CSA OCEANS
JPI Oceans support action

SEVENTH FRAMEWORK PROGRAMME

Needs and gaps in infrastructure and human capacity building to feed the SRIA

WP 6 – Deliverable 6.2

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CONTENT

1. INTRODUCTION

JPI Oceans aims to address broad priority thematic areas which lie at the intersections of the marine environment, climate change and human activities. In order to understand these interactions, capacities in terms of human resources and infrastructures are required.

Because of the very nature of the marine system and climate interaction, there is a need for sustained long-time series as well as integrated observations bringing together physical, chemical, and biological data of the different parts of the seas and oceans. Added to this is the need for geological data to understand hazards and risk, in addition to measurements of sediments for instance in river basins, to measure natural historical vs. human induced climate change.

All these infrastructures for ocean observation (permanent, temporary and exploratory) and experimentation/testing are expensive to build, upgrade, maintain and to operate and will benefit from the European planning approach offered by the JPI Oceans mechanism[1].

In order to identify where JPI Oceans can add value in the field of infrastructures and human capacity building, this work package first conducted a mapping of existing infrastructures, observation/data and human capacity building based on a broad stakeholders consultation. The mapping exercise and the stakeholders' consultation demonstrated that Europe benefits from a wide variety of MRI, existing, in continuous development or in construction, with a total of more than 900 facilities. A preliminary analysis allowed to highlight a number of key issues related to each types of marine research infrastructure[2].

Regarding Human Capacity Building (HCB), CSA Oceans has built on previous initiatives, in particular the achievements of the SEAS-ERA project to map the European landscape and instruments to support education, training, and mobility[3]. This mapping exercise has been completed by the analysis of a case study specifically addressing the 'jobs of the sea' issue, targeting technology districts dealing mainly with maritime transport activities.

Based on the mapping and an in-depth analysis of the stakeholders consultation, the present report proposes needs and gaps that need to be covered for a sustained observation and collection of marine data and develop a long-term European observation system (Chapter 3.), existing gaps in infrastructures for laboratory research and experimentation in different marine and maritime fields (Chapter 4.), general marine research infrastructures gaps (Chapter 5.), as well as gaps and needs in human capacity building (Chapter 6.). These numerous gaps and needs call for an improved joint programming and coordination of marine RIs and HCB in Europe in terms of management and governing mechanisms.

[1] The overall aim of the Joint Programming process is to pool national research efforts in order to make better use of Europe's public R&D resources and to tackle common European challenges more effectively in a few key areas. (http://www.jpi-oceans.eu)

[2] See "Mapping and preliminary analysis of infrastructures, observation/data and human capacity building" Deliverable 6.1 – CSA Oceans

[3] See "Mapping and preliminary analysis of infrastructures, observation/data and human capacity building" Deliverable 6.1 – CSA Oceans

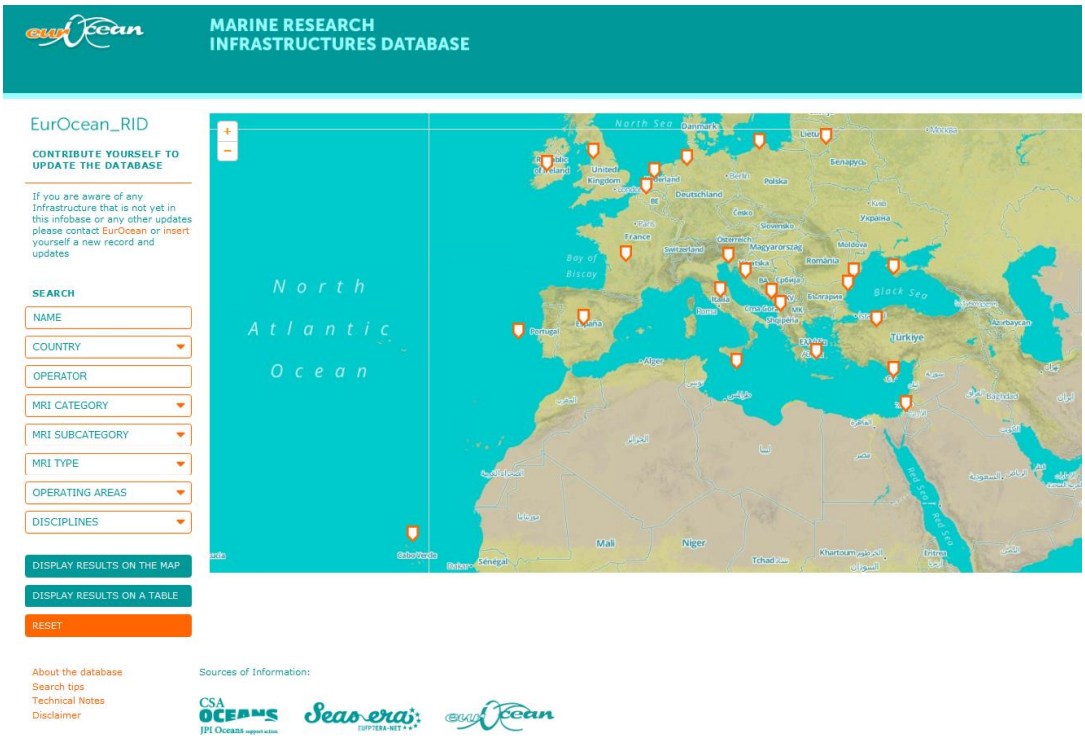
The structure of this report is based on the document “state of play - analysis of stakeholders’ consultation” presented to the JPI Oceans Strategic Advisory Board (StAB) and Management Board (MB) at the Oslo meeting (26-27 march 2014). In this structure, each sub-chapter corresponds to a category of needs identified by stakeholders (see also 2.2 analysis of the stakeholders’ consultation). Relevant gaps for JPI Oceans joint activities are listed for each of these issues.

As a next step, Work Package 1 of the CSA Oceans project will integrate output of this gap analyses into a coherent Strategic Research and Innovation Agenda (SRIA) and recommend joint actions based on an assessment of the suggested proposals.

2. METHODOLOGY

2.1 MAPPING OF INFRASTRUCTURES, OBSERVATION / DATA AND HUMAN CAPACITY BUILDING

In the first phase of the CSA Oceans project, Work Package 6 (WP6) has integrated mapping efforts conducted over the last years into one single repository, gathering all information on infrastructures related to marine and maritime research activities in Europe. This repository (http://rid.eurocean.org/), developed in cooperation with EurOcean, will ensure the long-term storage of all this information. As part of this mapping exercise, a broad stakeholders and public consultation was conducted in cooperation with WP3 (scientific needs, gaps and overlaps), WP4 (identification of barriers to science based innovation) and WP5 (identification of options for a science to policy mechanism) in order to collect input on potential needs/actions/tools to achieve the JPI Oceans goals.



Screenshot of the InfoBase of marine research infrastructure developed with EUROCEAN

Building on the mapping exercise, as well as on other existing initiatives (EURO-Argo, EMSO, EuroGOOS, EUROFLEETS, SEADATANET, JERICO, EuroSites, MyOcean, EMODNET, WISE Marine, Euromarine, SEAS-ERA etc.), the report D6.1 “Mapping and preliminary analysis of infrastructures, observation/data and human capacity building” provided an overview of existing marine and maritime research infrastructures and instruments to support education, training, and mobility as well as a preliminary analysis of the state of play and ongoing EU integration of marine research infrastructures and human capacity building.

2.2 ANALYSIS OF THE STAKEHOLDERS' CONSULTATION AND MAPPING OUTPUT

To fulfil the objectives of this second deliverable "Needs and gaps in infrastructures and human capacity building to feed the SRIA", WP6 conducted an in-depth analysis of the mapping exercise and the stakeholders' consultation.

As a first step, the needs and gaps related to infrastructures highlighted by stakeholders were grouped into three broad categories, each categories addressing specific key issues:

- **"European ocean observing system"** which include research vessels and their underwater vehicles (sea access and deep sea exploration/sampling), in situ data acquisition systems (seawater/seabed observation and monitoring), satellites (remote sensing for sea-surface monitoring), and marine data centres (for data validation, storage and dissemination through web portals, incl. access to high computing facilities & generic modelling)

- **"Infrastructures for laboratory research and experimentation"** which include needs related to marine land-based facilities for engineering (deep wave basins, water circulation canals, hyperbaric tanks, material behaviour in sea water testing laboratories, marine sensors calibration laboratories) and experimental facilities for biology and ecosystem studies (marine genomics, blue biotechnology, aquaculture, mesocosms).

- **"General issues"** related to all types of marine research infrastructures such as trans-national access to, or sharing of existing facilities.

The needs and gaps related to human capacity building are associated to a macro-category "new skills for human capacities". In particular, they are analysed according to four sub-categories:

- **"Support suitable training programmes"** refers to new approaches needed to train researchers/technicians with inter/cross/multi-disciplinary skills, in order to be prepared for future knowledge requirements.

- **"Promote a coordinated action addressing HCB needs of marine and maritime sector"** related to different steps and initiatives that allow to identify, update and effectively overcome HCB needs at cross national level.

- **"Boost the links between human capacities and research infrastructures"** explores the need of connecting as much as possible infrastructures and human capacities, combining HCB with managing, running and access.

- **"Promote the visibility and attractiveness of marine and maritime jobs"** which supports the JPI's goal of enabling the advent of a maritime economy by addressing the need of properly skilled human potential coupled with renewed long term working careers in different fields, to propose solutions to **make maritime careers more attractive** thereby contributing to blue growth.

As a second step, desk-based research was conducted in order to complement the findings of the consultation. An indicative list of reference documents is available in Annex 1.

As a third step, the most relevant needs and gaps were selected, taking into consideration:

- The principles of joint programming:[4] to contribute to overcoming fragmentation and wasteful duplication of publicly funded research, and contribute to more efficient and effective use of public resources, and involve the key public initiatives within the area.
- The three goals and 10 specific objectives of JPI Oceans[5].

- **Goal 1:** Enable the advent of a knowledge based maritime economy, maximising its value in a sustainable way.
- **Goal 2:** Ensure good environmental status of the seas and optimise planning of activities in the marine space.
- **Goal 3:** Optimise the response to climate change and mitigate human impacts on the marine environment.

10 Specific objectives of JPI Oceans:

- Foster enabling cross-cutting marine technologies across the maritime sectors
- Foster the marine bio economy in relation to new products, services and jobs
- Create the best enabling environment to maximise the development of marine renewable energies
- Develop the necessary knowledge and technologies to conquer the new deep-sea frontier
- Understand and mitigate impact of climate change and pressure from human activities on the marine environment, to reach GES (Good Environmental Status) of our seas by 2020
- Improve understanding of marine ecosystems and their processes, in particular delivery of ecosystem services and the impacts of human activities
- Understand climate change impact on coastal areas and the design of marine and maritime structures and activities, to optimise mitigation and significantly reduce costly damages
- Develop and sustain infrastructure to support an integrated data and information base enabling industrial development and supporting maritime governance
- Develop a research to policy mechanism, in particular to support of the marine strategy framework directive and marine spatial planning and management
- Foster the inter-disciplinary human capacities that are necessary to the JPI goals

[4] Communication from the Commission "Towards joint programming in research: Working together to tackle common challenges more effectively" http://ec.europa.eu/research/press/2008/pdf/com_2008_468_en.pdf

[5] JPI Oceans Vision document (approved by the Management Board, September 2011) http://www.jpi-oceans.eu/prognett-jpi-oceans/Documents/1253960389364

3. DEVELOPPING A LONG-TERM OCEAN OBSERVATION SYSTEM

3.1 SUPPORTING THE SET-UP OF THE EOOS CONCEPT

RATIONALE

In order to understand interactions between the marine environment, climate change and human activities, sustained long-time data series as well as integrated observations bringing together physical, chemical and biological data of the different parts of the seas and oceans are needed. Added to this is the need for geological data to better understand seabed and sediments, hazards and risk and to measure natural historical vs. change.

This requires a full range of infrastructures for ocean observation which are expensive to develop, operate, maintain and upgrade, and can benefit from the European strategic planning approach offered by the JPI Oceans mechanism.

The "EOOS" concept was first outlined in the Ostend declaration[6] which was adopted at the EurOCEAN 2010 conference. Essential components of EOOS include both the hardware and core resources including people, institutions (marine science and technology community in partnership with industry and the public sector), data and e-infrastructures that maintain and sustain operations. Four infrastructure fields are involved, namely (i) research fleets; (ii) observing and monitoring systems; (iii) land-based infrastructures e.g. marine stations; (iv) data management / e-infrastructures. Private infrastructures like ferries, ships of opportunity, oil & gas offshore platforms, etc. can provide a lot of additional platforms to extend the spatial coverage of the in situ data acquisition.

ADDED VALUE OF JPI OCEANS

The need for a common strategic vision and overarching coordination to make the concept of EOOS a reality was strongly highlighted in the funding agencies/ ministries consultation, as well as by other stakeholders. In particular, EOOS should provide relevant and timely products for society in areas like the management of living resources, stewardship of the marine environment, understanding the ocean - climate interaction, supporting the marine economy and marine safety (see also EC MRI expert group report, section IV[7]). As highlighted in the European Commission expert group report on MRI, it is unavoidable that a European process of prioritisation of funding for European MRIs is put in place. This could be made in the framework of JPI Oceans, with the support of competent organisation.

JPI Oceans indeed offers an unique opportunity to develop a long-term strategic vision on EOOS and to ensure that the broad landscape of infrastructures and fit-for-purpose solutions are considered for its implementation.

[6] EurOCEAN 2010 Ostend declaration : http://www.eurocean2010.eu/declaration

[7] European Commission Expert group final report on MRI (January 2013) :https://webgate.ec.europa.eu/maritimeforum/content/3158

The coordination of existing and planned ocean observation infrastructures is directly in line with the three JPI Oceans goals:

1. to ensure Good Environmental Status of the Seas[8] and optimise planning of activities in the marine space
2. to enable the advent of a knowledge based maritime economy, maximising its value in a sustainable way (ocean observation being an enabling area of activity)
3. to optimise the response to climate change and mitigate human impacts on the marine environment.

IDENTIFIED NEEDS AND SPECIFIC OBJECTIVES

The table below include the key infrastructures needs identified after the stakeholders consultation and the mapping exercise.

Focus	Identified Needs	Specific Objectives
Management / Coordination	- Need for an overarching coordination of research and monitoring capabilities and European / regional networks of infrastructures **to identify relevant gaps and priorities to address the environmental and societal challenges** taking into account the technology state of the art and short-term perspective.	Development of a strategic vision of the European Ocean Observing System including: - Set up an EOOS strategic board to develop the vision. The Board should design tools/mechanisms allowing the improved integration of the existing European ocean observing capacities, keeping in mind both research and monitoring objectives; In order to: - Enable both fully operational and sustained systems and coordinated new developments that can deliver cost efficient high quality scientific knowledge and in situ information to underpin environmental policy and management. - Allow member countries to fulfil research & monitoring obligations (e.g. Data Collection Framework in Fisheries, MSFD) by facilitating complementary uses of the various observing systems.

[8] See Directive 2008/56/EC Marine Strategy Framework Directive http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32008L0056&from=EN

3.2 FOSTER THE DEVELOPMENT OF OBSERVING TECHNOLOGIES

RATIONALE

Since the 90's ocean observation has evolved from being centred on a unique platform, the oceanographic ships with data availability being delayed in time, to observation based on multi-platform and integrated systems (using buoys, satellites, ships, autonomous underwater vehicles, HF radar, oceanic profilers, gliders etc.), also assuring quasi real time, and quality controlled data availability for both researchers and society.

This calls for long-term joint planning for the continuous development of new technologies, as an important driver to set up an European ocean observing system, in order to broaden the range of measured parameters: *in situ* sensors and embedded electronics adapted for automation and long-term series of data (miniaturized, low energy consumption, protected against bio fouling, stability of the measurement accuracy, etc…).

JPI OCEANS ADDED VALUE

Firstly, observing technologies are at the heart of the development of the European Ocean Observing System which will benefit from the joint programming approach in terms of governance. In addition, the **development and integration of new technologies (sensors, autonomous instrumented platforms, real-time data transmission…) are costly and require long-term actions** and would benefit from the long-term planning approach of JPI Oceans.

This issue is in line with the specific objectives of JPI Oceans (1) "Foster enabling cross-cutting marine technologies across the maritime sectors" as well as (4) "Develop the necessary knowledge and technologies to conquer the new deep-sea frontier".

IDENTIFIED NEEDS AND SPECIFIC OBJECTIVES

The table below includes the key infrastructures needs identified after the stakeholders consultation and the mapping exercise.

Focus	Identified needs	Specific Objectives
Management	- To ensure continuous development of new cost-effective, innovative and compact integrated instrumentation which can be deployed on mobile and fixed platforms - To improve the performance of fixed and mobile platforms in order to strengthen their capabilities of providing long-term series of data (autonomy), real-time data	As part of the EOOS strategy, set-up a EOOS instrumentation guidance which will: - Broaden the range of in situ measured parameters in accordance with EU monitoring strategies - Develop cost-effective and innovative ocean observation and monitoring solutions - Provide the appropriate level and quality of marine data to respond to emerging scientific questions (climate change issues: CO2 uptake by ocean, ocean acidification) and

	transmission (e.g. cabled seabed stations), exploring deeper areas (e.g. < 2000m for profilers new generation) or remote ones (e.g. under the ice cover).	monitoring needs (deeper measurement, Polar Regions, underexplored seas) in relation to societal drivers (key biological/ecological parameters). - Facilitate collaboration between private and public sectors (e.g. academic research and SMEs)
Technology	- To improve underwater vehicles capacities for hot-spot observation and sampling and for sub-sea instrumentation deployment and maintenance - Foster interoperability of underwater vehicles and payloads on the wider range of research vessels and in connexion with deep-sea observatories - To deliver a digital map of the entire seabed of European waters by 2020 (cf. EU Action Plan 'Blue Economy')	- HOV (Hybrid Operating Vehicles): Improved ability to recover water column, seafloor, and sub-seafloor samples. - ROV (Remote Operating Vehicles): Continued development of advanced ROV capabilities (e.g. higher power, greater depth ratings, sampling tools, sensors), including ROVs to be deployed from coastal or regional vessels not equipped with DP Systems (Dynamic Positioning), - ASVs (Autonomous Surface Vehicles) and AUVs (Autonomous Underwater Vehicles) with larger payloads (e.g. for seabed fine cartography), higher endurance, and ability to work in rough conditions.
Research and Management	- Respond to the demand for short-term forecasts (e.g. harmful algal events along the European coasts.)	- Facilitate the combined use of satellite image analysis (ocean colour) , in situ data and modelling capabilities
Management	- Contribute to enlarge the ocean observing community, to share their challenges and concerns with shipping and other ocean industries by developing Public-private-partnership.	Development of programmes aiming at: - Developing a participative approach with voluntary fishing vessels, commercial vessels and platforms to collect fisheries and in situ environmental data. - Support the development of cabled sea-floor stations related with opportunities for public / private cooperation in those fields (telecom industry)

3.3 PROVIDING ACCESS TO MARINE DATA, ENSURING THE HARMONISATION, STANDARDISATION OF PROTOCOLS

RATIONALE

A complete observing system implies a range of data services for the collection, storage and dissemination of a growing number of geo-referenced marine data, as well as interpolation and prediction services through the use of numerical modelling. However, stakeholders argued that access to marine data is still a major barrier, and harmonisation, standardisation and data interoperability are important issues still to be addressed. The need to develop a pan-European network of data centres (e.g. SEADATANET) to respond to this need was highlighted by many stakeholders.

JPI OCEANS ADDED VALUE

While data collection and management remains the responsibility of national data centres, inter-operability of, and or free access to, raw and end-application data across European regional seas is of high scientific and economic value. **By promoting the use of common standards (SEADATANET, ODIP - for the international dimension and coherence - , INSPIRE Directive) and integrating platforms (EMODNET - European Marine Observation and Data Network, MyOcean for short to medium-term prediction capacity at high resolution), and proposing innovative solutions (flexible agreements in the framework of joint programmes), JPI Oceans can contribute to add considerable value to data acquired nationally**, in line with its objective to "Develop and sustain infrastructure to support an integrated data and information base enabling industrial development and supporting maritime governance." In addition, coordination at European level can help ensure that data is acquired once and used as much as possible.

The pilot sea basin checkpoints for the Mediterranean and the North Sea currently being tested under the integrated maritime policy, offer an opportunity for stakeholders to assess the monitoring in those sea basins through a structured process. The aim is to guide the identification of gaps and a assessment of future priorities and lessons learned from this exercise could feed into a more permanent process in the framework of JPI Oceans. A monitoring process to follow and steer the coordinated development of national marine data management systems could be put in place, in cooperation between the European Commission and JPI Oceans.[9] This could progressively remove obstacles to access marine data.

IDENTIFIED NEEDS AND SPECIFIC OBJECTIVES

The table below includes the key infrastructures needs related to the access to marine data and the harmonisation and standardisation of protocols identified after the stakeholders consultation and mapping exercise.

[9] European Commission Expert group final report on MRI (January 2013) : https://webgate.ec.europa.eu/maritimeforum/content/3158

Focus	Identified Need	Specific Objectives
Research/ coordination	Data collection (see EOOS) and management: - To map and to lower remaining barriers to free exchange of marine data (incl. the legally-mandated ones produced at national level for monitoring purpose e.g. national regulations, regional sea conventions) through cooperative agreements between providers. - Harmonisation of methods and protocols for data collection, storage and dissemination to develop interoperability of existing national databases. - Improve the cooperation and links between economists and marine scientists in order to assess the social economic impact of marine data acquisition and information provision; - Promote strong interaction between data producers and data/knowledge/information systems managers	Draft an EOOS data guidance which will: - Encourage the further development of a world-class network of marine data centres adopting common standards, - Foster a truly open access data policy (e.g. by proposing an overall JPI Oceans agreement for data free exchanges between all marine data providers) to ensure that all collected data becomes known and available/formatted for re use by all stakeholders, and safeguarded for further use by long-term stewardship of the data. This common data infrastructure must be based on existing integration initiatives (SEADATANET, EMODNET, MyOcean, EuroGeo Surveys, WISE-Marine, LIFEWATCH) taking into account the needs of all users (research, monitoring and private sector). - Clarify EOOS positioning with EMODNet; - Better organise EMODNet and WISE-Marine in connection with all marine data provided by the research community, by customising the machine-to-machine interface as planned by SEADATANET II.

	Data assembly for services to end users through applications: - Harmonisation of data requirements for the descriptors in the framework of the Marine Strategy Framework Directive (MSFD) , maritime spatial planning (MSP) and existing regional sea conventions (Helcom, Ospar, Barcelona, Bucharest) - Increase scientific and economic value of raw and end-application data across European seas.	- Data assembling per sea region/sub-region and per thematic for MSFD to give access to basic data sets required for the MSFD implementation: sub--regional seas provide both natural level and right scale of integration for marine data, both economically and environmentally.

3.4 SUPPORT E-INFRASTRUCTURES FOR COMPUTING, MODELLING AND FORECASTING (INCLUDING EARLY WARNING SYSTEMS AND PROVISION OF SERVICES TO END USERS)

RATIONALE

A key objective of JPI Oceans is to foster the collection, integration, sharing and multi-use of marine data, seeking to avoid duplication and maximise applications for industries and policy-making, as described in the chapter above. It requires to pay attention to e-infrastructures which support these activities, and to high computing resources, in order to manage increasing volumes of data to develop sophisticated modelling and to produce marine information products. In particular, the provision of dedicated web-based resources and e-infrastructures is essential for advanced research in marine ecology and biotechnology (see 4.2 supporting European marine biotechnology research capabilities).

JPI OCEANS ADDED VALUE

Stakeholders see a role for JPI Oceans to consolidate a pan-European e-infrastructure for the marine data and information management system, as well as the need to facilitate access to computational capacity in order to perform analyses or processes. **Member countries of JPI Oceans could join forces towards the development of such integrated e-infrastructure and when relevant develop common modelling approach / framework.** The support to e-infrastructures for computing, modelling and forecasting is a key issue to contribute to JPI Oceans goals “improve understanding of marine ecosystems and their processes, in particular delivery of ecosystem services and the impacts of human activities” and “develop and sustain infrastructure to support an integrated data and information base enabling industrial development and supporting maritime governance.”

As an intergovernmental platform led by member-states, JPI Oceans can work towards the improvement of access to:

- existing high performing computing facilities (e.g. PRACE) and ICT platforms (e.g. i-Marine)
- ocean modelling framework allowing several ocean related components of the earth system to work together or separately (e.g. NEMO)
- forecasting capacities (e.g. My Ocean).

IDENTIFIED NEEDS AND SPECIFIC OBJECTIVES

The table below include the key infrastructures needs identified after the stakeholders consultation and the mapping exercise.

Focus	Identified Need	Specific objectives
Management	- Improve high resolution prediction of the future evolution of marine ecosystems under different scenarios - Development of new modelling approaches to specifically address inter-disciplinary prediction and complex environments e.g. coastal marine hazard tracking. integrating ecosystems, climate and economics	- Improve and foster access to existing high performing computing facilities (e.g. PRACE), to ocean modelling framework allowing several ocean related components of the earth system to work together or separately (e.g. NEMO[10]) and to forecasting capacities (e.g. My Ocean) - Set-up and agree on a JPI common view on H2020 international calls, notably e-infrastructures calls on the "Research Data Alliance." - Reduce the level of uncertainty in prediction within the ecosystemic approach and respond to policy needs in ocean monitoring

[10] NEMO ocean modelling framework : http://www.nemo-ocean.eu/About-NEMO

4. INFRASTRUCTURES FOR LABORATORY RESEARCH AND EXPERIMENTATION

4.1 CONTRIBUTE TO THE DEVELOPMENT OF "OMICS" AND BIO-INFORMATICS EQUIPMENT

RATIONALE

Central to the understanding of the biology of marine organisms (as well as their biotechnological potential) is the assessment of their genetic capabilities, i.e. sequencing of their genome and annotation of the genes. This understanding is the focus of genomics.

Today, marine genomics knowledge is a vital part of "blue biotechnology", and is leading to applications in the management of natural and cultured resources, and preserving marine environments. Marine genomics therefore hold great potential for societal problem solving and industrial commercial advantage. However, no single institution has the capacities and resources to afford the full range of sampling and sequencing equipment and technology needed to explore the marine biodiversity at gene scale and no state has access to all ecosystems needed to understand coastal zone processes and connections between regional seas. In order to intensify the screening of marine genomes with molecular tools and fully capitalise on the novel genes, proteins, enzymes and small molecules found in marine macro and microorganisms, the development of bioinformatics resources and e-infrastructure is needed.

JPI OCEANS ADDED VALUE

Based on recommendations from ongoing projects such as EMBRC, **JPI Oceans could offer a framework to implement common programming of research activities in this area taking full advantage of the use of specific "omics" infrastructures and equipments** (incl. typically sequencing platforms, microaary, 2D-gel electrophoresis, GC-MS + crystallography, electronic microscope, diffractometer…) in line with its specific objective to "foster the marine based bio-economy in relation with new products, services and jobs".

IDENTIFIED NEEDS AND SPECIFIC OBJECTIVES

The table below include the key infrastructures needs identified after the stakeholders consultation and the mapping exercise.

Focus	Identified Need	Objective
Research/ coordination	- Strengthen common European platforms in the field of “omics” research (incl. typically sequencing platforms, microaary, 2D-gel electrophoresis, GC-MS + crystallography, electronic microscope, diffractometer…) , with associated bioinformatics and e-infrastructures and the development of centres for systems biology and synthetic genomics, recognising that Marine Biology research & valorisation draws from a wide range of multi-disciplinary outputs and tools. - Integrate genomic information with environmental, socio-ecological and other biological data. - Mainstream biodiversity- genetic variation - into Earth Observation systems to enable predictive modelling of biodiversity dynamics and resultant impacts on ecosystem services. - Integrate aquaculture with "omics" technology to identify robust/resistant phenotypes for sustainable growth and breeding + microbes and novel pharmaceuticals.	Develop a RI biology global vision to contribute to: - Develop European capacities for a leading edge research in marine biology and biodiversity including those related to microbes and novel pharmaceuticals - Develop databases, methods and programs for genome bioinformatics and computational biology, sequence and structure analysis, and molecular evolution. - Integrate classical methods of observational ecology with those of “omics” and numerical models

	- For marine biology (as for other domains already mentioned), act towards the standardisation/calibration of data/methods between research infrastructures in Europe in order to develop common indicators and enable comparability studies which will facilitate joint response to policy needs.	- Develop common indicators to enable comparability study to facilitate responses to policy needs.
	- Better align communication, coordination of efforts, and sharing of protocols and ideas during the preparatory, implementation, and operations phases of the projects of the different European marine stations, in relaying on EMBRC RI and MARS network.	- Create a RI Community to allow the provision of seamless services to the private and public research community, reduce duplication and excess funding. - Ensure coastal marine research infrastructure are coordinated with needs of users and offer integrated access programmes for interdisciplinary users, including industry.

4.2 SUPPORTING EUROPEAN MARINE BIOTECHNOLOGY RESEARCH CAPABILITIES

RATIONALE

In the context of a global economic downturn, European countries are now facing complex and difficult challenges such as the sustainable supply of food and energy, climate change and environmental degradation, human health and aging populations. Marine Biotechnology can make an increasingly important contribution towards meeting these societal challenges and in supporting economic recovery and growth in Europe by delivering new knowledge, products and services. However, a coordinated effort is needed at pan-European level to mobilise and optimise human resources and available infrastructures.

JPI OCEANS ADDED VALUE

Based on existing initiatives (Euromarine, EMBRC, ERA-MarineBiotech) **JPI Oceans could contribute to a roadmap of common pre-commercial research activities, a network of technical platforms, and support innovation and start-up initiatives**, in line with its specific objective to "foster the marine bio economy in relation to new products, services and jobs".

IDENTIFIED NEEDS AND SPECIFIC OBJECTIVES

The table below include the key infrastructures needs identified after the stakeholders consultation and the mapping exercise.

Focus	Identified Needs	Specific Objectives
Coordination	- Need for closer linkages between current and planned European scientific research laboratories in Marine Biotechnology and technical platforms - Increasing need for marine-derived products, including food, biomedical and biotechnological products, energy etc. - Improve access to marine bio-resources and biotechnology research infrastructures to stimulate innovation in this promising sector	Develop a European RI biotechnology vision (based on existing initiatives like the ERA Marine Biotech) in order to: - Capitalise the knowledge and experience gained in different member-states for further optimization of nationally-based projects, cooperative initiatives and funding. - Establish a European marine biotechnology institute or centre, at least virtual, through a permanent secretariat and network with key nodes

4.3 DEVELOP A NETWORK OF AQUACULTURE RESEARCH INFRASTRUCTURES

RATIONALE

As highlighted in the stakeholders' consultation, aquaculture is an important industrial sector in Europe which can contributes substantially to a sustainable "blue growth". In addition, European aquaculture technology is one of the areas where Europe has the edge and can make a difference in the future. Nevertheless, the European aquaculture industry is facing increasing challenges due to a more demanding and selective market combined with competition from outside Europe. These complex challenges require new technological solutions that can be developed with the contribution

of the public research community relying on excellent experimental facilities, high level expertise in biology and in environmental constraints, alongside experienced professionals of the private sector.

JPI OCEANS ADDED VALUE

Based on existing initiatives (e.g. AQUAEXCEL), **JPI Oceans offers a flexible mechanism to develop synergies between the public research community and the private sector**. In addition, the development of a long-term network of aquaculture research infrastructures would strengthen research in automation to enhance the design and operation of marine biological production and harvesting systems by creating a critical mass.

IDENTIFIED NEEDS AND SPECIFIC OBJECTIVES

The table below include the key infrastructures needs identified after the stakeholders consultation and the mapping exercise.

Focus	Identified Needs	Specific Objective
Coordination	- Development of European network of top class experimental facilities, improving transnational access, coordination and integration of national aquaculture infrastructures. It should cover all types of EU environments, systems and species that can meet current and emerging research needs or industry needs. - Develop offshore aquaculture	- More effectively support the development of a sustainable European production of high quality seafood with reduced environmental impact. - Strengthen research in Automation in Fisheries and Aquaculture e.g. how automation can be applied to enhance the design and operation of marine biological production and harvesting systems. Important topics include systems biology, mathematical modelling of biological processes and production systems, aquaculture process control, marine instrumentation and aquatic telemetry.

4.4 STRENGHTEN LAND-BASED FACILITIES AND DEVELOP IN SITU TESTING SITES, FOR OCEAN ENGINNEERING AND SHIPBUILDING, OCEAN ENERGY

RATIONALE

The design and qualification of fixed, floating platforms and ships are key issues for the development of the maritime sector in general and especially for the ocean renewable energy emerging sector. In situ testing sites are particularly important for fully qualifying performance and reliability of prototypes before their commissioning.

JPI OCEANS ADDED VALUE

JPI Oceans could act to **avoid fragmentation of the expanding efforts in this demanding domain in terms of investment and operating costs, facilitate the sharing of experiences in measurement technologies and issuing common model tests and procedures to provide reliable and comparable results for the industrial sectors and policy makers.**

A European network could facilitate access to the numerous facilities which perform model tests for ocean engineering projects (offshore oil and gas, ocean renewable energy, ocean mineral resources). This issue is directly in line with the JPI goal: “to enable the advent of a knowledge based maritime economy, maximising its value in a sustainable way” and the specific objective “create the best enabling environment to maximise the development of marine renewable energies.”

IDENTIFIED NEEDS AND SPECIFIC OBJECTIVES

The table below include the key infrastructures needs identified after the stakeholders consultation and the mapping exercise.

Focus	Identified Needs	Specific Objectives
Management	**Ocean energy** - Sustain and extend a network of research centres and organisations on the basis of existing projects such as MARINET. (the network should include facilities which can performed model tests - wave basins, water circulation flumes…- and scale one prototypes - in situ testing sites adapted for each type of Ocean energy converters : waves, stream and tidal currents) - Promote mutually beneficial public-private partnerships that support the involvement of marine industries and other stakeholders in emerging maritime sectors such as marine Renewable - Accelerate the development and commercial deployment of marine renewable technologies. **Shipbuilding and offshore engineering** - Develop a European network to facilitate access to the numerous facilities which perform model tests for ocean engineering projects (offshore oil and gas, ocean renewable energy, ocean mineral resources).	- Take advantages of existing deep wave basins, water circulation canals, hyperbaric tanks, material behaviour in sea water testing laboratories, marine sensors calibration laboratories, In situ testing sites for ocean energy and associated hydrodynamics skills to strongly support industrial sector in these high investment / high reward activities - Facilitate the sharing of experiences in measurement technologies and issuing common model tests and procedures to provide reliable and comparable results for the industrial sectors and policy makers. - With the maritime community, design and Develop common RI prototypes for both research and commercial uses (offshore oil and gas, ocean renewable energy, ocean mineral resources).

5 GENERAL MARINE RESEARCH INFRASTRUCTURES ISSUES

5.1 SHARED USE OF INFRASTRUCTURES, TRANSNATIONAL ACCESS

RATIONALE

The shared use of research infrastructures is typically a cross-cutting issue which would benefit from the new cooperation mechanism offered in the framework of JPI Oceans (variable geometry, high level decision-making process). This calls for various scales of implementation: depending on the research needs, shared use of infrastructure could be addressed either at regional scale (in the same sea basin shared by bordering countries), or at pan-European level (e.g. to address together remote open ocean issues) or even with the two dimensions combined for an optimal efficiency (e.g. Euro-GOOS and their regional ROOS).

JPI OCEANS ADDED VALUE

The variable geometry approach offered by the joint programming process allow various scale of implementation (from regional to pan-European level) of infrastructure sharing models. In addition, a high political commitment and dialogue between the relevant authorities is required to ensure sustainability and cost-efficiency of observing systems: JPI Oceans, as an initiative lead by member-states with high level commitment offers a platform for such a dialogue.

Different stakeholders groups, from science organizations to technology platforms, highlighted the fact that many infrastructures are still operated at national level and JPI Oceans could facilitate the coordination, shared use and access of research to infrastructures and promote their multipurpose use (e.g. multipurpose fishing vessels)." The shared use of infrastructure also respond to the need to reduce the cost of monitoring.

IDENTIFIED NEEDS AND SPECIFIC OBJECTIVES

The table below include the key infrastructures needs identified after the stakeholders consultation and the mapping exercise.

Focus	Identified Needs	Specific Objectives
Management / Governance	- To offer the best infrastructures to EU scientists, especially in the framework of joint scientific programme. - To optimise the use of existing infrastructures in order to avoid days of inactivity which are costly - To take advantage of multi-	Set-up a common vision for a joint programming for RI use and access which will ensure: - Better coherence science needs / research infrastructures support, - Cost/efficient approach, to avoid days of inactivity, - Develop public-private partnership, to stimulate

	purpose capacities of infrastructures to address multi-disciplinary objectives, e.g. Fisheries or Physical oceanography at sea campaigns combined with MSFD monitoring tasks when compatible - More use of private infrastructures by public research for issues like ocean full observation or aquaculture new process development, and reciprocally more open access to public RI for the industrial sector, including for SMEs at regional level, to stimulate the innovation process.	innovation.

Example 2: JPI Oceans Pilot action "Increasing the cost-efficiency of fisheries infrastructure for data acquisition and marine monitoring: towards an integrated approach to monitoring of the North Sea"

This joint action, involving most countries bordering the North Sea, aims at

- Increasing the value of each Euro spent nationally on marine infrastructure and research by smart coordination and collaboration;
- Jointly collecting data required by European and national legal obligations;
- Jointly collecting data for research purposes;
- Evaluating the suitability of indicators to be integrated into particular surveys;
- Increasing experience with joint data collection, storage and processing.

The overall approach is directed towards the following components: (1) setting up integrated monitoring surveys, (2) enhancing integration of monitoring efforts and, (3) designing general protocols for data acquisition where necessary, (4) promoting data sharing and integrated information systems, and (5) determining the additional requirements with respect to man power, training and lab facilities.

5.2 SET UP COMMON PROCUREMENT STRATEGIES, DEVELOP COMMON BUSINESS PLANS

RATIONALE

New investments in infrastructures are still mostly a national affair without any real European up-stream vision, with the recent exception of the ESFRI approach (EURO ARGO, EMSO, and EMBRC). The European dimension is also relevant for small / medium investments of distributed MRI like regional vessels and underwater vehicles, observing systems (oceanic profilers, gliders, and coastal observatories), laboratories equipment: marine biology and biotechnologies laboratories, experimental facilities for aquaculture, testing facilities for ocean engineering: for ocean energy new sector.

JPI OCEANS ADDED VALUE

All 3 JPI goals actually can take advantage of a shared vision of future developments / new investments in research infrastructures to better address their specific objectives. Moreover, JPI Oceans can help develop common procurement strategies and associated business plans. This approach could be compared, at the scale of the marine sciences community, to the approach used by ESFRI. This approach is also linked to 5.3, as less but more modern infrastructures means more developed shared use and/or trans-national access.

This issue is particularly important in the field of research vessels. As highlighted in the European Commission marine research infrastructure report, oceanographic vessels will continue to be an essential component of marine research infrastructures. However, the development of sensors and the increasing use of autonomous and unmanned platforms may change how ships are used. Many oceanographic vessels of the European regional fleet will need to be renewed in the coming years. There is a need for strategic reassessment and coordination at European level of oceanographic vessels as part of a broader assessment and coordination of European marine research infrastructures (see also 3.1 supporting the EOSS concept). JPI Oceans could provide an opportunity to make such an assessment, coordinated with member countries and the European Commission, and building upon the work done by Eurofleets.

IDENTIFIED NEEDS AND SPECIFIC OBJECTIVES

The table below include the key infrastructures needs identified after the stakeholders consultation and the mapping exercise.

Focus	Identified Needs	Objectives
Management / Governance	- Need for less but more modern, multi-purpose (when relevant) and standardised / interoperable research infrastructures - New investments more adapted to societal needs	Set-up a common strategy for RI common use and access: - To streamline and harmonise national infrastructures roadmaps by consulting at the regional, European level before investing at national level. - To develop common procurement

	- Optimal spatial coverage of Open Ocean and coastal waters by autonomous observing systems and their vessels for deployment and service.	strategies and business models with the advantages of economy of scale, shared investment risk, standardisation and interoperability fostering common logistics concept and simplified access.

5.3 INTERNATIONAL COOPERATION ON INFRASTRUCTURES FOR GLOBAL OCEAN OBSERVATION

RATIONALE

Global Ocean Observations are of paramount importance for the sustainable management of the "blue planet" at world scale. Observing systems and marine data centres are key infrastructures and international cooperation in this domain is essential to fully address JPI Oceans goals.

The information continuously provided by ocean observation networks (within GOOS) will enable altogether to better learn, assess and predict the state of the global ocean. EOOS has already existing equivalent systems around the world (IOOS in the USA, Neptune in Canada, Donet in Japan, IMOS in Australia).

JPI OCEANS ADDED VALUE

As highlighted in the stakeholders' consultation, **JPI Oceans as an intergovernmental body offers a framework to link the Europe Ocean Observing System's (encompassing relevant EU marine infrastructures) with its international counterparts** in order to stimulate the creation of a truly global integration of existing marine infrastructures.

IDENTIFIED NEEDS AND SPECIFIC OBJECTIVES

The table below include the key infrastructures needs identified after the stakeholders consultation and the mapping exercise.

Focus	Identified Needs	Specific Objective
Networking	- To link the Europe Ocean Observing System encompassing all relevant EU marine infrastructures with its international counterparts - To enable interactions and exchange of best practices (in design,	- To stimulate the creation of a truly global integration of existing marine infrastructures and networks - Cost optimisation of the new developments and operation in observing systems - To open a worldwide market to the European industrial sector for in-situ

	instrumentation, management, governance) between different Regional Ocean Observing Systems, from the coast to the deep ocean - To develop a complete and sustainable GOOS for the successful operation and management of GEOSS - To foster standardization of protocols and methods in data treatment at the international level - To promote specialized observing systems to other regions globally	sensors and instrumentation

6 NEW SKILLS FOR HUMAN CAPACITIES

6.1 SUPPORT SUITABLE TRAINING PROGRAMMES

RATIONALE

JPI Oceans aims at fostering the inter-disciplinary human capacities that are necessary to fulfil identified goals and objectives. A new approach to train researchers/technicians with inter/cross/multi-disciplinary skills is therefore needed to be prepared for future knowledge requirements. Acting at JPI level can motivate the creation of funding opportunities where multidisciplinarity is a prerequisite for each project, hence concretely supporting the concept of a new training approach.

Some concepts outlined in the chapter on training of the European Marine Board Position Paper *Navigating the Future IV*[11], have been reiterated during the CSA Oceans stakeholders. In order not to lose a critical mass of scientists in some disciplines (e.g. taxonomy) while pushing a critical mass in others (e.g. ecosystem values), multidisciplinary human capacity-building initiatives for scientists and technicians coupling both classical disciplines and skills in new technologies need to be developed. These should bring together scientists across different organizations (e.g. academics and marine institutes' sites) through suitable training/networking programmes for researchers/technicians with cross disciplinary approach, in close collaboration with industry.

JPI OCEANS ADDED VALUE

JPI Oceans can firstly ensure that capacity building issues are embedded in relevant joint actions in continuity with the approach undertaken by other initiatives like the SEAS-ERA and COFASP ERA-NETs. Moreover, **JPI Oceans can raise the voice on some relevant processes to be jointly undertaken like the set-up of standard programmes and related funding schemes dedicated to marine and maritime HCB**. Young scientists tools, long-range training schools, vocational education and training; doctoral and postgraduate grants, joint training, teaching and exchange programmes, summer courses, master classes, international and collaborative research projects: these are some of the ideas, shared during the workshops with the stakeholders, that can benefit from a common scheme, provided that the same recognition of training outputs is guaranteed in different countries.

As explained in the paragraph below, acting at JPI level can also emphasize the importance of filling the science-policy gap.

[11] http://www.marineboard.eu/images/publications/Navigating%20the%20Future%20IV-168.pdf

FOCUS ON SCIENCE-TO-POLICY PROFILES

Besides research and technical profiles, JPI can tackle the improvement of relevant human skills, like science-to-policy profiles needed in order to properly address the focus issue of developing a research-to-policy mechanism (e.g. to support the Marine Strategy Framework Directive and Marine Spatial Planning and Management). These profiles can be built through: in house training, step by step guides to help researchers transfer knowledge to policy, secondment opportunities to the EU, JPI Secretariat, user workshops (e.g. in the framework of research projects), training modules for communicating science to the media, participation in working groups, advisory bodies and workshops directly linked to international organizations and bodies responsible for providing scientific evidence to support policies like ICES, CECAF, NAFO, ICCAT, GFCM, SCAR-FISH, GES-WG, MEDPOL, OSPAR, etc. To mention a best practice: some organisations have a permanent interface with policy bodies (like GEOHAB with IPHAB/IOC), therefore allowing an active involvement on working at the interface between science and policy. Another example is the PEGASO project in which a platform/incubator for scientists and policy makers has been set up to compile current knowledge at regional level for implementation of ICZM.

IDENTIFIED NEEDS AND SPECIFIC OBJECTIVES

The table below include the key HCB needs identified after the stakeholders' consultation and the mapping exercise.

Focus	Identified Need	Specific objectives
Capacity building policy	- Anticipate education needs for overcoming the future multi-disciplinary needs - Up-skill of the marine workforce, providing researchers with the suitable skills needed to tackle multidisciplinary and cross-sectoral challenges (e.g. systems biology should include also societal and economic issues) - Training harmonization at pan-European level - Attract non-EU researchers (mobilizing also competitive funding) - Develop competences of local young researchers for increasing the scientific level (also in the outermost regions) - Develop formal education products to ensure both ocean and non-ocean scientists have a broader understanding of the complex interactions of the ocean with other branches of science and the major influence of the ocean in issues of societal importance (*) - Promote workshops specially inviting young scientists from different marine related disciplines (*)	- Educate a new generation of inter/multi- disciplinary marine scientists/technicians with inter/multi-disciplinary skills (e.g. biologists and modellers) - Develop new/adapted training courses and suitable lifelong learning initiatives - Promote research training networks of research institutions, universities and industries across Europe - Increase information exchange on capacity building opportunities - Strategic oceanographic and marine education and training roadmaps addressing in particular the younger generation - Support: o centres of excellence o programmes for sharing human capacities o tailored education and training programmes (e.g. maritime doctoral schools)

Technical/ thematic capacities	- Marine bioinformatics and bio-analysis skills increasing the level of mathematical capacity in classical disciplines like biology - Quantitative/molecular geneticists - Taxonomists - Renewed human capital within the aquaculture sector - Focused modelling capability - Data manager, providers and librarian as new profession of data operators (data set quality to be ensured) - Socio-economists - Interdisciplinary specialists-to-specialists communication - Science-to-policy profiles - Communication skills to run projects aimed	- Be well equipped while developing emerging disciplines (e.g. for '-omics' discipline be prepared to organize and store all genomics and plus genomics tools and data also to be more attractive from the industry perspective) - Pursue an integrated collaborative research integrating classical methods with the use of -omics and numerical models - Develop a generation of scientific leaders that can articulate the benefits of ocean science policies and practices - Improve the interface between life and social sciences

(*) specific indication arisen from the CSA web consultation, with particular regard to the answers to the question "In your opinion, what activities could JPI Oceans undertake to foster inter-disciplinary and cross-sectoral human capacities?"

6.2 PROMOTE A COORDINATED ACTION ADDRESSING HCB NEEDS OF MARINE AND MARITIME SECTOR

RATIONALE

Seas and oceans boundaries do not overlap with those of countries. Human capacities needs should therefore be identified, updated and overcome at cross national level. Still in line with the objective to foster inter-disciplinary human capacities that are necessary to fulfil the JPI's goals and on a long-term perspective, the evolution of the need described in the previous paragraph of supporting suitable training programmes can be the implementation of a coordinated action addressing selected HCB needs of the marine and maritime sector.

As assessed by SEAS-ERA[12], the starting point can be to combine a training project with a research call having a clear pre-requisite to address training issues. Before calling for a coordinated project on training, key issues should be identified, and synergies between universities and research centres

[12] SEAS-ERA D5.3.1, *Proposal for Human Capacity Building calls within Common Programs and Joint Calls*, Dec 2012

reinforced. As intermediate step toward a consolidated action on HCB, a long-term train-programming plan can be set up to fund, through appropriate schemes, projects for training in specific emerging issues in marine science (e.g. systems biology). Thus the action starts to assume a long term perspective in terms of impact. Moreover, having a structured initiative on HCB, it can be possible to adapt it in order to support peculiar needs of the marine and maritime sectors like some arisen from the stakeholders' web consultation: women in science, ocean literacy, demonstrators (e.g. adapting offshore technology to aquaculture). Among the best practices collected from the stakeholders, IOC has successfully developed a unique network with the most talented scientists across the world and with research institutes in all regions, and is playing an essential role in addressing urgent issues related to the protection and sustainable development of the ocean and coasts. The core principle of IOC capacity development is that it should be issue-based and self-driven.

Coming to the inputs at EC level, as stated by the EC COM(2014)254, 8 May 2014 *Innovation in the Blue Economy: realising the potential of our seas and oceans for jobs and growth, addressing 'skills for the blue economy'*: "Growth in the blue economy will require an appropriately skilled workforce [...]. The Marie Sklodowska-Curie Actions (MSCA) are the main support mechanism in Horizon 2020 for human resources in all areas of research and innovation [...] MSCA combine research excellence with mobility, training and attractive career opportunities [...] A further avenue for supporting the development of skills in the blue economy and closer cooperation between higher education and the private sector are Knowledge Alliances, [...] structured partnerships bringing together relevant actors from higher education and business to stimulate innovation in and through higher education. A Sector Skills Alliance (SSA) could also help by bridging the gap between education/training and the labour market. [...] The Commission encourages stakeholders in the blue economy to apply for a Knowledge Alliance and marine Sector Skills Alliance".

JPI OCEANS ADDED VALUE

JPI Oceans can trigger the implementation of coordinated actions that at the same time address specific needs of marine and maritime sectors, and fit the policy framework. For example a *Marie Curie Slodowska Action* on marine observing systems can be the suitable instrument linking HCB programming, marine infrastructures, and jobs creation. Another coordinated HCB initiative can be the promotion of standardized schemes and develop joint curricula on marine sciences and maritime engineering, in order to effectively address emerging marine and maritime HCB needs with a long term perspective. According to the proposals arisen in the stakeholders' consultation, once the thematic has been agreed upon, through a coordinated initiative it can be possible to develop for example:

- common specialist training programmes/ secondment;
- cross sectorial sharing of experiences and best practices among practitioners/ implementers;
- Networking in cross-cutting scientific areas (educational, scientific and technological capabilities).

Finally **one of the most ambitious action proposed by the stakeholders is the creation of a JPI Oceans Academy, to answers in terms of capacity building to the JPI goals. The long-term perspective and variable geometry mechanism of the JPI Oceans suit this kind of process.**

The implementation of a JPI Oceans Academy appears to be a multipurpose tool through which realizing a coordinated action whose objectives can differ according to specific needs. Acting as a platform of permanent consultation as well as repository, being the HCB counter part of JPI pilot

actions, advising on HCB actions to be implemented through suitable schemes: the role of such structure can definitely add value to the EU landscape where a strong interaction between HCB and infrastructures is needed as well as a close dialogue between the education and the economic system, in order to boost the blue economy.

IDENTIFIED NEEDS AND SPECIFIC OBJECTIVES

The table below include the key HCB needs identified after the stakeholders' consultation and the mapping exercise.

Focus	Identified Need	Specific objectives
Actions	- Address training issues in research calls as clear pre-requisite - Implement a marine Marie Sklodowska-Curie Action (e.g. on marine observing systems) - Set up a European Marine Science Education Programme - Launch a *call-for-courses* package for persons that are at the same time a high-level expert in one topic but a sort of knowledgeable into others of the same package;	- Accomplish the coordinated action at the European level addressing HCB - Train within an objective driven/long-term perspective, planning an integrated strategy for training the next generation of marine scientists
Supporting tools	- Favour marine based knowledge hubs - Promote a joint working group with participation of key marine research institutes and networks of higher education institutes of Europe - Set up a platform for permanent dialogue between the marine research communities and leading European universities - Maintain a repository of surveys, questionnaires, success stories - Support workshops, conferences and meetings (i.e. networking) with stakeholders and scientists from different research fields	- Globally assess marine capacity and strategy at EU level - Develop educational programs relevant for future needs of marine science and technology - Communicate different needs and therefore align following research activities - Push the frontiers of knowledge and become a driver for innovation and economic growth; they can contribute to a more relevant education, candidates who are more prepared for the challenges in the industry, and a private sector that is more supportive towards research - Revise the curricula and adapt them to the emerging needs of marine science in order to have a properly trained next generation of scientists and technologists

6.3 BOOST THE LINKS BETWEEN HUMAN CAPACITIES AND RESEARCH INFRASTRUCTURES

RATIONALE

In line with CSA-Oceans WP6 core tasks of connecting infrastructures and human capacities, marine research infrastructures represent a typical example where there is a need of defining frameworks for combining HCB with managing, running and access.

A step forward towards this idea has been moved by the framework programme Horizon2020 foreseeing dedicated activities to support the training of staff managing and operating RIs, the exchange of personnel and best practices between facilities as well as the engagement with universities to prepare curricula and specific courses for pan-European RIs.
A strong emphasis on the link between marine research infrastructures and capacity building has been pointed out also in the JPI stakeholders' consultations. Human capital is indeed fundamental to sustain a European Ocean Observing System. To reinforce this idea as part of a virtuous circle, a 'training flag' can be considered an added value for the RI itself.

JPI OCEANS ADDED VALUE

By analysing European research infrastructure capacity**, strategies on human capacities for research infrastructures can be addressed in a comprehensive way, making them well known throughout Europe. As a long-term intergovernmental body, JPI Oceans is well-placed to implement joint strategies on human capacity**.

IDENTIFIED NEEDS AND SPECIFIC OBJECTIVES

The table below include the key HCB needs identified after the stakeholders' consultation and the mapping exercise.

Focus	Identified Need	Specific objectives
Curricula	- Combine human capacity building with access to infrastructures - Ensure availability of highly competent operating staff - Reinforce p-p collaboration on shared access to MRIs - Respond with adequate skills to programmes of shared MRIs - Ensure continuity of MRIs proper running	- Training programmes related to marine infrastructures - Multidisciplinary PhD programme together with industry (e.g. a MSCA on marine observing systems) - Transnational access to help students defining their own infrastructures in the future - Train at sea European scientists and technicians through access to infrastructures, including young users and scientists from non-equipped countries - Exchange of scientists and technicians among different infrastructures (including private sector) - Participation in research cruises for foreign young scientists thanks to networking of institutes/universities operating or using RI - Training and networking of the research pool, meaning the technical support staff that run the instrumentation
Best practices	- Advertise on the RID database if a RI is available or has been available specifically for on-field (paid/free) training (e.g. in the framework of national/ international/EU programmes/projects)	- Increase training opportunities on MRIs - Fill the gap of lacking sea-going technicians supporting science (e.g. ROV-AUV pilots) - Continue virtuous experiences, e.g.: MARTECH bi-annual global networking moment for marine technicians where real hands-on knowledge can be exchanged among technicians of various marine institutes - EUROFLEETS-like training courses and workshops on technical issues (e.g. multi-beam operations) focusing on specific instruments

6.4 PROMOTE THE VISIBILITY AND ATTRACTIVENESS OF MARINE AND MARITIME JOBS

RATIONALE

The cross-cutting issues JPI focuses on are aimed among other things at fostering the marine bio-economy in relation to new jobs. In this framework, it is of uttermost importance to increase the visibility and attractiveness of marine and maritime jobs, effectively addressing the need of renewed long term working careers in different fields. Technical career paths, non-high education and technology/ knowledge transfer need to be supported along with training towards researchers. This in order to support with properly skilled human potential the JPI's goal of enabling the advent of a maritime economy.

To propose solutions to make maritime careers more attractive thereby contributing towards blue growth, is a main task for the European Commission. Aligned to this, in the framework of the CSA-Oceans deliverable D6.1 'Mapping and preliminary analysis of infrastructures, observation/data and human capacity building', a case study focused on non-academic training in the transportation sector has been developed with the aim of analysing the support that can be provided by the research sector to the jobs of the sea. To recall some findings, the following issues have been addressed in order to detail the trends to be pursued in the short and medium term for a smart and effective "blue economy" development and revamping:

- concentrate the support of the institutions and investments on a selection of priorities, challenges and development requirements, fundamental for the "knowledge-based society";
- support the technological innovation and trials, promoting also the investments in the private sector;
- guarantee the full participation of all the stakeholders involved in the education paths;
- provide for valid monitoring and assessment systems of the education actions.

According to the case study, the capacity to activate dynamic synergies between the training system and the economic system is lacking.

JPI OCEANS ADDED VALUE

Under the umbrella of the JPI, a virtuous process in which future skills needs, labour market supply and demand trends in the marine and maritime area could be identified and tailored to higher education (vocational and professional). Moreover, **the attractiveness of the jobs of the sea could benefit from the coordination of a think tank bringing together the education system and the private sector to facilitate the dialogue between them and towards the policy makers**. This idea is reinforced by the following idea of interest arisen from the CSA extended questionnaire (with particular reference to the answers to question "In your opinion, what are the main needs/gaps, the actions and the most suitable tools/instruments to address human capacity building to advance towards the 3 goals of JPI Oceans?"): the creation of 'JPI centers' as hubs of reference for the setting-up of cross-disciplinary PhD and Post-doctoral training network.

From a technical point of view, the starting point can be the implementation of an extended case study on the jobs of the sea embracing different sectors and countries can be pursued as one of the future actions of the JPI, linked to a research project or in the framework of the next CSA Oceans.

IDENTIFIED NEEDS AND SPECIFIC OBJECTIVES

The table below include the key HCB needs identified after the stakeholder's consultation and the mapping exercise.

Focus	Identified Need	Specific objectives
Supporting actions	- Create jobs for marine young scientists in marine and maritime industry - Promote a Common European pool of human capacities for marine and maritime issues - Implement suitable EU/national policy instruments - Provide recommendations on the better management of funding schemes- Build a match-making portal related to marine science and technology aiding career development especially for young professionals - Support: o synergetic training programmes focused on marine and maritime issues, associating knowledge development with knowledge transfer o public-private exchange programmes o human capacity recycling, i.e. training people with no specific competences all the way along their life o diversification, e.g. in fisheries sector, tourism with a focus on fishing, diversification can bring to profitability improvement	- Cross-sector and international joint curricula on marine sciences and maritime engineering - Mapping of specific gaps in relation to the skills needed by industry, i.e. continuing analysing HCB needs looking at the courses available in all Europe to monitor, assess the impacts and fill gaps specifically related to the skills needed by industry - Contribute to build human capacity responding to the needs of the maritime sector - Bring in the industry more closely aligned to researchers and enhance the interfaces - Allow people to see the industry options from an early stage - Promote the idea: from "new knowledge" to "operational" - Implement cross-disciplinary PhD and Post-doctoral training network - Make maritime careers more attractive thereby contributing towards blue growth - Promote smarter working in the maritime sector, facilitating social innovation
Thematic input	- Improve the skills of researchers working in the field of fisheries and fish populations and improve their modelling skills - Promote an attractive/knowledge based aquaculture industry	- Development of training networks courses/programmes for exchange of researchers/fellowships in 'new tools applications for fisheries and environment assessment'

- **CSA OCEANS D6.1 Mapping and preliminary analysis of infrastructures, observation/data and human capacity building**

- European Commission Expert group final report on MRI (January 2013) : https://webgate.ec.europa.eu/maritimeforum/content/3158

- Marine Board position paper "Navigating to the future IV", and especially its chapter 11 dedicated to the EOOS issue (European Ocean Observing System) (June 2013) : http://www.marineboard.eu/images/publications/Navigating%20the%20Future%20IV-168.pdf

- Marine Biotechnology: A new Vision and Strategy for Europe, Marine Board-ESF Position Paper 15 http://www.esf.org/fileadmin/Public_documents/Publications/marine_biotechnology_01.pdf

- Seas-Era deliverables related to the MRI and HCB: http://www.seas-era.eu/np4/19.html

    - D4.1.1 "MRI updated overview, European integration and vision of the future" (October 2012)

    - D4.2.1 "MRI common management guidelines for joint research activities" (March 2013)

    - D4.3.1 "Access methodology to both private and public MRI" (October 2013)

    - SEAS-ERA D5.3.1, Proposal for Human Capacity Building calls within Common Programs and Joint Calls, Dec 2012

- OceanObs'09 Plenary and Community papers : http://www.oceanobs09.net/

- 'A Framework for Ocean Observing' , report prepared by the post-Oceanobs'09 Task Team for an Integrated Framework for Sustained Ocean Observing (IFSOO – UNESCO 2012) : http://unesdoc.unesco.org/images/0021/002112/211260e.pdf

- EuroGOOS Strategy for 2009-2013 http://www.eurogoos.org/documents/eurogoos/html_page/eg09_05eurogoos_strategy5.pdf

- EurOCEAN 2010 declaration : http://www.marineboard.eu/images/publications/EurOCEAN%202010%20and%20Ostend%20Declaration-76.pdf

- Consultation on "Marine Knowledge 2020 : from seabed mapping to ocean forecasting" (15 dec. 2012) : http://ec.europa.eu/dgs/maritimeaffairs_fisheries/consultations/marine-knowledge-2020/index_en.htm

- Marine Data Infrastructure: Outcome of Public Consultation. EC staff working document SEC(2010)73 final : https://webgate.ec.europa.eu/maritimeforum/system/files/COMM_PDF_SEC_2010_0073_F_EN_AUTRE_DOCUMENT_TRAVAIL_SERVICE.pdf

- The Rio Ocean declaration (16 June 2012) : http://www.unesco.org/new/fileadmin/MULTIMEDIA/HQ/SC/pdf/pdf_Rio_Ocean_Declaration_2012.pdf

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