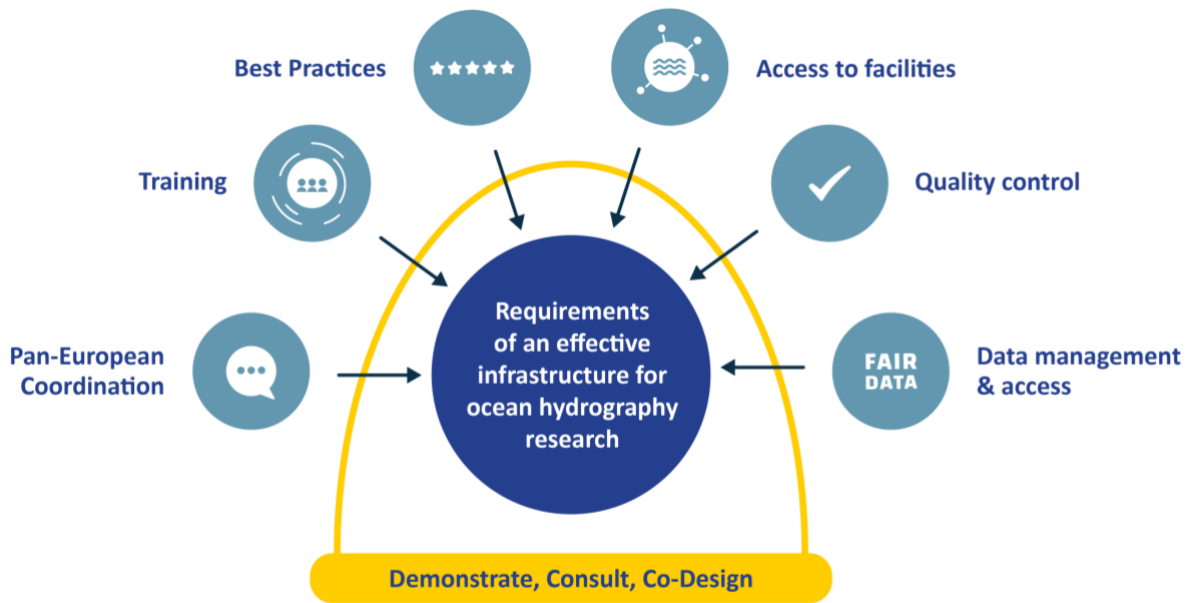


Figure 1: Initial scope of an effective infrastructure for ocean hydrography research in Europe.

Table 1: Initial concept for EuroGO-SHIP

Element	Rationale
Pan-European Coordination	Coordination of activities lies at the heart of any RI. This enables the system to be stronger than the sum of its component parts, via leveraging existing capability and capacity to maximise the return on the collective investment. Defining the requirements of stakeholders, end-users and data originators requires ongoing communication with them to ensure that the scope of the infrastructure evolves to meet evolving requirements.
Best Practices	Best practices are at the core of the RI concept; adopting common ways of undertaking key tasks in a reproducible manner is a prerequisite for obtaining comparable and temporally consistent datasets of the highest quality. Maintaining an oversight of best practice whilst incorporating the International GO-SHIP recommendations, and evolving it in parallel with technological progress, will be an ongoing requirement of EuroGO-SHIP.
Training	Those delivering RI activities, both now and in the future (including making observations, quality control and data pathway activities), require training in best practices at sea, in the laboratory, or virtually. EuroGO-SHIP will scope and survey the requirements for each form of training.
Access to facilities	Since some facilities are too expensive to develop and support in every country, it makes sense to have a shared model where individual countries



	<p>have specific facilities and operate them across the whole continent. These facilities might include specialised analysis, equipment, or containerised laboratories. EuroGO-SHIP will investigate the details of which facilities sit in this category. In addition, reference materials need to have common standards and be comparable across the whole network, including being regionally useful to European Seas. EuroGO-SHIP will therefore assess the requirement and models for delivery of these shared facilities.</p>
<p>Quality control</p>	<p>Common data quality control (QC) procedures are needed at two levels, firstly over individual cruises, usually on the ship (primary QC), and secondly across datasets that include multiple cruises (secondary QC). EuroGO-SHIP will undertake actions in both areas, including developing software for primary QC and methods to QC whole data sets, including the development of methods to objectively determine data uncertainty.</p>
<p>Data management and access</p>	<p>EuroGO-SHIP will need to distribute its data in a FAIR way. Our approach to this will be:</p> <ul style="list-style-type: none"> • Findable: a lifetime digital object identifier (doi) for a cruise that will be linked to associated observations will ensure a cruise data set is uniquely identifiable and therefore findable. • Accessible: best practices for data submission pathways and data access policies will ensure that European hydrographic data is available and curated in a consistent way, therefore accessible. • Interoperable: standard data submission formats, vocabularies, and exchange protocols, showcased by work on ADCP data • Reusable: delivery of suitable (based on end-user requirements) data to end users at portals such as CMEMS (https://marine.copernicus.eu/) will ensure that data can be reused. <p>EuroGO-SHIP will map exiting data pathways and link to end users to improve its service offers and ensure maximum societal benefit.</p>



4. Shared facilities within EuroGO-SHIP

In the GO-SHIP and broader hydrographic community, international cooperation exists at different levels of maturity, from exploratory (e.g., equipment and expertise sharing) to mature (e.g., advanced data quality control). We will investigate mechanisms to enable access to shared facilities that satisfy requirement of the community (Initial concept described in Table 1). The methodology for the suggested components of the shared facilities is as follows:

- **Capability**

We will explore the requirement for specialised measurements (e.g., transient tracers and low concentration nutrient analysis) for which the expertise to make the measurements only exists in a few nations. When the requirement is established, we will explore a model for enabling access. An important part of the work is to provide a list of groups that can offer these services, and the associated costs.

- **Certified reference materials (CRMs) for high quality analyses and comparability**

We will determine the scientific requirement for nutrient CRMs relevant to European Seas ranging from eutrophic (high nutrient concentration) to ultraoligotrophic (low nutrient concentration) waters. The regional chemical balance is indicated by characteristic regional salinity values, including Atlantic water (average salinity 35-37 psu), Mediterranean water (38-40 psu), Black Sea water (17-18 psu), and Baltic water (average 6 psu). These waters have differing nutrient balances from the Pacific water (34-35 psu), which makes up the majority of the widely used Japanese (KANSO TECHNOS) nutrient reference materials. The sensitivity of nutrient analyses to salinity means that the analysis of nutrients in European Seas would be better served by certified reference materials made from European waters. We will explore the requirement and the projected costs of these CRMs as a component of EuroGO-SHIP.

We will make a batch of reference materials that will serve the European community. This activity will contribute to ongoing international activity on establishing best practice for production and storage of secondary standards. This activity will also be used to explore the potential for a European hub for secondary carbon standards. As for nutrient CRMs, carbon CRMs are made from modified local (Pacific Ocean) low salinity water (~33). This is not representative for many ocean regions, which adds a challenge especially for the analysis of alkalinity. Thus, we will also explore the requirements for carbon CRMs adapted to different European waters to add resilience to the European community's ability to make high-quality carbon observations in the future.

- **Training (including virtual, in land-based laboratories and at sea)**

We will establish the requirement for training offered on research cruises at sea and in land-based laboratories. Research cruise berths are available for training scientists in nutrient and salinity analyses within the EuroGO-SHIP project and we will facilitate visits to different expert laboratories across Europe, as required, for more focused training in these analyses. Training



will also be more broadly explored for all aspects of new services and access opportunities including, for example, dedicated workshops (e.g., for hands-on handling of instrumentations and analyses) or virtual training (e.g., for processing of data from CTD, and ADCP). We will also explore the requirements for videos of sampling and analyses, made available via the EuroGO-SHIP homepage.

- **Software for Primary quality control of observational data**

Such software is a way of facilitating the adoption of unified best practice from researchers. Within the EuroGO-SHIP project, we will collate existing software and explore the demand for further software. Here we will showcase software that was conceived and developed in the AtlantOS project (<https://atlantos-h2020.eu/>), but which now requires updating because of advances in computer and software technology. This software (which we describe as an application or app) can be used by Principal Investigators on oceanographic cruises to undertake primary quality control of carbon system parameters. The development of the application will include a cross-platform, user-friendly graphical interface while adhering to the requirements of open-source technologies and open access programming languages. The app will be made widely available at github or similar together with installers, code, relevant manuals and guidelines, with DOIs and following FAIR principles (www.go-fair.org/).

- **Best practice (for all aspects of observing and data handling including cruise logistics)**

EuroGO-SHIP will take an overview of the traceable best practice for the lifetime of the observations including cruise planning, sample analysis and data handling. Within the project we will demonstrate work on best practice relating to salinity sample analysis, and preservation techniques for nutrient analyses. In addition EuroGO-SHIP will explore the requirement for assistance and guidance with logistical support related to research cruises with a focus on nations/individuals new to hydrographic investigations and for early-career scientists. We will collate existing information (national and international) into an easy access document outlining the key elements that need to be in place to run a EuroGO-SHIP cruise and offer training and guidance (forum-based).

- **A European Marine Equipment Pool: (EMEP)**

This will provide a common pool of shared equipment that is otherwise unavailable, ranging from individual sensors and analytical equipment to containerised labs that are easily transported and mobilised. Some pieces of equipment are so expensive, specialised, or infrequently used that it makes no sense for all individual countries to provide their own. In addition, a peak in demand might mean that equipment that would otherwise be available is unavailable. We will study the requirement for a broad range of equipment required to deliver EuroGO-SHIP cruises and suggest models of access and costs of provision including shipping, insurance and training.



5. KPIs and initial scope of shared facilities

Relevant EuroGO-SHIP KPIs for this deliverable are:

- KPI 2.1 Determine the requirement, cost and possible supply models for new user facilities
- KPI 3.3 Enable European nations to submit fully compliant cruises to International GO-SHIP supporting the International GO-SHIP mission to monitor, map and understand oceanic heat and carbon uptake

We will use the elements of KPI 2.1: requirement, cost, and possible supply models to structure our initial scope for shared facilities. Each of these elements will be related, in turn, to an observed parameter with an initial focus on the International GO-SHIP level 1 parameters (carbon system parameters, temperature, salinity, oxygen, transient tracers, inorganic nutrients, ADCP and underway observations). We will expand the list beyond these level 1 parameters based on input we receive during stakeholder consultations that will take place during the project. In addition, we have a non-parameter category of 'The cruise' where facilities such as training for principal scientists or best practices for cruise logistics and planning are included. We note that in the initial scope our focus is on requirement, but we aim to add information in each column of Table 2 for existing and yet-to-be determined rows. This work will be undertaken in Task 2.1 and will result in the final scope that will be detailed in Deliverable 2.2 in month 24.

Table 2: Structure of initial scope of shared facilities

Parameter	Description	Known requirement?	Is a cost model in place?	Does a supply model exist?	Notes
Carbon parameters	CRMs	yes			We will monitor the international situation that is mobilising to offer a permanent solution and assess the level of demand for carbon CRMs within the European hydrographic community with the ambition of offering an interrupted supply of CRMs to this community.
	Regional CRMs	yes			
	Training for analysis	yes			EuroGO-SHIP has been approached by two groups that expressed a requirement for training in analysing water samples for carbon parameters in a laboratory. We will therefore explore these specific requests in more detail during our consultations and will establish how widespread this requirement is across the broader European hydrographic community.
	Access to analytical instrument				CNR-ISMAR can offer access to their spectrophotometer for the analysis of pH. Issues to be explored: access models, including shipping processes, insurance, cost model, and related topics; requirement for analytical systems for other carbon parameters.
Temperature and salinity	Calibration facility				Access to a facility for calibration of temperature and salinity probes can be offered by CNR-ISMAR. The requirement needs to be explored, and if other labs can offer similar access. The model for access, and related costs, need to be assessed.

Parameter	Description	Known requirement?	Is a cost model in place?	Does a supply model exist?	Notes
Salinity	Shared equipment and training: salinometer	yes			
	Shore-side analysis of samples		yes	yes	Services of both analysis and training on salinity analyses can be offered by the NOC Calibration Laboratory, using an Autosal or Portasal. The requirements from the community need to be established. There is a cost-per-sample, and a one-day course can be provided. The costing will differ for in-house scientists, external not-for-profit customers with similar institutional mission of ocean observation, and other external customers.
Oxygen	Training			yes	Services of training on Winkler titration for dissolved oxygen can be offered by CNR-ISMAR, both on land and at sea.
	Access to analytical instrument				CNR-ISMAR can offer access to their Winkler titration system for the analysis of dissolved oxygen. The requirement needs to be explored, but the system can be shipped to other groups with the help of CNR-ISMAR. Issues regarding insurance, cost model, and related topics need to be evaluated.
Transient tracers	Transient tracer analysis:	yes			Transient tracer analysis is a capability held by few European countries. Within the project we will explore the demand for

Parameter	Description	Known requirement?	Is a cost model in place?	Does a supply model exist?	Notes
(CFCs and SF ₆)	specialist measurement				transient tracer measurements beyond those countries. This could entail embarking a team with experience of transient tracer analyses on cruises or (for smaller ships and/or shorter cruises) protocols should be established for sampling, storage, and transport of the samples back to one of the main labs.
Inorganic nutrients	Regional CRMs	yes			The science rationale for regional inorganic nutrient CRMs is set out in the preceding section, particularly relating to the range of salinities found in European Seas. Our task will be to demonstrate the science impact through our modelling task and strongly encourage European hydrographers to include these CRMs in their routine analyses, so enabling comparability between data from different laboratories analysing the same regional seas.
	Low concentration nutrient analysis: specialist measurement	yes			We will look to determine the current capabilities for low level (nanomolar) nutrient analysis across European laboratories. We will also investigate the current and future requirements for low-level nutrient analyses, and to assess possible training and sharing of best practices between users.
	Shore-side analysis of samples		yes	yes	Services of analysis of nutrient samples can be offered at GEOMAR by the Central Laboratory for Chemical Analysis. The requirements need to be established. Analyses can be order by request. The costing differs according to three categories:

Parameter	Description	Known requirement?	Is a cost model in place?	Does a supply model exist?	Notes
					<ul style="list-style-type: none"> • Internal measurement by temporarily assigned GEOMAR staff in the central laboratory • Internal commissioning of the central laboratory to carry out the measurements • External commissioning of the central laboratory to carry out the measurements.
	Shared equipment and training: auto-analyser	yes			EuroGO-SHIP was made aware of an occasion when peak demand for auto-analysers meant that an auto-analyser was not available through the usual national channels. We will explore the extent of this type of event both in terms of equipment and frequency and explore solutions for shared equipment and training that means that observing opportunities are not lost.
Stable isotopes	Analysis and training of seawater samples		yes	yes	This can be offered as an analysis service both by the British Geological Survey (BGS), and GEOMAR. The requirement needs to be established. BGS can analyse isotopes of the 56 most common elements in inorganic forms in seawater, and they can offer this service to external customers. They also offer training, which can range from advice on sample collections, to someone visiting for a few days to be familiarised with the facilities, to visiting for a few months to learn and then analyse your own samples. In the latter case there would be a discounted rate for the use of the machines relative to the rate if samples were run by BGS technicians. At GEOMAR the Central Laboratory for



Parameter	Description	Known requirement?	Is a cost model in place?	Does a supply model exist?	Notes
					Chemical Analysis can offer a service of analysis of the stable isotopes C-13, N-15, and S-34.
LADCP	Shared equipment and training: LADCP	yes			Lowered-ADCPs are specialist pieces of equipment that are not held by all European countries that occupy International and associated GO-SHIP cruises, with the result that International GO-SHIP cruises being occupied by European nations are not fully compliant. We will explore the broader demand for specialist pieces of equipment and the support and training that would be required for installation, maintenance of the instrument, and data processing.
Under-way observations	pCO ₂ measurements	yes			Surface measurements of pCO ₂ (and temperature and salinity) are among the GO-SHIP Level 1 parameters. This is presently not available for all groups, but the requirement needs to be explored. There are several successful examples of pCO ₂ systems borrowed for certain cruises from another group, but EuroGO-SHIP should explore a general model for access, which should include cost and insurance issues.
Best practices	Ongoing review of best practices	yes			Best practices are a key part of any high-quality observing system. We will assess the requirement for best practices (including accreditation, documentation, and training) and their ongoing review and updates for EuroGO-SHIP. This will include protocols for sampling, storage, conservation (when relevant)



Parameter	Description	Known requirement?	Is a cost model in place?	Does a supply model exist?	Notes
					<p>and transport of samples to laboratories for analyses, laboratory analysis of samples, calibration of sensors, and cruise planning and data submission. The above-mentioned protocols are developed and available at the web pages of international GO-SHIP, but EuroGO-SHIP will make these easily accessible also for groups outside the community. Assistance with different tasks related to cruises, from planning and logistics, through operation, and final reporting and data submission is an important task set out by EuroGO-SHIP. These items are described in more detail below.</p>
<p>The cruise (facilities for cruise planning, delivery and logistics)</p>	<p>Training principal scientists</p>				<p>Operating as a principal scientist (PS) requires an additional set of skills – organising, planning, and managing a variety of requirements and people – which are not necessarily contributed to by training as a scientist, even one who has spent time working at sea. Training provided to prepare future or potential principal scientists before cruises ranges from serving as a co-PS with an experienced PS, to attending a seminar or short workshop of varying content, to no training to speak of. There may be considerable differences within the network, and requirements should be explored. Outlining and creating shared knowledge documentation or resources would help principal scientists lead more productive cruises.</p>



Parameter	Description	Known requirement?	Is a cost model in place?	Does a supply model exist?	Notes
	Cruise logistics: advice and training				Logistics around cruises can be very challenging at times and is often handled by others than the principal scientist(s). This often includes shipping of equipment and personnel to and from the ship used for the cruise, often in different countries. Included in equipment is here anything needed for potential on-board analyses, which besides analytical instruments, may include chemicals and gasses, which needs to be handled as hazardous material. Furthermore, some samples that will be sent for onshore analyses may need to be handled as cooled, or frozen, goods. EuroGO-SHIP will collect and make easily accessible documentation for guidance and assistance on these issues.
	Real-time data transmission				Software and training on sharing real time CTD data from ship to the WMO GTS for forecasters to use. When the software/method is more mature, it could be considered a shared resource. This is unlikely to be within the lifetime of this project, but it could be an aspiration. The gap analysis (WP Task 2.2 / Deliverable 2.3) will inform this better as the EuroGO-SHIP project continues. Our present knowledge is that real-time temperature and salinity profiles are shared by UK research vessels using ship-board software to email data ashore, and that this can be extended to include dissolved oxygen.



6. Final remarks

The value of any research infrastructure (RI) should be determined by the impact it has on the stakeholders it sets out to serve. An RI's legacy therefore lies in how it helps to answer the questions and challenges of those stakeholders (see science impact task in WP4), including for EuroGO-SHIP the network of observers, endusers of the data and funding agencies and governments (see stakeholder engagement in WP4). The shared services developed in EuroGO-SHIP focus on the needs of the network of observers, their requirements for shared services as well as access to and provision of those services including a cost model.

In this report we have documented a range of shared facilities, identified in white papers from international and regional observing communities and from initial EuroGO-SHIP discussions in the first months of the project. This document shows the initial scope of EuroGO-SHIP that will be developed into a full and final scope within Task 2.1. Within this task we will both add further shared facilities (identified through consultation with the observing networks) and complete the missing information in Table 2 that largely relates to cost and supply models. Considerations for these cost and supply models includes insurance and transport associated with pan-European sharing equipment sharing. We will explore European transnational access (TA) as a blueprint for such services. We will further explore the relative merits of centralised versus distributed or regional facilities, including laboratories and access points. This will be assessed in Task 2.1 of and presented in the final scope of Shared facilities and, ultimately, in the Statement of Requirement (synthesised product of WPs 2, 3 and 4) for EuroGO-SHIP.