PUBLICATIONS OF THE ACADEMY OF FINLAND 6/03

European Strategy on Marine Research Infrastructure

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Report compiled for the European Strategy Forum on Research Infrastructure by the Ad Hoc Working Group on Marine Research Infrastructure, April 2003

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Summary

The material conditions required for European scientists to advance marine science to its full capacity can be summarised into four strategic visions for the coming decade:

– European research vessels and associated marine equipment will constitute a coherent, flexible facility that can effectively respond to a wide array of research needs in European and international waters.
– European waters will be supplied by a network of buoys, profilers and sea bottom observation systems that will provide coherent data for monitoring the state of the environment, for modelling the ocean system, for tracing climate changes, for early warning of hazardous events (e.g. harmful algal blooms, storms), for search and rescue, and for operational forecasting.
– Samples, data analysis and other information retrieved by European marine scientists will benefit from the networks of well equipped marine centres, which provide on-line access to data, calibration and quality control procedures.
– European marine research will be supported by an integrated and interactive information system provided by new information technologies.

The review of the diversity, operation, management and co-ordination of Europe's marine research infrastructures as well as future requirements and investments, reveals the need of:

- better co-ordination and management of Europe's diverse marine research infrastructures
- long-term coherent planning of marine research infrastructure requirements and investments
- mechanisms to facilitate access to existing marine research infrastructures
- interactive web-based information systems to provide access to information on Europe's marine research infrastructures

Priority areas which need to be addressed include:

- research vessels and other mobile infrastructures (e.g. submersibles)
- marine monitoring and observing systems
- new emerging technologies/infrastructures
- marine data centres and databases

The co-ordination of existing marine research infrastructures and planning of future infrastructures would be most efficiently planned and executed in the context of a European Marine/Ocean Research Policy, which does not, at the moment, exist. The reform of the Common Fisheries Policy, the draft report of DG Environment 'Towards a Strategy to Protect and Conserve the Marine Environment' and recent discussions in the context of safety and security at sea are positive developments. The 2002 European Science Foundation Marine Board Position Paper 'Integrating Marine Science in Europe' is a potential framework for a European Marine/Ocean Research Policy.

In order to promote the development towards the strategic goals, the Ad Hoc Working Group of Marine Research Infrastructures recommends the establishment of a **Marine Infrastructures Strategy Group (MISG).** The Group should be composed of members mandated by Member States and Associated States active in marine research. The Group must be adequately resourced, be supported by a Secretariat and have the facility to establish working groups and expert panels as appropriate.

The establishment of a Marine Infrastructures Strategy Group would contribute significantly to the political vision of creating a European Research Area, including a European Marine Research Area; would lead to a more effective and cost-efficient use of Member States' and Associated States' Marine Research Infrastructures; would facilitate decisions on future research infrastructure requirements and investments; and would better inform the evolving EU Marine/ Ocean Research Policy.

Preface

The initiative to outline a European strategy on marine research infrastructure emerges from the concept of the European Research Area (ERA) which aims to co-ordinate research activities and facilitate the convergence of research and innovation policies, at national and EU levels. The final goal in the development of the ERA is to build a research and innovation equivalent of the 'common market' for goods and services.

This document was produced by an *ad hoc* Working Group on Marine Research Infrastructure, appointed by the European Strategy Forum for Research Infrastructure at its meeting in April 2002.
The scope of the Strategy Forum is:

- *to support a coherent and strategy–led approach to policy making on research infrastructures in Europe,*
- *to facilitate multilateral initiatives leading to a better use and development of research infrastructures*

The aim of this Working Group report is to identify the 'hot topics' with regard to marine research infrastructure that need to be addressed in order to improve the current situation, and thus provide material conditions for the development of the marine science field within the ERA. The Sixth EU Framework Programme offers mechanisms which should be used by the marine research community towards the advancement of the marine ERA.

The Working Group included representatives from thirteen EU Member States, three Associate Candidate Countries, one Associate Country, the European Commission. The working group members are:
Kaisa Kononen (Chair, Finland)
Rudy L. Herman and Dr George Pichot (Belgium)
Lars Stemmerik (Denmark)
Juri Elken (Estonia)
Gilles Ollier (European Commission)
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Mike Webb (United Kingdom)

Niamh Connolly (the Marine Board of the European Science Foundation) and Laurent d´Ozouville (European Centre for Information on Marine Science and Technology) attended some of the meetings as observers.

The Working Group met on four occasions: the 18th September 2002 in Helsinki, the 2nd December 2002 in Athens, the 7th and 8th January 2003 in London, and the 28th March 2003 in Lisbon.

Kaisa Kononen
Chair of the Working Group

1 Introduction

The European Union, by virtue of the priorities and foci of its Member State's marine resource development and Research & Technological Development (RTD) programmes, hosts a suite of sophisticated and expensive marine research infrastructures. These infrastructures include research vessels, submersibles and unmanned vehicles, research aircraft, moored instruments, tide gauges, Lagrangian observations facilities, coastal and marine observatories, marine laboratories, satellite oceanography centres, modelling and data centres, and ships of opportunity (see Annex 1 for more information). These infrastructures are scattered across the continent and it is widely regarded that the existing excellence in research, research funding and infrastructure is not optimally exploited or co-ordinated at a European level.

2 The need for a European Strategy on marine research infrastructures

The existence of, and access to, comprehensive research infrastructure is a prerequisite to a successful European research strategy, and as a consequence, to the sustainable use of Europe's marine resources for the betterment of society and the environment.

Given the size and economic importance (€110-190 billion/annum, EuroGOOS 1996) of the European marine resource and the suite of global issues (e.g. climate change, safety of navigation, state of the environment, etc.) which must be addressed at the global, regional and sub-regional levels, it is clear that Europe must in time evolve a Marine Resource Development or Ocean Management Policy, including a research policy component.

Despite the strategic and economic significance of marine resources, the EU does not have a coherent policy regarding marine resource development or marine RTD. Instead, individual EU Member States, to varying degrees, have national marine resource development and marine RTD policies or strategies. As a result, management of existing marine RTD infrastructures (vessels, observing systems, etc) and the planning of future marine research infrastructures is based on and reflects national rather than EU needs and priorities.

Europe is notably non-homogeneous with regard to marine RTD, the establishment of centres of excellence in marine science, the distribution and efficacy of the use of existing vessels, associated equipment and other infrastructures. Countries such as France, Germany, the Netherlands, Norway and the United Kingdom have well equipped research fleets, a strong scientific community, and the necessary funding to operate these marine facilities in national and international waters and in international programmes. The available infrastructure and marine RTD funding in Belgium, Greece, Ireland, Portugal, Spain and Sweden is sufficient for operating mainly in national and EU-funded programmes. Other countries, such as Finland and Estonia, either do not have the infrastructure or they have insufficient RTD funding to fully utilise such facilities.

An estimated 50 percent of national budgets for marine science is required for operating and replacing marine infrastructure assets. Cost-sharing the replacement of major infrastructures, widening access, and avoidance of overlap and duplication are necessary steps towards integration, in line with the EU Council of Ministers decision in June 2001.

As outlined by the ESF Marine Board publication 'Integrating Marine Science in Europe' (ESF-MB 2002), an enhanced pan-European large marine infrastructure capacity for monitoring and sustainable management of the ocean would result in operational services which would in turn support new industries, increase employment and protect the environment.

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2.1 The European Marine Resource

Europe has a sizeable marine resource by virtue of the 200-mile Exclusive Economic Zones and Extended Continental Shelves of its Member States. EuroGOOS (1996) estimates that this sea area adds 63 percent to the European land area. One could say that circa 40 percent of the European Union is underwater. It is, further, estimated that some 60 percent of the European population lives within 60 km of the 89,000 km European coastline (ESF-MB, 2002).

The value of the benefits derived directly from the European marine and coastal resource is estimated to exceed EUR 18 billion per annum. The value added by these activities is estimated to be of the order EUR 110-190 billion per annum (EuroGOOS, 1996). Ninety per cent of the EU's internal trade is conducted through shipping, with over 300,000 persons employed in the maritime and riverine transport chain in Europe.

These figures do not take into account the ecosystem services, calculated by Costanza et al. (1997) to be EUR 18,800 x 10^9 per annum for the global marine and coastal environment. This figure is equivalent to the global gross national product.

It is estimated that over 1 million Europeans are employed directly by the shipping, fisheries and aquaculture, and oil and gas sectors. In addition, considerable numbers are employed in leisure and tourism activities related to the sea. For example, the Mediterranean coastline is estimated to receive 75 million international and 60 million domestic visitors annually, all of whom have to be serviced by companies providing marine leisure activities (ESF-MB, 2002).

It is evident that an integrated strategy on marine research and its associated infrastructures is vital to secure effective and sustainable development of Europe's marine resource. Priority issues to ensure enhancement of marine research at regional level include the requirements to:
- promote regional research centres of excellence
- facilitate access to research infrastructures, and
- secure financial resources in relation to requirements.

2.2 European Marine Research & Technology Development

Currently, there is no EU Marine Resource Development/Ocean Management Policy, though policies in a number of related areas are developing (e.g. fisheries, marine environment, marine transport and safety). In addition, there is no European Marine RTD Policy, though:

(i) there is a clear convergence of national marine RTD Programmes (G. O´Sullivan, personal communication, CREST Working Group on 'Opening Member State RTD Programmes – Marine Science'),

(ii) the Commission is advocating the establishment of a European RTD Policy in the context of its 'European Research Area' initiative, and

(iii) there are

- regional initiatives for more coherent and synergetic use of marine research infrastructures and
- co-ordinated marine observation systems at the European level, as initiated by global programmes.

The concept of a European Marine RTD strategy has recently been brought forward by the European Science Foundation Marine Board in its report 'Integrating Marine Science in Europe' (ESF-MB 2002) which sets the tenor for the establishment of a European Marine Research Area. Specific recommendations regarding marine technology are given in Annex 2. The report emphasises that long-term baseline funding is particularly required for the development and operation of ocean observatories. These are European responsibilities of profound significance to the citizens, transcending the responsibilities and resources of most national programmes.

While it is difficult to calculate how much European States spend on marine RTD, it is estimated that the figure is significant and that up to 50 percent of this expenditure is on large-scale infrastructures (such as research vessels, submersibles, ocean observing systems).

Within Europe, activities which have emerged in recent years are aiming at a more coherent and synergetic use of marine research infrastructure (Box 1).

2.3 Conclusion

Clearly, given the strategic and economic importance of the European marine resource and the need to provide an input at the global, regional and sub-regional levels, there is a need to better co-ordinate and plan the use of existing marine RTD infrastructures and to identify and plan co-ordination for future needs. The obvious advantages of such an approach are measured in terms of optimising the efficiency of existing infrastructures, ensuring best value for money, adopting of best operational practices, and providing increased opportunities for new and emerging marine science and technology developments, including solutions to current problems.

In this context, the Marine Infrastructures Working Group fully supports and endorses the recommendations on marine RTD infrastructures contained in the ESF Marine Board Position Paper (ESF-MB 2002) (see Annex 2).

Box 1: European activities aiming at a more coherent and synergistic use of marine research infrastructure

- The barter system of the Marine Facilities Tripartite Group (MFTG) that facilitates the sharing of Dutch, French, German, Spanish and UK marine facilities (established 1996)
- ESF Marine Board European Research Vessel Operators (ERVO) Group, to exchange information and best practice in operational procedures for small research vessels (established 1999)
- ESF Marine Board Oceanographic Vessel Operators Group, to exchange information, best practice and plan future requirements for large research vessels (established 2003)
- EuroGOOS, association of 31 agencies, founded in 1994, to further the development of Operational Oceanography in the European Sea areas and adjacent oceans
- the EU Marine XML project to improve the interoperability of data for the marine community and specifically in support of marine observing systems
- the European Information Centre for Marine Science and Technology (EurOcean), an information centre to encourage communication and co-operation between European organisations
- ECORD, the European Consortium for maximizing European countries' participation in the Integrated Ocean Drilling Program (IODP) and providing the program with drilling platforms fit to individual missions
- Aurora Borealis, a new research icebreaker designed to drill in deep, permanently ice-covered basins, co-ordinated by a consortium of European countries, and
- The Sixth EU 6th Framework Programme support for Transnational Access and Integrating Activities

3 Visions for marine research infrastructure

The material conditions required for European scientists to advance marine science to its full capacity can be summarised into four strategic visions for the coming decade.

3.1 Research vessels and associated marine equipment

Vision: *European research vessels and associated marine equipment will constitute a coherent, flexible facility that will effectively respond to a wide array of research needs in European and international waters.*

Research vessels and associated marine equipment form the basis of European marine science infrastructure. Research vessels have been designed for different purposes (e.g. fisheries research, ocean drilling research, polar research, near-shore research, deep-sea research, etc.) and therefore they vary in size, number of crew, sea-going capacity and on-board facilities. In this report, only vessels that are over 30 metres in length have been considered, as these are regarded as potential European-scale facilities, whereas smaller vessels are considered to be primarily national-scale facilities.

Europe lacks co-ordinated, strategic planning for future investments in research vessels and marine equipment. At present, the European research fleet consists of approximately 35 multi-purpose ships (greater than 50 m in length) of which 18 have ice-class hulls for high latitude operations (NatFleet 2000). Europe also has one deep-sea research submersible and four deep-sea remotely operated vehicles, in addition to several shallow water submarines and autonomous underwater vehicles (see Annex 1). These marine facilities are owned, operated and renewed by national research institutions and it is anticipated that, for example, 15 new research vessels (costing around EUR 1.2 billion), will be built during the next decade (see Annex 3). Decisions regarding the investment, design and building of new marine facilities have been, and continue to be, undertaken with minimal co-ordination and unsufficient attention to interoperability to ensure that technical problems do not hinder or prevent the transfer of equipment between ships.

Many of these problems could be solved through better co-ordination and sharing of facilities via a 'virtual' European pool. In the absence of any federal funding, such as that provided in the USA to pay for the co-ordination of the University-National Oceanographic Laboratory System (UNOLS, Box 2), the most appropriate mechanism for sharing marine facilities on a European scale would be to adopt barter arrangements similar to the one used by the France, Germany, the Netherlands, Spain and UK. In so doing, a 'virtual' European pool would be created that would allow for the exchange of marine facilities between European States. An inventory of research vessels over 30 m in length and other facilities that may be available for inclusion in this virtual European pool is detailed in Annex 4.

Box 2: Co-ordination of oceanographic research facilities in the United States

The University-National Oceanographic Laboratory System (UNOLS) is a US organisation of 64 Academic Institutions and National Laboratories involved in oceanographic research and joined for the purpose of co-ordinating oceanographic ships' schedules and research facilities. One of the primary functions of UNOLS is to ensure the efficient scheduling of scientific cruises aboard the 27 research ships located at 20 operating institutions in the UNOLS organisation. Under this system the full economic cost of each operational day of the facilities is paid for from US federal sources, such as the National Science Foundation (NSF) and the Office of Naval Research (ONR).

Since all marine facilities are nationally owned, mutually agreed conditions for access to a European pool would need to be established (See Box 3).

Box 3: Conditions for shared use of European research vessels

The main conditions for the shared use of facilities include:

- Mutual exchange agreements for the barter and/or charter of marine facilities must be set up on a global and on a regional scale (e.g. covering the Mediterranean Sea and the Baltic Sea);
- Mutual exchange agreements must be arranged so that they do not financially disadvantage any of the member organisations;
- Requests for marine facilities must be submitted 12-18 months in advance of when they are required due to the long-term planning requirements of marine facilities programmes. Requests at short notice will only ever be accommodated on an opportunistic basis;
- The programming of marine facilities will remain the sole responsibility of the owner;
- The cost of the loss replacement, and/or damage repair, of exchanged marine facilities (for which no operational support is provided) is the responsibility of the user.

The main problems to be resolved include:

- Programming timetables for marine facilities will need to be aligned if there is to be effective co-ordination of facilities;
- A system that assures equivalent values when exchanging facilities will need to be developed;
- Legal and administrative issues regarding transboundary mobility of ships and scientists will need to be solved;
- Member organisations will have to establish a mechanism that provides the internal financial flexibility to deal with the exchange of their marine facilities in return for access to another organisation's facilities.

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3.2 Observing and monitoring networks

Vision: *European waters will be supplied by a network of buoys, profilers and sea bottom observation systems that will provide coherent data for monitoring the state of the environment, for modelling the ocean system, for tracing climate changes, for early warning of hazardous events (e.g. harmful algal blooms, storms), for search and rescue, and for operational forecasting*

Observations of long- or mid-term, large- or meso-scale phenomena cannot be done without networks of observation systems extending beyond national or regional borders. There is a requirement for long-term ocean monitoring, predictions of ocean circulation at a monthly and seasonal time scales, and climate simulations. Further effort is required to improve: (i) observing and modelling methods and technologies, and (ii) global collaboration and capacity building. In particular, coastal areas are predicted to become increasingly vulnerable to the effects of global warming, including sea level rise, increased storminess, increased wave height etc. A long-term coastal observing network is needed in Europe to contribute to the monitoring and forecasting of extreme events predicted to occur.

A global framework for observations of ocean variables that are required to support ocean services are prepared within international programmes such as Global Ocean Observing System (GOOS) and Global Monitoring for Environment and Security (GMES). EuroGOOS represents the European contribution to GOOS and is also involved in GMES. Founded in 1994, EuroGOOS is an association of agencies, currently representing 31 members from 16 European countries. It was established to foster the goals of GOOS, and in particular the development of operational oceanography (Box 4) in the European Sea areas and adjacent oceans. EuroGOOS gives full recognition to the importance of existing systems in research and operational oceanography in Europe at national and European levels.

Within the EC GMES programme there is a requirement for sea floor observatories with a real time data capacity for providing alarm functions in the case of geo-hazards such as earthquakes, methane venting, slope slides and resulting tsunamis. Furthermore the sea floor around Europe supports immense biodiversity probably exceeding that of the land mass of Europe. Much of that biodiversity, including new species, is found in specialised and newly-discovered ecosystems, such as deep coral mounds, hydrothermal vents, mud volcanoes and seeps which are often highly localised, time-varying and vulnerable to damage. Understanding these systems requires long-term time-series data. In 2003, the ESONET programme – European Sea Floor Observatory Network - was set up to develop the concept of a network of sea floor observatories around the European ocean margin, from the Arctic Ocean to the Black Sea, for strategic long-term monitoring with capability in geophysics, geotechnics, chemistry, biochemistry, oceanography, biology and fisheries. Such a sea floor infrastructure with cables could also incorporate sensors of importance to GOOS.

Box 4: Operational Oceanography

Operational Oceanography can be defined as the activity of systematic and long-term routine measurements of the seas and oceans and atmosphere, and their rapid interpretation and dissemination. Important products derived from operational oceanography include:

- nowcasts providing the most useful accurate description of the present state of the sea including living resources
- forecasts providing continuous forecasts of the future condition of the sea for as far ahead as possible
- hindcasts assembling long -term data sets which will provide data for description of past states, and time series showing trends and changes.

Operational Oceanography usually, but not always, involves the rapid transmission of observational data to data assimilation centre, where powerful computers using numerical forecasting models process the data. The outputs from the models are used to generate data products, often through intermediary value-adding organisations. Examples of final products include warnings (of coastal floods, ice and storm damage, harmful algal blooms and contaminants, etc.), electronic charts, optimum routes for ships and predictions of seasonal or annual primary productivity, of ocean currents, and of ocean climate variability, etc. The final products and forecasts must be distributed rapidly to industrial users, government agencies, and regulatory authorities.

3.3 Data, computer centres and laboratories

Vision: *Samples, data analysis and other information retrieved by European marine scientists will benefit from the networks of well equipped marine centres, which provide on-line access to data, calibration and quality control procedures.*

Over recent decades, Europe has contributed significantly to advances in oceanography and marine sciences and technology, which have led to a rapid expansion of data and information related to the ocean and the marine environment. In parallel, the sustainable use of ocean and marine resources and services necessitates the collection of reliable and coherent marine data sets which transcend national or regional borders. Research is, however, often conducted at temporal and spatial scales that do not allow detection of long-term or large-scale trends. Data resulting from individual projects have to be combined in large databases, in order for them to be effective in providing answers to important issues, such as the effects of global warming, depletion of fish stocks or deteriorating environmental quality.

In order to better respond to today's and tomorrow's user demands, EU policy has to continue its efforts on the establishment of data and information networks. This will create the necessary critical mass, capacity and creative environment to facilitate the further development and maintenance of services and products, with emphasis on improving the efficiency and effectiveness of the data and information stream. This will strengthen the capacity of European countries to manage oceanographic and marine science data and information, to assist in a better provision of ocean data as well as information products and services.

Marine science involves data that is analysed by a full range of methodologies requiring a high level of specialised expertise and advanced, expensive technologies. Apart from the basic technologies necessary for every marine laboratory, laboratories have a limited capacity to expand their know-how and equipment for more sophisticated analyses. On the other hand, in many cases one laboratory or one country cannot operate and use its equipment at full capacity. Major benefits would arise from the networking of laboratories to provide high-quality services to marine scientists all over Europe.

Additionally, the standardisation of mobile laboratories, both shipping containers and shore based transport facilities, will contribute to the need for maximum portability. In parallel, the standardisation of methodologies, sampling procedures and protocols will benefit interoperability, exchange and joint use of marine research facilities. Also, data management has to be standardised, and satisfy minimum requirements for quality assurance. National and transnational agencies can act as data centres that can assist in implementing data management protocols, and as long-term stewards of project data. Furthermore, they can assure physical integrity of datasets for generations to come.

The enlargement of the European Union to include new countries (many of which have maritime borders and already possess valuable marine data sets) emphasises the necessity for having a European policy on oceanographic data (Box 5).

Box 5: Requirements for a European oceanographic data policy

European policy on oceanographic data would require:
- common rules for measurements
- standardisation of data
- secure storage of appropriate data
- agreement on access rights to the data (e.g. along principles similar to resolution 40 of WMO: World Meteorological Organisation)
- technological developments to access to the data through new technologies for information and communication (such as DataGrid project funded by EU)
- networking of national contact points in charge of these different topics

Simulations ranging from small-scale physical, chemical and biological processes to global-scale circulations and climate change forecasts require large computing capacities. The numerical simulation of the Earth system requires the representation of the ocean, the atmosphere, the cryosphere and the land surface, as well as their interactions with each other. Such simulations will require future investment in more powerful computer facilities than currently exist within Europe. An example of such a facility is the Japanese ‘Earth simulator’ (Box 6). To be useful, such a computer centre will not only require a large amount of infrastructure funding to provide for high running costs (for maintenance, engineering, peripherals, etc.), but it will also require a large amount of investment to provide the high-speed network connections which will link laboratories within the EU. Such a facility would obviously be crucial for Europe to stay at the forefront of climate and global change research, but given the high level of investments required, it is likely that the costs of such a facility will have to be shared by several EU States with additional funding provided through the EU. There are many issues related to the establishment of such a European computer centre that will need to be addressed.

Box 6: Japanese 'Earth Simulator' supercomputer

In order to solve global environmental problems and to take measures against natural disasters, the Japanese Science and Technology began an 'Earth Simulator' project in the fiscal year of 1997. It enables the forecast of various Earth phenomena through the simulation of a 'virtual Earth' in a supercomputer. This project is expected to be a breakthrough in bridging the geoscience and information science fields. Within this 'Earth Simulator' project, the GeoFEM group will deal with the modelling of atmospheric, oceanic and solid field phenomena and will carry out a high-resolution simulation. The 'Earth simulator' costs ca. EUR 400 million and is capable of 25 teraflops (i.e. 25 trillion floating point operations per second). When complete, this software will be able to deal with problems in the scale of 100 million degree of freedoms.

3.4 Integrated and interactive information systems

Vision: *European marine research will be supported by an integrated and interactive information system provided by new information technologies.*

Facilitating the access to information in marine research is a prerequisite to any initiatives aiming to structure the co-ordination and the co-operation of marine research infrastructure in Europe. This goal could be fulfilled through electronic focal points or Internet portals, which should facilitate the creation, circulation and maintenance of information for the scientific community, the operators and the decision makers. This should also facilitate exchange of information with the industry and SMEs, and other stakeholders, including the general public.

The information should be tailored according to the requirements of the end-users, and the appropriate tools, such as search engines, automatic mailings, discussion fora, newsletters, etc. should be made available for easy and efficient use. The content and the management tools of the internet portal could be selected by a group of experts representing the different categories of end-users, including the general public.

Internet portals EurOcean (http://www.eurocean.org) and Sea-Search (www.sea-search.net), are good examples of appropriate tools, needed for the realisation a marine infrastructure strategy for Europe.

4 Recommendation

Having exchanged and reviewed information on the diversity, operation, management and co-ordination of Europe's marine research infrastructures as well as future requirements and investments, the Working Group recommends the establishment of a **Marine Infrastructures Strategy Group (MISG).**

The Marine Infrastructures Strategy Group should be composed of members mandated by Member States and Associate States active in marine research.

The function of the Marine Infrastructures Strategy Group would be to advise on and promote mechanisms to:

- better co-ordinate and manage Europe's diverse marine research infrastructures
- advise on long-term marine research infrastructure requirements and investments
- facilitate access to existing marine research infrastructures
- establish an interactive web-based information system to provide access to information on Europe's marine research infrastructures, and
- address specific queries that may be put forward by the European Strategy Forum for Research Infrastructures or individual states

The Marine Infrastructures Strategy Group must be adequately resourced, be supported by a Secretariat and have the facility to establish working groups and expert panels as appropriate.

Priority areas which would be addressed include:

- research vessels and other mobile infrastructures (e.g. submersibles)
- marine monitoring and observing systems
- new emerging technologies/infrastructures, and
- marine data centres and databases.

The co-ordination of existing marine research infrastructures and planning of future infrastructures would be most efficiently planned and executed in the context of a European Marine/Ocean Research Policy, which does not, at the moment, exist. The Working Group regards the reform of the Common Fisheries Policy, the draft report of DG Environment 'Towards a Strategy to Protect and Conserve the Marine Environment' and recent discussions in the context of safety and security at sea as very positive developments. The Marine Infrastructures Working Group acknowledges the 2002 ESF Marine Board Position Paper 'Integrating Marine Science in Europe' as a potential framework for a European Marine/Ocean Research Policy and fully supports and endorses the recommendations contained in the ESF-MB Position Paper on marine research infrastructures.

The establishment of a Marine Infrastructures Strategy Group would contribute significantly to the political vision of creating a European Research Area, including a European Marine Research Area; would lead to a more effective and cost-efficient use of Member States' and Associated States' Marine Research Infrastructures; would facilitate decisions on future research infrastructure requirements and investments; and would better inform the evolving EU Marine/Ocean Research Policy.

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Annex 1: European marine research infrastructure

Research vessels

The European research fleet is comprised of some 98 ships greater than 30 m in lenght, belonging mostly to national research institutions (Figs 1, 2 & 3). The fleet is mainly supported by national funds, with the European Union contributing little or no money for its upgrading or maintenance. The fleet can be divided mainly to ocean-going vessels, many of them with ice-breaking capabilities, and ships for coastal research. The ships' operators range from Navy Hydrographic Services and Academic Institutions to Governmental Research Institutes and Private Companies. France, Germany, the Netherlands, Spain and the United Kingdom have proceeded to form a Tripartite Agreement among themselves, which ensures that services can be exchanged among vessel operators of different countries, based on a 'point' system (without exchange of currency). In the absence of European-level support, there is very little hope of further joint exploitation of the existing facilities. The construction of R/V Thalassa by combined French, Spanish and European structural funds, could serve as a pilot for the progressive replacement of the ageing European fleet of research vessels.

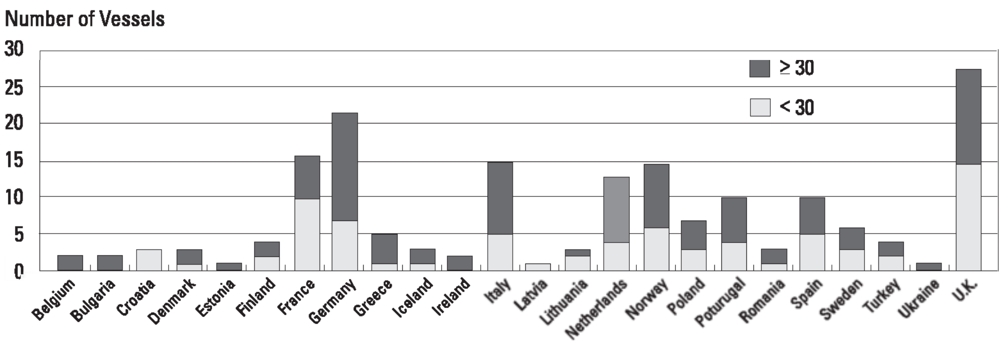

Fig. 1. European Research Vessels by Country (Total number of Research Vessels: 179)

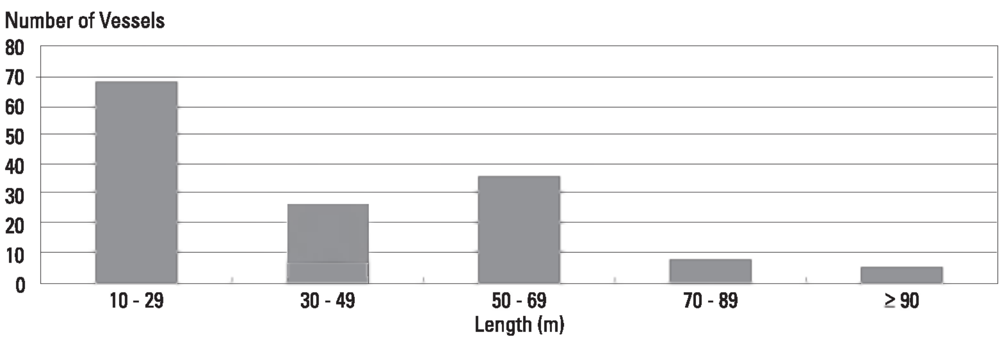

Fig. 2. European Research Vessels by Length (Total number of Research Vessels: 179)

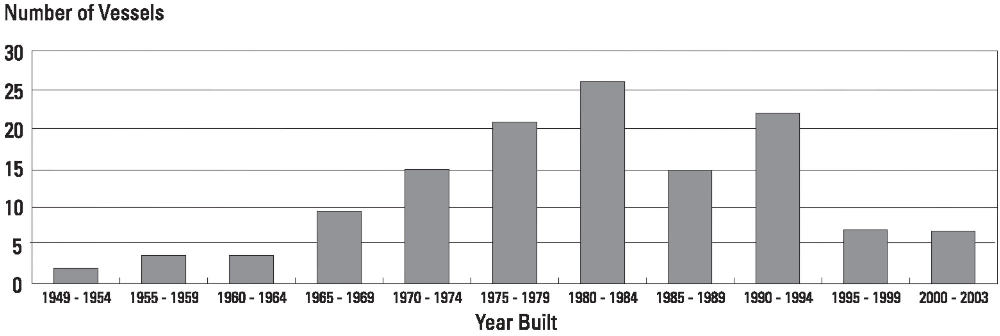

Fig. 3. European Research Vessels by building year (Total number of Research Vessels: 150)

Source: EurOcean database of European coastal to high seas research vessels. (Database under completion).

Research submersibles and unmanned vehicles

On a European level, France has one deep research submersible (Nautile), capable of operating at the depth of 6,000 m. Greece operates a COMEX submersible of REMORA 2000 type in the Mediterranean, with 600 m depth capability. A twin submersible is under operation by the manufacturer. In addition to the small fleet of research submersibles, a larger fleet of unmanned vehicles, remotely operated vehicles (ROVs) and autonomous underwater vehicles (AUVs) serves scientific, as well as commercial purposes. IFREMER's Victor 6000 ROV and the UK's ISIS ROV are both capable of operating at 6,000 m depth. Germany operates two ROVs: QUEST 5 is capable of 4,000 m depth and Cherokee as deep as 1,000m. NERC's Autosub is probably Europe's most modern and capable AUV, showing the direction that marine research could move in an effort to develop more efficient data collection methods.

Research aircraft

A few countries have several small aircraft devoted to environmental research. However, these aircraft mostly perform meteorological research. Occasionally, some of them are equipped with sensors useful to marine and air-sea interaction research, such as SAR.

Moored instruments

Several European countries, recognising the importance of observations and ocean forecasting on their societies, have undertaken initiatives (either co-funded by the EU and international organisations, or unilaterally), to establish networks of moored marine and meteorological monitoring stations. EuroGOOS, stated in the framework of the global GOOS, is an Association of Agencies, founded in 1994 to further the goals of GOOS, and in particular the development of Operational Oceanography in the European Sea areas and adjacent oceans. A number of operational oceanography initiatives are under way in several European countries. The European Seas are routinely monitored by several mooring networks: France, Greece, Ireland Norway, Spain, and the United Kingdom operate mooring networks in their EEZ zones to monitor weather, wave and oceanographic conditions in the framework of their respective national operational oceanography projects. Several other countries operate moorings in their waters, mostly for research purposes. For global weather monitoring and forecasting, some European countries have positioned several deep-sea moorings in oceans away from the European slope, such as the Tropical Atlantic (PIRATA and MOVE projects, both in the framework of CLIVAR). In addition to the above networks, the deployment of a marine seismographic network is under way in many countries.

Recent figures prepared by NOOS (2001) suggest that the benefits to be derived from improved ocean observing systems is around EUR 340-840 million per year.

Tide gauges

The oldest network in Europe for monitoring marine conditions is probably the tide-gauge network, for recording and mapping sea-surface elevation. The network operates mostly under the authorities of national Naval Hydrographic Services. Co-ordinating and upgrading the network would be very profitable not only in terms of data quality but also in early-warning applications.

Lagrangian observations facilities

One not-so-widely known activity of European (and global) dimension is the monitoring of oceanic circulation with the use of surface drifters and neutral-buoyancy floats. The use of surface drifters does not need much infrastructure (other than the satellite tracking, mostly through the ARGOS system), but neutrally buoyant floats demand the operation and maintenance of several sound sources deployed in the Atlantic Ocean, an operation which is costly and personnel-demanding. Currently, most of this maintenance is taken care of by the national Naval Services.

Marine observatories

Throughout the European coasts there are several coastal marine laboratories, operating under either national or local funds. Monitoring marine pollution is the main occupation of the majority, and thus they employ scientists of multiple disciplines. Here, we include calibration centres: facilities that are not very widely distributed among European nations and that could probably be much better exploited through efforts such as building the European Research Area.

In the last ten years, the use of coastal high-frequency radars for continuous monitoring of surface currents and wave-fields is gaining momentum. Such radars are being installed in several regions. Deep-sea observatories are still in their early stages of conception and pilot installation. The scientific and technological community in Europe is working under the umbrella of more than one concept (e.g. MOMAR, B-DEOS, ESONET). These efforts should be followed given their relevance to the integration of scientific and technological research for the study and monitoring of unique ecosystems of the deep-sea.

Satellite Oceanography Centres

Satellite data are of unique value to oceanography, as they supply an unprecedented amount of data, and continuous coverage of large or global regions, and because the ratio of cost to benefit is relatively small. Despite this fact, the use of satellite images in oceanography and marine resource management has not been extended much, due to the significant amount of specialised analysis needed. There are several centres (e.g. SAI/JRC, or the German DLR and French CERSAT) that specialise in such activities; extending the distribution of their products would greatly increase the gain of the community from satellite oceanographic applications.

Numerical modelling centres

Numerical modelling has become one of the major components of oceanographic research. Subjects such as global climate forecasting and operational oceanography demand great numerical power, and for some applications the use of supercomputing facilities is necessary.

Ships of opportunity

Ships of opportunity (or Voluntary Observing Ships) are extensively used in the world ocean as a cheap solution offering global coverage and repeated measurements, mostly in the framework of operational oceanography projects such as GOOS. Ships of opportunity provide meteorological, sea-surface, and upper ocean temperature observations on a routinely basis, while other parameters (like currents) could also be added to the list. The European components of the above initiative, BOOS and MedGOOS, have adopted such methodologies through projects like MFSPP, MFSTEP and FerryBox. There is a modern trend to replace SOP (VOS) methods with other, more modern and environmentally friendly methods, such as the use of Lagrangian surface drifters and profilers, as well as gliders and AUVs.

Annex 2: Recommendations extracted from the ESF Marine Board Position Paper 'Integrating Marine Science in Europe'

1 Strategic observing and monitoring systems

1.1 Coastal areas are predicted to become increasingly vulnerable to the effects of global warming. Effects include sea level rise, flooding of lowlands, inundation of installations and settlements (urban and tourist), changing erosion patterns, salt intrusion into groundwater, littoral zone exposure to extreme winds, and increased river flows due to wetter seasons. A European long-term coastal observing network is required to contribute to monitoring and forecasting extreme events predicted to occur more frequently under greenhouse scenarios.

1.2 There is an overall requirement within operational oceanography for long-term climate simulations, models of climate predictions, monthly ocean current, weekly meteorological predictions, and coastal current predictions of several days in advance. Few systems are currently in an operational state, and effort is required to improve observing and modelling methods and technologies, capacity building and global collaboration. Updating European bathymetric charts is necessary to contribute to the development of more accurate models for operational oceanography.

1.3 Research is required for the development of systematic means of acquisition (and production) of information from satellite and other sensor data delivered in a timely manner. There is a requirement for research to look beyond the oceanographic problem per se and include the processes required for data processing, data merging, and the for data and product delivery.

2 Critical technologies

2.1 To understand and predict ocean-climate coupling and the sustainable use of marine resources, and to describe the European component of global systems, long-term baseline funding for the development and operation of ocean observatories is required. These are European responsibilities of profound significance to its citizens, and also to the world, transcending the responsibilities and resources of most national programmes. Therefore, a special effort should be made to ensure a visible and effective research contribution by Europe to this domain.

3 Research Infrastructures

3.1 Availability of an oceanographic fleet, and associated equipment including underwater vehicles, will continue to be essential for research at sea. There are strategic requirements for a set of European policies and arrangements to maximise the use of these infrastructures on a pan-European scale and to advise the European Commission and national agencies on new specifications, improved access and cost sharing for these infrastructural investments. The strategic vision exists and the tools for collaboration and co-ordination are already available, and should be consolidated within the timeframe of the European Commission's FP6.

3.2 Europe should widen its support for integrated marine science by incentives for scientific and industrial partnerships and enhanced mobility. Researchers must be encouraged and facilitated in developing industrial links, including Public Private Partnerships (PPPs), to maximise the manufacture and exchange of novel technologies within Europe and to maximise European industrial competitiveness, for the benefit of both marine science and society. Attracting and retaining young researchers into marine science is particularly important to ensure continued development of European capacity and capability.

3.3 A revised effective European data policy should be rapidly elaborated and put into action to ensure: (i) secure storage of appropriate data; (ii) quality control; (iii) interoperability and open access for science in a timely manner to the petabytes of data and products expected from the next generation of ocean observatories and operational forecasts.

3.4 A forum should be established to address the issues of data standards, indexing, transfer and storage. This forum would provide a focus for increased co-ordination and co-operation between researchers, agencies and authorities.

3.5 As part of the European enlargement, investment in regional marine research and infrastructures should be enhanced so as to reduce regional disparity in scientific knowledge, innovation, RTD and competitiveness.

3.6 Europe's capacity for oceanographic monitoring from space should be enhanced, in particular with regard to research satellites for observing new parameters such as thickness of sea ice, surface salinity etc. In addition, there should be further investment in periodic satellites for observing oceanic evidence of climate change.

3.7 Investment priorities for marine research should be agreed across Europe, and should be designed so that they are not constrained by the limited lifecycles of national and European Union funding programmes. This will ensure not only long-term viability of observation networks, but also retention of capacity and capability within Europe.

Annex 3:
Planned investments in new research vessels

For the period 2003-2013, at least 15 large research vessels are planned to be built. Of these, six have actually been approved and are under construction or will soon be built. Total investment for these ships is estimated at around EUR 1.2 billion. This is only a minimum estimate of the planned investment in the European research fleet, as smaller coastal vessels and planned revisions or extensions of existing vessels are not included.

For the vessels at the planning stage, there is an interest in studying the possibility of joint investments. As an example, a feasibility study has been carried out to construct a new European multi-purpose ice-breaker called 'Aurora Borealis'.

A summary of the reports received:

Repair/extension- M€ (year)*	**New small vessels – M€ (year)***	**New large vessels (> 35 m) – M€ (year)**
Denmark – 0.5	France – 15 (2005)	France – 60 (2003)
Italy – 3 (2003)	Norway – 15 (2004)	Ireland – 32 (2003)
Finland – 0.5 (2004)	Finland – 1.5 (2004)	Norway – 54 (2003)
Spain – 10 (2004)		Germany – 53 (2004)
		Spain – 24 (2005)
		France – 66 (2005)
		UK – 54 (2006)
		Norway – 100 (2007)
		Germany – 50 (2007)
		Germany – 160 (2009)
		Poland – 50 (2010)
		UK – 90 (2010)
		France – 30 (2010)
		Germany – 300 (2012)
		Germany – 150 (2015)
14 M€	3 vessels 31.5 M€	15 vessels 1,253 M€

* this is an underestimate, as information provided was incomplete

Annex 4:

Contents

Marine research infrastructure potentially available for inclusion in the European pool

A. RESEARCH VESSELS over 30m in length

Country	Name	L m	Year	Type	Operation area	Technical Details	No crew/ scientists	Contact person	Owner	Vessel pool	Avail- ability	Barter	Charter	Unique Facilities	Scheduling months
BELGIUM	BELGICA	55	1984	MP	North Sea, Atlantic margin	www.mumm.ac.be	15/16	André Pollentier, MUMM, 3de en 23ste Linieregimentsplein, B-8400 Ostend, Belgium. A.Pollentier@mumm.ac.be	Belgian State	Y	R	Y	N		15
	ZEELEEUW	56	1977	MP	North Sea, coastal	www.vliz.be/En/Activ/zeeleeuw.htm	10/25	André Catrijsse, Flanders Marine Institute, andre.cattrijsse@vliz.be	Flaat division (Ministry of Flanders)	Y	R	Y	N		3
DENMARK	GENETICA II	15	1964/1990	OCE	Until 6° East. North Sea	www.biology.au.dk/genetica	2/4 (12)	Verner.Damm@biology.au.dk	University of Aarhus		S			Triaxus TOW /Trawl	
	H/S DANA	78	1981	DS	North Atlantic, Baltic	www.dfu.min.dk	15-17/8-12	Mogens Bugge	DFU	N			Y		
FINLAND	ARANDA	59	1989	MP	Baltic, Polar	www2.fimr.fi/en/aranda.html	13/25	Hannu Grönvall, Finnish Institute of Marine Research, PO Box 33, 00931 Helsinki. hannu.gronvall@fimr.fi	Finnish Institute of Marine Research Ifremer	N	S	Y	Y		6
FRANCE	ATALANTE	85	1989	OCE	Global	www.ifremer.fr/flotte	30/30	Jean.Xavier.Castrec@ifremer.fr	Ifremer	Y	S	Y	Y	Support Nautile and Victor 6000	24
	THALASSA	74	1996	FIS	Global	www.ifremer.fr/flotte	25/25	Jean.Xavier.Castrec@ifremer.fr	Ifremer	Y	S	Y	Y	Support Victor 6000	24
	SUROIT	56	1975/ 1999	OCE	Global	www.ifremer.fr/flotte	23/17	Jean.Xavier.Castrec@ifremer.fr	Ifremer	Y	S	Y	Y		24
	NADIR	56	1974, soon retired	SUP	Global	www.ifremer.fr/flotte	17/25	Jean.Xavier.Castrec@ifremer.fr	Ifremer	Y	S	Y	Y	Support Nautile	24
GERMANY	POLARSTERN	118	1982	MP	Polar, Global	www.awi-bremerhaven.de	41/50	Hartmut Keune, BMBF. hartmut.keune@bmbf.bund.de	BRD/BMBF	Y	S	Y	N	Research Ice Breaker	
	METEOR	90	1985/ 1986	MP	Global	www.ifm.uni-hamburg.de/ves/ves_leit.html	32/30	Hartmut Keune, BMBF. hartmut.keune@bmbf.bund.de	BRD/BMBF	Y	S	Y	N		
	ALKOR	50	1990	MP	Atlantic	www.ifm.uni-hamburg.de/ves/ves_leit.html	10/15	Hartmut Keune, BMBF. hartmut.keune@bmbf.bund.de	BRD/BMBF	Y	S	Y	N		
	HEINCKE	50	1990	MP	Atlantic	www.ifm.uni-hamburg.de/ves/ves_leit.html	10/15	Hartmut Keune, BMBF. hartmut.keune@bmbf.bund.de	BRD/BMBF	Y	S	Y	N		

Year: year in which vessel entered into service/year of refitting
Type of vessel: FIS - fisheries, OCE - oceanographic, MP - multipurpose, SUP - support vessel, ICE - ice-breaker, DS - Deep Sea Stem Trawler
Vessel Pool: Is the vessel currently part of a bilateral or multilateral sharing arrangement? Y - yes, N - no
Availability: S - on the basis of standard charter/barter agreement, JP - in joint projects, R - restricted
Barter: Are barter arrangements possible.Y - yes, N - no
Charter: Are charter arrangements possible. Y -yes, N - no

Country	Name	L m	Year	Type	Operation area	Technical Details	No crew/ scientists	Contact person	Owner	Vessel pool	Avail-ability	Barter	Charter	Unique Facilities	Scheduling months
GERMANY	MARIA. S.MERIAN	90	2004/ 2005	MP	Atlantic/ Ice edge	www.ifm.uni-hamburg.de/ves/ves_leit.html		Hartmut Keune, BMBF. hartmut.keune@bmbf.bund.de	BRD/BMBF	Y					
	SONNE	97	1977/ 1991	MP	Global	www.rf-bremen.com	30/25	Hartmut Keune, BMBF. hartmut.keune@bmbf.bund.de	Partenreederei MS SONNE	Y	S	Y	N	Geophysical equipment; can support Victor 6000	
GREECE	AEGAEO	62	1985	MP	Mediterr. and Black Sea	site under construction	21/20	Dimitris Georgopoulos, National Centre for Marine Research, Institute of Oceanography, P.O. Box 712, 190 13 Anavyssos, Greece. dgeor@ncmr.gr	National Centre for Marine Research	N	S, JP	N	Y	Can support the submersible THETIS	6
IRELAND	CELTIC VOYAGER	31	1997	MP	Atlantic	www.marine.ie/rnd+facilities/ research+vessels/celtic+voyager/ index.htm	6/8	Mick Gillooly, Marine Institute, Galway Technology Park, Parkmore, Galway, Ireland. michael.gillooly@marine.ie	Marine Institute	Y	S	Y	Y		
	CELTIC EXPLORER	66	2003	MP	Atlantic	www.marine.ie/rnd+facilities/ research+vessels/celtic+explorer/ index.htm	13/18	Mick Gillooly, Marine Institute, Galway Technology Park, Parkmore, Galway, Ireland. michael.gillooly@marine.ie	Marine Institute	Y	S	Y	Y	Acoustically Insulated (ICES) / Multibeam echosounder	
ITALY	OGS EXPLORA	73	1972	MP	Ocean, Polar	www.ogs.trieste.it	17/21	P Berger - OGS, Borgo Grotta Gigante 42/C, 34010 Trieste, Italy. pberger@ogs.trieste.it	OGS	Y	JP	Y	Y		18
	URANIA	61	1992	MP	Mediterr.		13/7	M. Buzio - CNR	Sopromar/CNR	Y	JP	Y	Y		18
	UNIVERSITATIS	45	2002	MP	Mediterr	www.conisma.it		President CONISMA	CONISMA	Y	JP	Y	Y		18
NETHERLANDS	PELAGIA	66	1991	MP	Global	www..nioz.nl/en/facilities/vessels/pelagia/ pelagia.htm	10 / 15	Marieke J. Rietveld, Royal NIOZ, PO Box 59, NL-1790 AB Den Burg. rietveld@nioz.nl	Royal NIOZ	Y	S	Y	Y		16th Sept

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Availability: S - on the basis of standard charter/barter agreement, JP - in joint projects, R - restricted
Barter: Are barter arrangements possible.Y - yes, N - no
Charter: Are charter arrangements possible. Y -yes, N - no

Country	Name	L m	Year	Type	Operation area	Technical Details	No crew/ scientists	Contact person	Owner	Vessel pool	Avail-ability	Barter	Charter	Unique Facilities	Scheduling months
NORWAY	G.O.SARS	78	2003	MP	Atlantic	www.imr.no		Per W. Nieuwejaar, Institute of Marine Research, P.O. Box 1870 Nordnes, N-5817 Bergen. per.nieuwejaar@imr.no	Inst.of Marine Research	Y	S				
	JOHAN HJORT	64	1990	MP	Atlantic	www.imr.no	13/18	Per W. Nieuwejaar	Inst.of Marine Research	Y	S				
	HÅKON MOSBY	47	1980	MP	Atlantic	www.imr.no	8/17	Per W. Nieuwejaar	Inst.of Marine Research	Y	S				
	G.M. DANNEVIG	28	1979	MP	Atlantic	www.imr.no	3/9	Per W. Nieuwejaar	Inst.of Marine Research	Y	S				
	DR.FR. NANSEN	57	1993	MP	Global	www.imr.no	11/20	Per W. Nieuwejaar	Inst.of Marine Research	N	S				
	JAN MAYEN	63	1988	MP	Atlantic	www.nfh.uit.no	11/29	Jon E. Hansen	Univ. of Tromsø	Y	S				
	JOHAN RUUD	31	1976	MP	Atlantic	www.nfh.uit.no	8/11	Jon E. Hansen	Univ. Of Tromsø	N	S				
	LANCE	61	1978/ 1981	OCE	Polar	www.npolar.no	12/25	Mikelborg	Insti. of Polar Research	N	S				
POLAND	OCEANIA	49	1985	OCE	N. Atlantic, Baltic	www.iopan.gda.pl/oceania/oceania.html	14/14	Jacek WyrwiDski, Institute of Oceanology PAS 81-967 Sopot, ul. Powstancow Warszawy 55 telex: 0512785 opan PL phone: (++48-58) 51-21-30	Institute of Oceanology, PAS	N	S	Y	Y		12
	BALTICA	41	1993	FIS	Baltic Sea	www.mir.gdynia.pl	11/11	Roman Osmólski	MIR/IMGW	N	S	Y	Y		12
PORTUGAL	NORUEGA	47	1980	FIS	Atlantic	ipimar-iniap.ipimar.pt/navios.html	18/12	Eng. Joaquim Pissarra; IPIMAR, Av. Brasilia 1449-006 Lisboa, Portugal; tel:+351 213027000	Instituto de Investigacao das Pescas e do Mar (IPIMAR)/Min. of Ag. & Fisheries	N	S		Y		6 to 12

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Charter: Are charter arrangements possible. Y -yes, N - no

Country	Name	L m	Year	Type	Operation area	Technical Details	No crew/ scientists	Contact person	Owner	Vessel pool	Avail-ability	Barter	Charter	Unique Facilities	Scheduling months
PORTUGAL	CAPRI-CORNIO	47	1971/ ?	FIS	Atlantic	ipimar-iniap.ipimar.pt/navios.html	18/19	Joaquim Pissarra; IPIMAR, Av. Brasilia 1449-006 Lisboa, Portugal	Instituto de Investigacao das Pescas e do Mar (IPIMAR)/Min. of Ag. & Fisheries	N	S		Y		6 to 12
	D. CARLOS.I	68	1989/ 2003	OCE	Atlantic	www.hidrografico.pt/hidrografico/navios/ navios.htm	34 & 12	Rua das Trinas, 49, 1249-093 Lisboa, Portugal; tel +351 210943000; dirgeral@hidrografico.pt	Instituto Hidrografico/ Min. of Defense;	Y?	S	Y?	Y		6 to 12
	ALMIRANTE GAGO COUTINHO	68	1985/ 2003	OCE	Atlantic	www.hidrografico.pt/hidrografico/navios/ navios.htm	34/12	Rua das Trinas, 49, 1249-093 Lisboa, Portugal; tel +351 210943000; dirgeral@hidrografico.pt	Instituto Hidrografico/ Min. of Defense	Y?	S	Y?	Y		6 to 12
	ANDROMEDA	31,5	1987	OCE	Atlantic	www.hidrografico.pt/hidrografico/navios/ navios.htm	18/ 6	Rua das Trinas, 49, 1249-093 Lisboa, Portugal; tel +351 210943000; dirgeral@hidrografico.pt	Instituto Hidrografico/ Min. of Defense		S		Y		6 to 12
	AURIGA	31	1987	OCE	Atlantic	www.hidrografico.pt/hidrografico/navios/ navios.htm	19/6	Rua das Trinas, 49, 1249-093 Lisboa, Portugal; tel +351 210943000; dirgeral@hidrografico.pt	Instituto Hidrografico/ Min. of Defense		S		Y		6 to 12
ROMANIA	MARE NIGRUM	82	1971/ 2003	MP	Global	www.geoecomar.ro	25/25	Gh. Oaie, GeoEcoMar, 23-25 D.Onciul St., Bucharest, ROMANIA, goaie@geoecomar.ro	GeoEcoMar	N	S	Y	Y		
SPAIN	HESPERIDES	83	1991	MP polar	Atlantic, Mediterr., Polar	www.utm.csic.es/hesperides	50/30	Juan José Dañobeitia - UTM - CSIC Paseo Marítimo de la Barceloneta 37-49. 08003 Barcelona. jjdanobeitia@utm.csic.es	Spanish Army	N	S	Y	Y	Seismic equipments	12
	GARCIA DEL CID	37	1977	MP coa-stal	Atlantic, Mediterr	www.utm.csic.es/Gdc	14/12	Juan José Dañobeitia - UTM - CSIC Paseo Marítimo de la Barceloneta 37-49. 08003 Barcelona. jjdanobeitia@utm.csic.es	Spanish Council of Scientific Research	N	S	Y	Y		6 to 12

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SPAIN	CORNIDE DE SAAVEDRA	67	1972	MP	Atlantic, Mediterr., Polar	www.ieo.es	27/31	Carlos Massó U/B, I.E.O. Avda. Brasil, 31, 28020 Madrid carlosmasso@md.ieo.es	Instituto Espanol de Oceanografia	N	S	Y	Y		6
	FRANCISCO DE PAULA NAVARRO	30	1987	MP	Atlantic, Mediterr., Polar	www.ieo.es	10/7	Carlos Massó U/B, I.E.O. Avda. Brasil, 31, 28020 Madrid carlosmasso@md.ieo.es	Instituto Espanol de Oceanografia	N	S	Y	Y		6
	ODON DE BUEN	24	1973	MP	Atlantic, Mediterr., Polar	www.ieo.es	6/6	Carlos Massó U/B, I.E.O. Avda. Brasil, 31, 28020 Madrid carlosmasso@md.ieo.es	Instituto Espanol de Oceanografia	N	S	Y	Y		6
	VIZCONDE DE EZA	53	2001	MP	Atlantic, Mediterr., Polar	www.mapya.es	15/19	Jerónimo Hernández , S.G.P.M. C/ Ortega y Gasset, 57, 28006 Madrid jhriesco@mapya.es	Secretaria General de Pesca Maritima	N	S	N	N		6
SWEDEN	ODEN	108	1988	ICE	Global	www.sjofartsverket.se/navigering/htm/ frameset/htm		Swedish Maritime Administration, SE-601 78 Norrkoping. opc@sjofartsverket.se	Swedish Maritime Authority	Y	S		Y	Polar ice class	
	SKAGERAK	38	1968	MP	Baltic, Atlantic	www.gmf.gu.se/english/eng_index.htm		Leif Djurfelt, dept of earth Sciences, Göteborg University, SE-405 30 Göteborg. ledj@oce.gu.se	University of Gothenburg	N	R	Y	Y		
UNITED KINGDOM	CHARLES DARWIN	69	1985	MP	Global	www.researchshipunit.com/	20/18	Mike Webb, NERC, mweb@nerc.ac.uk	NERC	Y	R	Y	Y	Swath system	12
	DISCOVERY	90	1962	MP	Global	www.researchshipunit.com/	21/28	Mike Webb, NERC, mweb@nerc.ac.uk	NERC	Y	R	Y	Y		12
	JAMES CLARK ROSS	99	1990	MP	Global	www.antarctica.ac.uk/ Living_and_Working/Virtual/ James_Clark_Ross/techspec.html	29/31	Mike Webb, NERC, mweb@nerc.ac.uk	NERC	Y	R	Y	Y	Swath system	12

Year: year in which vessel entered into service/year of refitting
Type of vessel: FIS - fisheries, OCE - oceanographic, MP - multipurpose, SUP - support vessel, ICE - ice-breaker, DS - Deep Sea Stem Trawler
Vessel Pool: Is the vessel currently part of a bilateral or multilateral sharing arrangement? Y - yes, N - no
Availability: S - on the basis of standard charter/barter agreement, JP - in joint projects, R - restricted
Barter: Are barter arrangements possible.Y - yes, N - no
Charter: Are charter arrangements possible. Y -yes, N - no

B. SUBMERSIBLES

Country	Name	Depth m	Year	Type	Operation area	Technical Details	Support Staff	Contact person	Owner	Vessel pool	Avail-ability	Barter	Charter	Unique Facilities	Scheduling months
BELGIUM	MAUVE	100		LC	Coastal areas	www.mumm.ac.be/SUMARE/	3	Georges Pichot, G.Pichot@mumm.ac.be		N		N	N	In development	
FRANCE	NAUTILE	6000	1984	MAN	Global	www.ifremer.fr/flotte	6	Jean.Xavier.Castrec@ifremer.fr	Ifremer	N	S	N	Y		24
	VICTOR 6000	6000	1998	ROV	Global	www.ifremer.fr/flotte	3	Jean.Xavier.Castrec@ifremer.fr	Ifremer	Y	S	Y	Y		24
	SAR	6000	1984	DT	Global	www.ifremer.fr/flotte		Jean.Xavier.Castrec@ifremer.fr	Ifremer	N		N	Y		24
GERMANY	MOVE	6000	2004/2005	AUV	Global	Project under development with NIOZ		G.Wefer/Univ.Bremen, gwefer@univbremen.de						benthic reserach range 1km, 6months	24
	QUEST 5	4000	2002	ROV	Global	www.marum.de		V.Rathmeyer vrathmeyer@univbremen.de	Univ. Bremen			Y	Y		
	CHEROKEE	1000	2002	ROV	Global	www.marum.de		V.Rathmeyer vrathmeyer@univbremen.de	Univ. Bremen			Y	Y		
GREECE	THETIS	610	1999	MAN	Mediterr., Black Sea	www.ncmr.gr	3	volonakis@ncmr.gr	NCMR	Y	S	N	Y		12
NETHERLANDS	MOVE	6000	2004/2005	AUV	Global	Under development joint project with Bremen/MARUM								benthic research range 1 km 6 months	
NORWAY	ROV AGLANTHA	2000		ROV	Global	www.imr.no		Kaare Hansen	Inst.of Marine Research	N		Y	Y		n/a
PORTUGAL	LULA	500	1999	MAN	Regional-Azores	www.rebikoff.org	3	Rua Rocha Vermelha, Praia do Almoxarife 9900 Horta Portugal; tel:+351 292949505	Fundacao Rebikoff Niggeler	N			Y		
	INFANTE	200	2003	AUV		dsor.isr.ist.utl.pt/Projects/Infante/index.html		Antonio Pascoal; Institute of Systems and Robotics; Av. Rovisco Pais 1049-001 Lisboa Portugal; Tel: +351 218418289; antonio@isr.ist.utl.pt	Institute of Systems & Robotics	Y	S		Y		
UNITED KINGDOM	ISIS	6500	2003	ROV	Global	www.soc.soton.ac.uk/OED/ROV/index.php	10	Mike Webb, NERC, mweb@nerc.ac.uk	University of Southampton	N	N/A	Y	Y		1st April
	AUTOSUB2	1500	2002	AUV	Global	www.soc.soton.ac.uk/OED/Autosub/index.php	5	Mike Webb, NERC, mweb@nerc.ac.uk	University of Southampton	N	N/A	Y	Y		1st April

Depth: maximum operation depth
Year: year in which submersible entered into service
Type: AUV - autonomous vehicle, DT - deep towed, LC - low cost, MAN - manned, ROV - remotely operated vehicle,
Vessel Pool: Is the submersible currently part of a bilateral or multilateral sharing arrangement? Y - yes, N - no
Availability: S - on the basis of standard charter/barter agreement, JP - in joint projects, R - restricted
Barter: Are barter arrangements possible.Y - yes, N - no
Charter: Are charter arrangements possible. Y -yes, N - no

C. RESEARCH AIRCRAFT

Country	Name		Year	Type	Operational area	Technical Details	Support Staff	Contact person	Owner	Vessel pool	Avail-ability	Barter	Charter	Unique Facilities	Scheduling months
BELGIUM	B02		1990	Britten Norman	Noth Sea	http://www.mumm.ac.be	3	Benoit Loicq, B.Loicq@mumm.ac.be	Belgian State	N	R	N	N	SLAR	1

Year: year of delivery
Vessel Pool: Is the aircraft currently part of a bilateral or multilateral sharing arrangement? Y - yes, N - no
Availability: S - on the basis of standard charter/barter agreement, JP - in joint projects, R - restricted
Barter: Are barter arrangements possible.Y - yes, N - no
Charter: Are charter arrangements possible. Y -yes, N - no

D. OCEAN OBSERVING SYSTEM

Country	Name	Year	Area	Purpose	Technical Details	Support Staff	Contact person	Host Institute	Network	Brief description of sensors
BELGIUM	OPTOS	2002	North Sea	Marine forecast	www.mumm.ac.be	3	Virginie Pison, V.Pison@mumm.ac.be	MUMM	Y	
FRANCE	MAREL	1996	Coastal	Sea water monitoring	www.ifremer.fr/prod/marel		gaetan.stanislas@ifremer.fr	Ifremer		CTD, FFU, Ph, NO3, 02, turbidity
	PROVOR	1998	Global	Vertical profiler	www.ifremer.fr/francais/produits/moyens.htm		gerard.loaec@ifremer.fr	Ifremer		CTD
GERMANY	MARNET		North Sea, Baltic	Environmental Monitoring	www.bsh.de		Nils-Peter Rühl, ruehl@bsh.de	Bundesamt f. Seeschifffahrt	Y	CTD, ADCP , Nutrients, Fluorescence, Meteorol.
GREECE	Dept. Operational Oceanography	1998	Aegean Sea	Buoy network and Forecasting models for the East Mediterr.	www.poseidon.ncmr.gr		Dimitris Georgopoulos dgeor@ncmr.gr	National Centre for Marine Research (NCMR)		Air pressure, Air temperature, Wind Speed and Direction, Surface wave, Sea Surface Temperature and Salinity, Surface Currents, Dissolved Oxygen Light, Attenuation, Fluorescence/Chl-a, Radioactivity. CT sting down to 50 m

Year: year of establishment
Network: Is the system currenly part of a European network? Y -yes, N -no

Country	Name	Year	Area	Purpose	Technical Details	Support Staff	Contact person	Host Institute	Network	Brief description of sensors
IRELAND	Irish Marine Data Buoy Network	1999	Local	Meteorological Forecasting	www.marine.ie/scientific+services/ data+services/data+buoy/default.htm	2	Guy Westbrook, Marine Institute, Galway Technology Park, Parkmore, Galway, Ireland. Guy.westbrook@marine.ie	Marine Institute	Y	sensors measuring: atmospheric pressure, wind direction, wind speed, wind height, wave height, wave period, sea temperature, air temperature & relative humidity
NETHERLANDS	LOCO	2003/ 2004	Atlantic/ Indian	Environmental monitoring (thermohaline circ.)	not yet available	3	rietveld@nioz.nl	Royal NIOZ		Morings with current meters, ADCP, CTD
NORWAY	M/V Polarfront		Atlantic	Meterological	www.met.no			Meterological Institute		Moored vessel
	ARGOS		Atlanctic	Ocenography	www.imr.no		Kaare Hansen	Inst. of Marine Research		3 ARGO drifting buoys surfacing every 10 days to transmit data via satellite to remote sensors
	Moored buoys		Atlantic	Oceanography	www.imr.no		Kaare Hansen	Inst.of Marine Research		20 oceonographic moored buoys
PORTUGAL	CPR	2002	Atlantic/ Portuguese EEZ	Environmental Monitoring	ipimar-iniap.ipimar.pt/navios.html		Joaquim Pissarra; IPIMAR, Av. Brasilia 1449-006 Lisboa, Portugal; tel:+351 213027000	Instituto de Investigacao das Pescas e do Mar (IPIMAR)/Min. of Ag. & Fisheries		Continuous Plankton Recorder
	HAZO	2000	Atlantic-Azores	Satellite receiving station	www.horta.uac.pt/projectos/detra/	2	Ana Martins/ Dep. Of Oceanography and Fisheries, University of Azores, PT-9901-862 Horta. Tel: +351292292400; e-mail: amartins@dop.horta.uac.pt	IMAR-University of Azores		SeaWifs; AVHRR

Year: year of establishment
Network: Is the system currenly part of a European network? Y -yes, N -no

E. NATIONAL MARINE EQUIPMENT POOL

Country	Name	Year	Type	Operation area	Inventory Web Address	Support Staff	Contact person	Host Institute	Net-work	Avail-ability	Barter	Charter	Unique Facilities
DENMARK	DanSeis	2000		Global	www.geo.au.dk/seislab	2	H. Lykke-Andersen, Department of Earth Sciences, Finlandsgade 8, DK-8200 Aarhus N, Denmark	Dept. Of Earth Sciences, University of Aarhus, Finlandsgade 8, DK-8200 Aarhus N, Denamrk	Y	S	Y	Y	
FRANCE	Marine environment tests and research infrastructure			France	www.ifremer.fr/metri/		yvon.le.guen@ifremer.fr	Ifremer		S	Y	N	Deep wave basin (20 m.) - Hyperbaric testing tanks
GERMANY	OBS			Global	www.gfz-potsdam.de		A.Lauterjung	GFZ Potsdam		S			
IRELAND	Irish National Equipment Pool	2001		Ireland	www.marine.ie/rnd+facilities/marine+institute+facilities/equipment+pool/index.htm	2	Sheena Fennell, Marine Institute, Galway Technology Park, Parkmore, Galway, Ireland. E-mail sheena.fennell@marine.ie	Marine Institute	Y	S	N	N	
ITALY	Calibration centre	2001	CTD Calibration	2 Labs	www.ogs.trieste.it	3	Nevio Medeot OGS	OGS	N	JP	N	N	
NETHERLANDS	National pool	1983		Global	not yet available	11	rietveld@nioz.nl	Royal NIOZ		S	Y	N	XRF Core scanner (see http://www.avaatech.com/)
UK	National Marine Equipment Pool	2001		Global	www.soc.soton.ac.uk/OED/UK_Ocean_Research_Services/nmep.php	50+	Mike Webb, NERC, mweb@nerc.ac.uk	University of Southampton	Y	S	Y	Y/N	

Year: year of establishment
Network: Is the pool currenly part of a European network? Y -yes, N -no
Availability: S - on the basis of standard charter/barter agreement, JP - in joint projects, R - restricted
Barter: Are barter arrangements possible.Y - yes, N - no
Charter: Are charter arrangements possible. Y -yes, N - no

F. NATIONAL MARINE DATA CENTRE

Country	Name	Year	Type	Operation area	Informatikon	Support Staff	Contact person	Host Institute	Net-work	Avail-ability	Barter	Charter	Unique Equipment
BELGIUM	BMDC	2002		North Sea	www.mumm.ac.be	3	Serge Scory, S.Scory@mumm.ac.be	MUMM	Y	Free			
	VMDC	1999		North Sea/ N.Atlantic, Global	www.vliz.be/Vmdcdata/index.htm	3	Ward Vanden Berghe, Flanders Marine Inst, wardvdb@vliz.be		Y				North Sea Benthos Survey (ICES); MASDEA
FRANCE	SISMER	1990	Oceano-graphic data	Global	www.ifremer.fr/sismer	15	catherine.maillard@ifremer.fr	Ifremer					
	CERSAT	1991	Space oceano-graphic data	Global	www.ifremer.fr/cersat	13	bertrand.chapron@ifremer.fr	Ifremer					
GERMANY	DOD		Environ. Data	Global	www.bsh.de		Nils-Peter Rühl	BSH	Y	Free			
	PANGEA		Paleo-, Climatic & Bio-geche mical Data	Global	www.pangea.de		W.Grobe	AWI	Y	Free			
GREECE	HNODC	1986	Ocean-ographic Data	Mediterr. and Black Sea	www.hnodc.ncmr.gr	3	Efstathios Balopoulos, National Centre for Marine Research, Institute of Oceanography, P.O. Box 712, 190 13 Anavyssos, Greece	NCMR	Y	Free			

Year: year of establishment
Network: Is the pool currenly part of a European network? Y -yes, N -no
Availability: S - on the basis of standard charter/barter agreement, JP - in joint projects, R - restricted
Barter: Are barter arrangements possible.Y - yes, N - no
Charter: Are charter arrangements possible. Y -yes, N - no

Country	Name	Year	Type	Operation area	Informatikon	Support Staff	Contact person	Host Institute	Net-work	Avail-ability	Barter	Charter	Unique Equipment
IRELAND	Irish Marine Data Centre	1991		Atlantic	www.marine.ie/rnd+facilities/ marine+institute+facilities/ marine+data+centre/index.htm	8	Jonathan White, Marine Institute, 80 Harcourt Street, Dublin 2, Ireland. Jonathan.white@marine.ie	Marine Institute	Y	S	Y	Y	Unique data from the Atlantic Continental Shelf Area
NETHERLANDS	NODC	1997		Global	www.nodc.nl/ and www.nioz.nl/en/ facilities/dmg/dmg0.htm	2,5	bruin@nioz.nl	Royal NIOZ		S	n/a	n/a	Research data collected by RV Pelagia
NORWAY	Norsk marint datasenter			Atlantic	www.imr.no		Helge Sagen	Inst.of Marine Research		S			
UK	BODC			Global	www.bodc.ac.uk/		Juan Brown	Proudman Oceanographic Laboratory	Y	S			

Year: year of establishment
Network: Is the pool currenly part of a European network? Y -yes, N -no
Availability: S - on the basis of standard charter/barter agreement, JP - in joint projects, R - restricted
Barter: Are barter arrangements possible.Y - yes, N - no
Charter: Are charter arrangements possible. Y -yes, N - no

5. Other

Country	Name	Year	Type	Operation area	Technical Details	Support Staff	Contact person	Host Institute	Net-work	Avail-ability	Barter	Charter	Unique Equipment
IRELAND	Irish National Seabed Survey	2000		Irish Conti-nental Shelf	www.marine.ie/scientific+services/ surveys/seabed/index.htm	35	Eoin Sweeney, Marine Institute, 80 Harcourt Street, Dublin 2, Ireland. E-mail: eoin.sweeney@marine.ie	Marine Institute/ Geological Survey of Ireland	Y	Under consi-der-ation			Multibeam Bathymetry; Sub-bottom profiles; sand velocity profiles; gravity; magnetics
PORTUGAL	LabHorta	1997		Atlantic - Azores		1	Ricardo Serrão Santos/ Dep. Of Oceanography and Fisheries, University of Azores, PT-9901-862 Horta. Tel: +351292292400; e-mail: ricardo@dop.horta.uac.pt	IMAR-University of Azores					Lab for experimental studies of deepsea organisms

Annex 5: List of acronyms and abbreviations

ARGOS	Satellite-based system which collects environmental data from autonomous platforms and delivers it to users worldwide
AUV	Autonomous Underwater Vehicle
B-DEOS	British-Dynamics of Earth and Ocean Systems
BOOS	Baltic Operational Oceanographic System
CERSAT	Centre ERS d'Archivage et de Traitement (French ERS Processing and Archiving Facility)
CLIVAR	Climate Variability and Predictability – international research programme
DLR	Deutsche Zentrum für Luft- und Raumfahrt
ECORD	European Consortium for maximizing European countries' participation in the Integrated Ocean Drilling Program (IODP)
EEZ	Exclusive Economic Zone
ERA	European Research Area
ERS	Satellites for Earth Observation
ESF Marine Board	European Science Foundation Marine Board
ESF-MB	European Science Foundation Marine Board
ESONET	European Sea Floor Observatory Network
EU Marine XML	a project demonstrating the use of XML technology for marine data
EurOcean	European Centre for Information on Marine Science and Technology
EuroGOOS	A European association fostering European co-operation on GOOS
FerryBox	Project: From on-line oceanographic observations to environmental information
GMES	Global Monitoring for Environment and Security
GOOS	Global Ocean Observing System
IFREMER	French Research Institute for Exploitation of the Sea
InterRidge	International Co-operation in Ridge-Crest Studies
IODP	Integrated Ocean Drilling Program
JRC	Joint Research Centre
MedGOOS	Mediterranean association fostering co-operation on the GOOS
MFSPP	Mediterranean Forecasting System Pilot Project
MFSTEP	Mediterranean Ocean Forecasting System
MISG	Marine Infrastructures Strategy Group, proposed by this Working Group
MOMAR	Monitoring of Middle Atlantic Ridge
NERC	Natural Environment Research Council, UK
NSF	National Science Foundation (USA)
ONR	Office of Naval Research (USA)
ROV	Remotely Operated Vehicle
RTD	Research and Technological Development
SAI	Space Applications Institute
SAR	Synthetic Aperture Radar

Sea-Search	Internet portal for Marine Data & Information in Europe
SME	Small and medium sized enterprise
SOP	Ship of opportunity
UNOLS	University-National Oceanographic Laboratory System (USA)
WMO	World Meteorological Organisation
VOS	Voluntary Observing Ship

European marine research is highly fragmented and costly in terms of investment. Maintenance of the research infrastructure accounts for as much as half of the entire amount of research funds. A working group was set up by the European Strategy Forum for Research Infrastructure to review various cooperation types and practices as well as possibilities of building a joint infrastructure. The aim of the Ad Hoc Working Group on Marine Research Infrastructure was to identify the 'hot topics' with regard to marine research infrastructure that need to be addressed in order to improve the current situation, and to provide material conditions for the development of marine science within the European Research Area. This report compiled by the working group presents visions for the coming decade and identifies both the priority areas and requirements that need to be addressed.

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