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Report on existing fleets foreseeable evolution for the next 10 years

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1. INTRODUCTION

The role of the ocean inside the global economy is becoming more and more relevant and a strategic vision is necessary to deal with the new challenges. The request to improve the ocean understanding is growing, while the rapid evolving of new technologies open to a novel vision of the ocean. In this scenario the ocean survey needs the development of new approaches, where Research Vessels and associated equipments have a central role.
The EUROFLEETS project and, more specifically, its WP1 (Strategic coordination vision) has the main objective to promote an European strategic view of research fleets and associated equipment. A key point is to define a "common procurement strategy" (Task 1.2).

Following what is indicated in the DOW, the work will consist of :
- determining the long term tendencies (10 years and more) for both the Global/Ocean and the Regional research vessels,
- defining the list of perspectives for Regional research vessels new investment, as they need an important renewal effort now;
- defining the list of perspectives for the major new investment for underwater equipment,
- collecting the available data concerning innovative ship funding and disseminate it through the beneficiaries to facilitate investment,
- collecting coherent needs within Europe to get better services or supplies via common acquisition procedures,
- defining a reference framework for the co-funding and the cooperation of new vessels and new major underwater equipment, including guidelines for the governance, legal, financial and logistical aspects, taking stake of the EC communication about research infrastructures framework;
- fostering discussion about these proposals/ perspectives in all existing fora, as OFEG, ERVO…

Perspectives for research vessels and underwater equipment should be science/challenges oriented and driven by technology advances.
As first step, the following issues need to be developed:
1) the knowledge of the fleets to date,
2) the description of the most probable scenario in terms of research challenges, future technologies,
3) the fleet expectation in relation to new needs

The present document (D1.1) will present a picture of the existing vessels and their short term foreseeable evolution, to provide the necessary information for an effective strategic view of European fleets.

2. PRESENT SITUATION OF VESSELS

In the following the current status of existing Research Vessels will be described in the domain of research activities outside coastal regions. To this purpose the report will examine the vessel data available in the European Research Vessel Infobase (http://www.rvinfobase.eurocean.org/) and will benefit from the information collected by the Ocean Research Fleets Working Group (OFWG) and described in the ESF position paper 10 (ESF Marine Board, 2007).
The following ships are excluded from the present study:

- Ships built/used for local and/or coastal research only (usually with ship length less than 35m);
- Ships not readily accessible to research (mostly naval Research Vessels).

The general features used to identify the most important indicators for planning future investments and potential synergies are the following:

- *Class*
The classification chosen is coherent with that of the US Research Vessel fleet operated by University National Oceanographic Laboratory System (UNOLS) [1]:

- **Global vessels** are large (>65 m) and currently operate on an at least multi-Ocean scale, e.g. RV *L'Atalante*, RV *James Cook* , and RV *Meteor*;
- **Ocean vessels** are large enough (>55 m) to currently operate on an Ocean scale, e.g. RV *Charles Darwin*, RV *Le Suroît*, RV *Pelagia*, RV *Poseidon*;
- **Regional vessels** currently operate generally on a European Regional scale, e.g. RV *Alkor* (Baltic Sea), RV *Bilim2* (Eastern Mediterranean and Black Seas);

- *Age*
It is essential to give an estimate as to when the ship is likely to be taken out of service and eventually replaced. Normally, this period is about 30 years. In some cases a vessel may have undergone a major refit and therefore could be in service for an extended period (estimated of about 15 years)

- *Major research activity*
From a technical point of view, this category describes the type of research that can be conducted onboard: multipurpose, oceanography, fishery, other activities.

- *Major technical facilities*
This category examines the presence of standard and non-standard equipment, possibility to host underwater vehicles or other special capabilities such as icebreaking capacity etc., together with permanently installed, or permanently allocated large equipment, including mobile equipment.

[1] UNOLS, The University-National Oceanographic Laboratory System is an organisation of 61 U .S. Institutions that have academic research and education programs in the ocean sciences and an interest in promoting the best possible national shared use facilities to support these programs.

2.1 Existing vessels, their present status

We mainly refer to the EurOcean database[2] (http://www.rvinfobase.eurocean.org/) which provides an overview of how European Research Vessels that matches the above criteria, of what size and age they are, which major capabilities and facilities they have, and other technical details.

Vessel Class

The European fleets include 36 Global class, 22 Ocean class and 32 Regional class vessels which are run by 23 of the 27 European coastal states[3], all encompassing Member Organisations of the European Science Foundation.
With respect to the OFWG Report (ESF Marine Board, 2007), which mainly focused on multipurpose Academic Vessels, in the following the investigation has been widened to all available research vessels, including vessels capable of stock assesment, fisheries research and environmental monitoring (only Naval vessels have been excluded). The situation is resumed as follows:

Vessel Class	Number of vessels	%	Number of operating countries
Global	36	40.4%	14
Ocean	22	24.7%	14
Regional	31	34.8%	15
Total	**89**	**100.00%**	**24**

Table 1: Current European Research Fleets composition

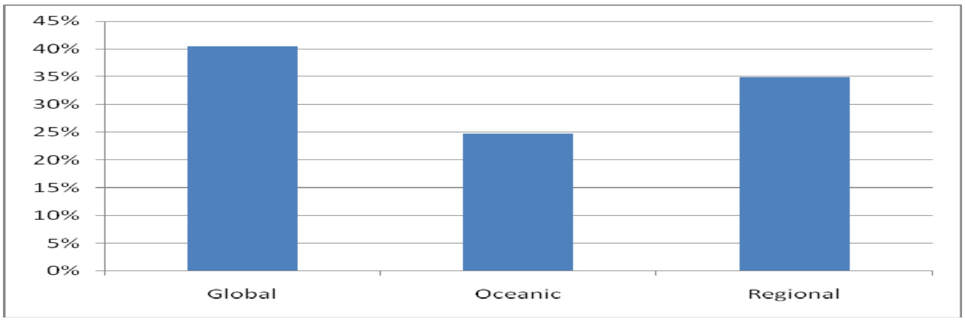

***Figure 1:** Current European research fleets composition (percentage)*

We may observe a significant presence of vessels in all different classes which well balance the need of global and regional interests. When we examine the distribution per country (Tab. 2), a certain

[2] EurOcean maintains a searchable database of the European research vessels (RVs) operating in Europe and abroad. It includes research vessels from the coastal to high seas (≥ 10 meters). Information on vessel specifications, contact information and the real time position of the large RVs is online for consulting. This information is regularly updated by the RV operators.
[3] Two candidate countries (Croatia and Turkey) plus Ukraine, two associated countries (Iceland, Norway) and 18 EU member states (Belgium, Bulgaria, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Lituania, Estonia, Netherlands, Poland, Portugal, Romania, Spain, Sweden, United Kingdom).The other three EU costal states (Cyprus, Malta, Slovenia) has only local/coastal boats.

imbalance appears evident: partially related to their geographic position, it seems mainly to be because of the individual countries interest in marine and maritime affairs on a global and/or regional scale. The larger vessel numbers are found in Germany with its balanced interest both on a global and a regional scale, and conversely for UK, but for France also, the main interest seems to be on a global scale. More balanced is the vessel distribution of other countries.

Country	Vessel number	Vessel Class		
		Global	Ocean	Regional
Belgium	3			3
Bulgaria	1		1	
Croatia	1			1
Denmark & Faroe Islands	3	1	1	1
Estonia	1			1
Finland	1		1	
France	7	5	1	1
Germany	15	4	5	6
Greece	2		2	
Iceland	2	1	1	
Ireland	1	1		
Italy	5	2		3
Lithuania	1		1	
Nederland	5	2	2	1
Norway	8	3	4	1
Poland	3		1	2
Portugal	2	1		1
Romania	1	1		
Spain	6	3		3
Sweden	6	1	1	4
Turkey	3		1	2
Ukraine	1	1		
UK	11	10		1

Table 2: Distribution of Vessels per country

Vessel Age

Table 3 and figure 2 shows the age distribution of European vessels: within all classes approximately half the vessels are more than 20 years old, with the regional reaching the 65.6%. Furthermore four ocean vessels and one global vessel are refitted. Vessel age appears to be a weakness of the European fleets and the replacing of older vessels (19 vessels are more than 30 years old) should be a top priority. The requirement to meet high standards in capabilities and equipment is crucial for research vessels, and an old vessel may hinder necessary innovation and limit the possibilities to do the necessary observations, monitoring and sample collection with the required quality that modern marine science is based on a cost effective manner.

Years	Global	Ocean	Regional	Total
≤ 5	4	0	0	**4** (4.5%)
6-10	6	0	5	**11**(12.4%)
11-15	5	3	2	**10** (11.2%)
16-20	3	9	4	**16** (18.0%)
21-30	13	5	10	**28** (31.5%)
> 30	3	5	10	**19** (20.2%)
not available	2	0	0	**2** (2.2%)
Total	**36**	**22**	**31**	**89** (100%)

Table 3: Current *European Research Fleets composition (2011)*

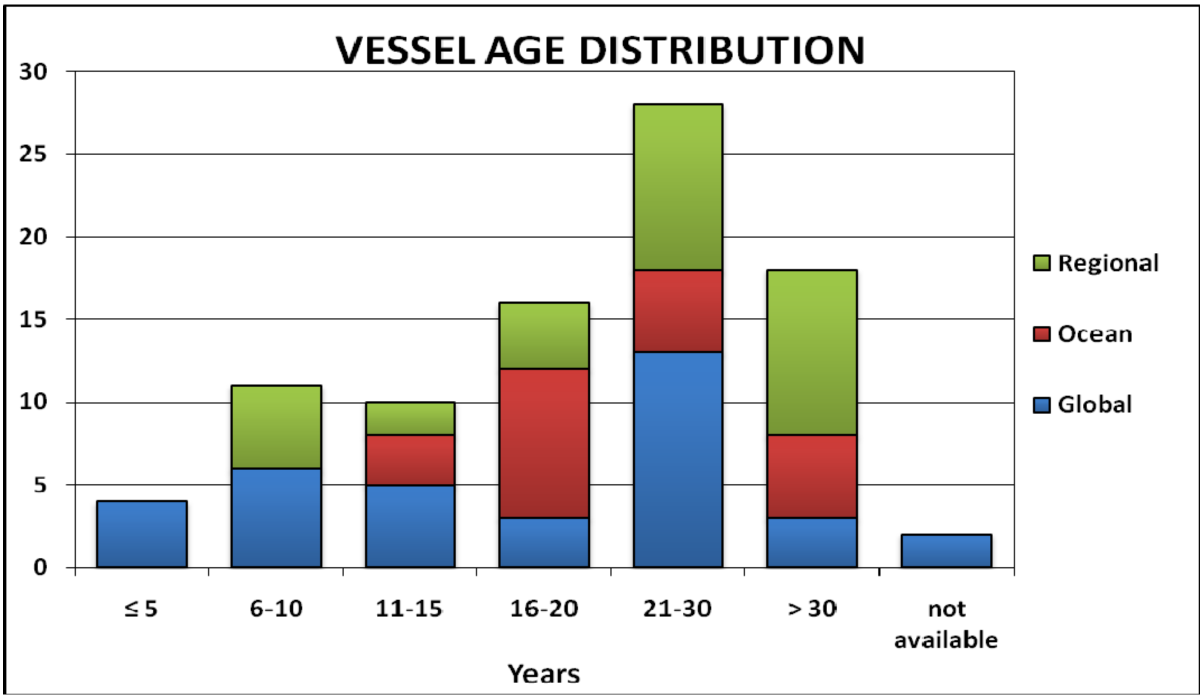

Figure 2: Current Vessel age distribution (2011)

2.2 Prevalent Activity and Technical Facilities

Moving on to examining the prevalent activity (Tab. 4 and Fig. 3), multipurpose research vessels accounts for 50% of the total vessel fleet and prevails in all three classes, followed by oceanographic vessels (22%) and fisheries research vessels(16%). Fisheries research is the second largest activity for the Regional vessels, while for Global vessels it is oceanography.

Main Activity	Global	Ocean	Regional	Total
Fisheries	5	2	7	**14** (15.7%)
Ice-going operations	1	1	0	**2** (2.2%)
Multiple activities	18	12	14	**44** (49.4%)
Oceanography	11	4	5	**20** (22.5%)
not available	1	3	5	**9** (10.2%)
Total	**36**	**22**	**31**	**89** (100%)

Table 4: Current *Vessel activity distribution*

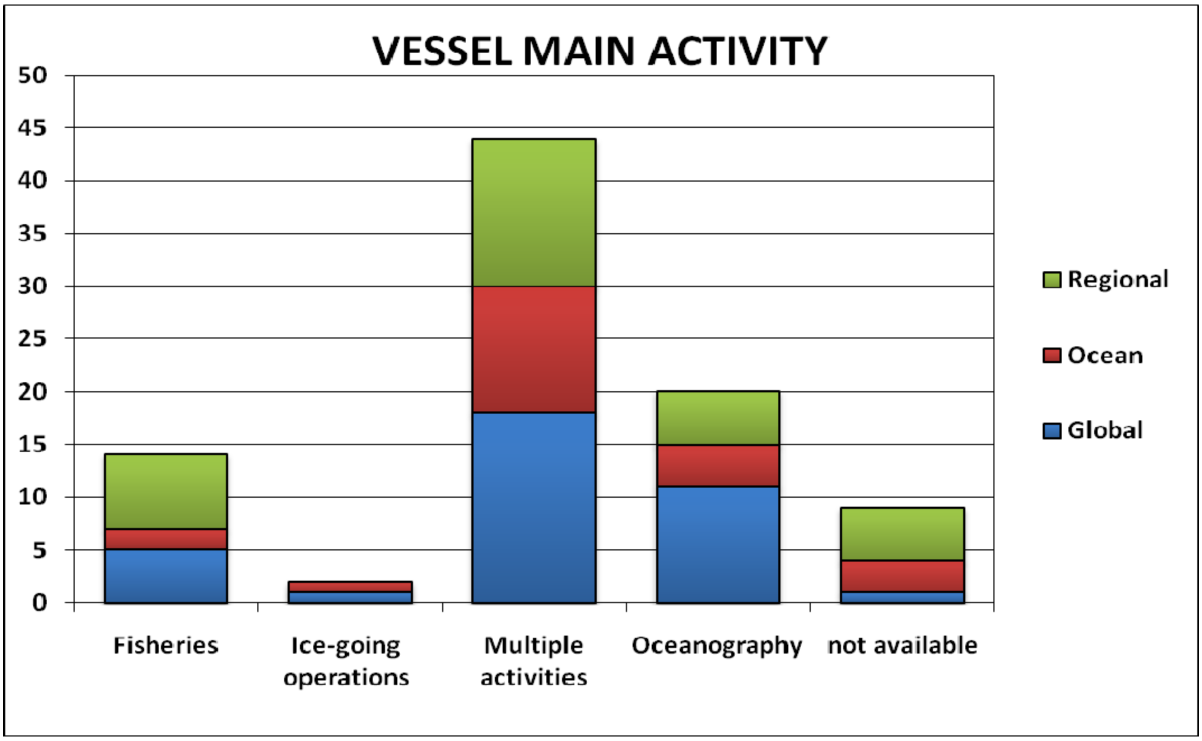

Figure 3: Current Vessel activity distribution

Concerning technical facilities[4], almost all vessels are able to provide basic data processing together with CTD capabilities. Coring capability is available in a large number of vessels, with different capacities, in relation to the vessel class. Regarding acoustic and profiling capabilities all vessel have an echosounder, while the presence of ADCP and multibeam systems are almost the same. They are present in almost 45% of the vessels: more in global class vessels (56%), less in ocean class vessels (38%). The presence of ADCP and multibeam systems in the regional vessels are 39% and 43%, respectively. If all global class vessels are said to be capable to host underwater vehicles, that capacity reduces to 67% and 44% on ocean and regional class vessels, respectively.

[4] We have to make aware that several vessels didn't provide any description concerning several facilities. The vessels conditions are estimated on the vessel subset with available information.

2.3 Present ship time costs

European countries that own Research Vessels made available to the scientific community differ in their ways of funding the coverage of their running costs.

In case of large countries with a large research fleet, running costs of the research fleet are fully or partly covered by specific funding from their government, or the specific research council/institution. There are, however, other countries with smaller research fleets, or with only one Research Vessel, whose running costs are not fully guaranteed by public national funds. The implication is that these vessels are underfunded and that funds have to come from other sources, for example through commercial charter (ESF Marine Board, 2007).

Going to examine the cost per day, indicated in the DoW (pages 40 and 53) , for the research vessels participating to EUROFLEETS, we have the following distribution (Fig. 4):

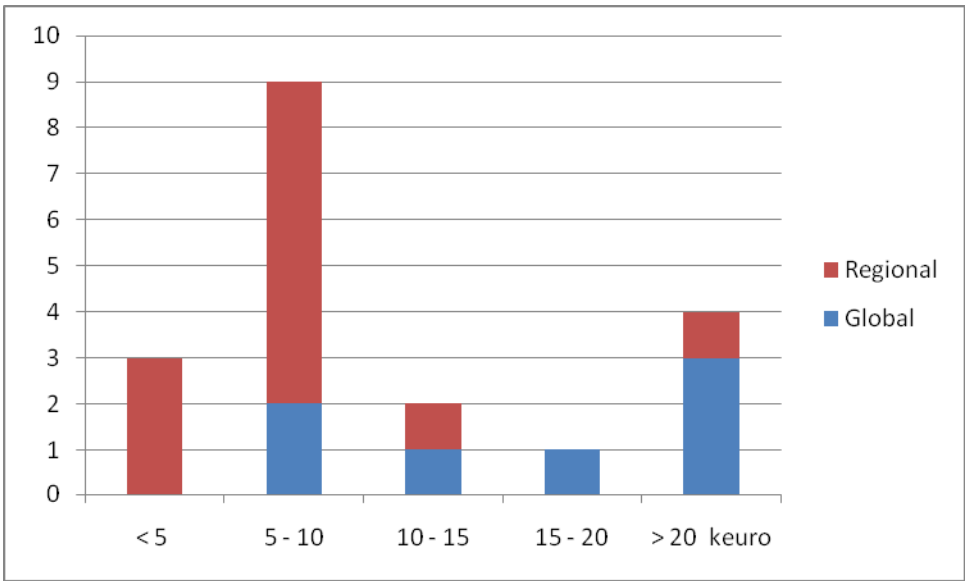

Figure 4: Distribution of running vessel cost per day in Keuro

As we can see, there is a concentration in the 5-10 Keuro range, which appears to be the typical running cost per day for a Regional vessel, while the typical cost for a Global vessel exceeds 20 Keuro per day. Nevertheless little is known about the cost composition. We have only generic information, but one of major/serious problems related to RV management is the continuous increase of operative ship costs. It may be estimated that maintaining and operating research vessels account for up to half of the costs of marine research.

Running costs of any ship may be subdivided into two components:

- the active costs, correlating with actual usage of a ship: fuel and other supplies to operate at sea, additional labor and sustenance costs for the crew and permanent laboratory personnel required by QA standards of some ships, and other action-related costs;

* the passive costs, not correlating directly with the number of days-at-sea: basic salary for crew, regular maintenance and inspection costs, port costs etc.

For what concerns active costs fuel consumption is an important voice. It is nearly proportional to the size and speed of the vessels. The fuel costs for the research fleets have escalated over the past few years and the unstable nature of recent oil prices suggest that they may remain a significant aspect of total operating costs in the future.
The passive costs roughly range from 50 to 80% of the total costs: crew salaries and benefits are consistently the greatest cost driver for the research fleet. In any case this type of costs, mainly concerning each institution/country, may be difficult to reduce at institution/country level. Many research vessels are not used to their full potential today, mainly due to lack of funds. Many ships stay in port for long periods along the year. This condition, more recurrent among regional vessels, will be extensively developed in the incoming deliverable D1.3 "Report on perspectives for Regional Research Vessels".
What might be interesting to deepen is an estimate of how much money can be saved and/or how much more science can be done for the same amount of money through a more cost-effective and coordinated use of available research vessels on a regional scale. The implementation of an integrated information portal of European vessels (WP2) will be a key tool for this purpose.

3. SHORT TERM VESSEL EVOLUTION

The vessel age distribution (Tab. 3 and Fig. 2) shows that only four vessels are less than five year old, evidencing an almost stable condition during the last years (2006 – 2010) in terms of vessel number and classes. This means a tendency toward an rapidly aging fleet.

3.1 Vessels planned or under construction

In order to have complete information on European fleets for the next 10 years, a questionnaire was sent to each EUROFLEETS member (Appendix I) asking for information about the existence of renewal fleet initiatives in each country. Positive news seems to come for the next future, because questionnaire answers indicated that 14 countries (approximately 50% of the European coastal states) are planning a fleet renewal. Twenty-seven projects are planned or are ongoing: twenty-two projects concerning construction of new vessels and five to refit existing vessels. Details can be seen in table 5.
From the planned projects we may note that the 81% are new vessel projects, mainly Global and Regional class vessels. Among these projects, 10 are not replacement of existing vessels, but go to increase the number of vessels in the fleet. The remaining projects are vessel refits distributed between the three classes of vessels (Global/Ocean, Regional, Coastal). Both replacement and refit usually don't modify the previous vessels mission.

Country	Vessel number	Vessel Class			scheduled year	Old vessel replacing/ refitting
		Global /Ocean	Regional	Local		
Belgium	2	1	1		2012 and 2015	two replacement
Denmark	1		1		2013	
Estonia	1		1		after 2020	
France	2		1	1	2015-2017	
Faroe Islands	1		1		2013	
Germany	4	3	1		2015-20 2011	three replacements one refit
Ireland	1	1				Refit
Lebanon	1		1			Non European
Norway	3	2	1		2013-2018	three replacements
Romania	1		1		2015	
Spain	3	1	2		2010, 2015, after 2016	two replacement, one refit
Poland	2	1	1		2011	one refit
UK	1	1				replacement
Turkey	4	1	1	2	two new in 2012 & 2014	one refit
Total	27	11	13	3		

Table 5: New vessel plan

The new/refit vessel distribution in term of classes can be summarized in figure 5, with the following percentage: 11% of coastal, 48% regional and 41% global/ocean.

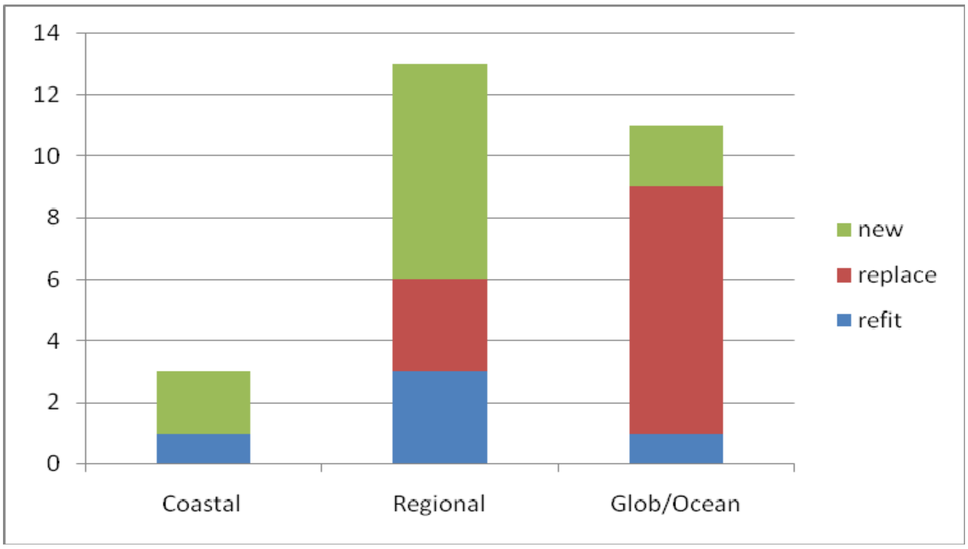

***Figure 5**: Number per class of foreseen* new/refit *vessels for the next 10 years (2011-2020)*

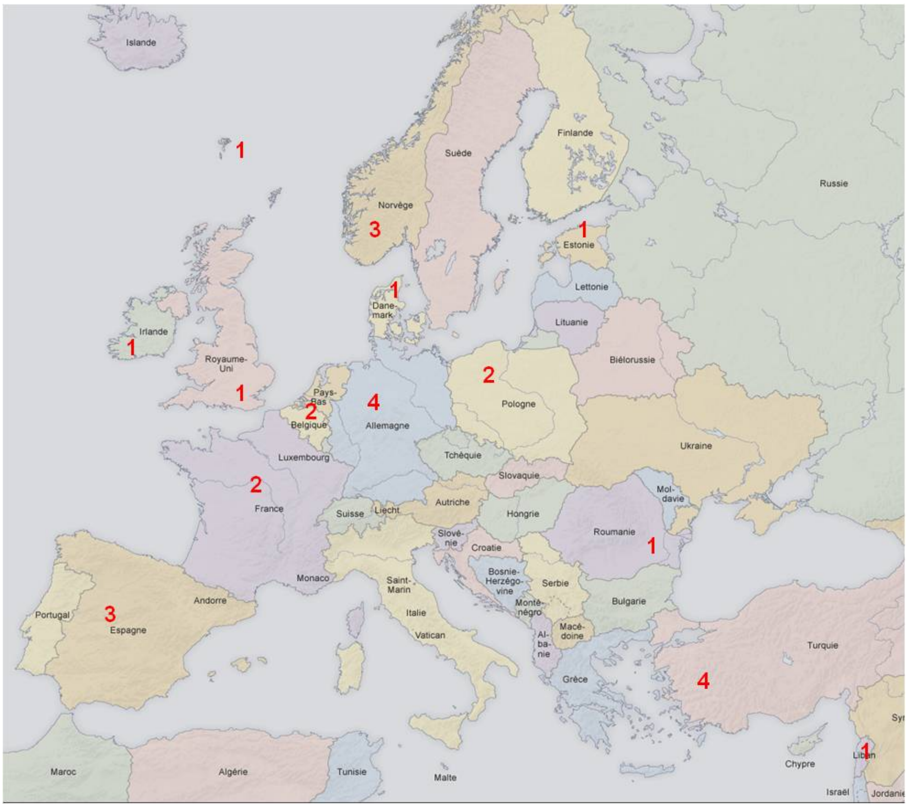

Figure 6: *Location and number of projects per country*

When we examine the country distribution (Fig. 6), we may observe a prevalence of northern countries, but we may consider that France and Spain cover both the northern and Mediterranean regions. Concerning partnerships, several agreements are established between institution inside the same country, but very few are formally established between different countries or at a regional level. Nevertheless, a large interest appears for country/regional agreements and we are confident that many of them will be reached in the next future.

Concerning capabilities, besides all basic supports for hydrography (CTD), current measurements (ADCP) and acoustic equipments, almost all new vessels will be able to receive mobile equipments (especially ROV and AUV). Other relevant characteristic is the attention given to low noise radiation and enhanced communication facilities.

3.2 Vessel scenario for the next years

It may be useful to compare the present situation (2010-11) to what may be foreseen for the next future (2020), when we may expect that the planned new vessels will be operational. In table 6 the blue columns resume the present situation restricted to vessels which are no more than 30 years old. The first two yellow columns shows how the vessel availability will be in 2020 without any new vessels in place. The last two columns represent the 2020 availability including the new projects. We may assume that the situation indicated in first two yellow columns is the less favorable (none of the planned vessels will be ready), while the last two yellow columns may represent the most favorable situation (All planned vessels will be operative). Also the most favorable situation evidences a significant reduction in vessels from 69 to 50, mainly due to the decrease of the total number of Global/Ocean vessels from 48 to 32 and a small reduction of Regional vessels. The reduction of vessels may be considered a negative indicator, but we have to be aware of the reduced request of direct human intervention for data collection, due to the continuous growing of autonomous systems (see later). Conversely, we may at the same time register a significant reduction of fleet age: at the present, only the 11% of vessels is less than 10 year old (Tab. 3), while the decadal projection (Tabs. 5 and 6) indicates that, at the end of next decade, the same age range will include a number of vessels close to 50%. We may also remark that more than half of new projects should be completed during the next five years (Tab. 5).

CLASS	2011		2020 projection			
	Number of vessels	**%**	**Number of 2011 existing vessels still operating**	**%**	**Total number of foreseen vessels**	**%**
GLOBAL	31	**45**	18	**44**	32	**63**
OCEAN	17	**25**	12	**29**		
REGIONAL	21	**30**	11	**27**	19[5]	**37**
Total	**69**	**100%**	**41**	**100%**	**51**	**100%**

Table 6: Comparison between the present Fleets condition with the foreseen situation in 2020

The previous scenarios suggest, for the next future, positive conditions for European vessel fleets which seem able to consolidate their capabilities. The new research vessels will be more capable in terms of types and capabilities for the on board scientific equipment, number of scientist cabins, number of laboratories, vessel speed and endurance and reduced crew than the vessels they have replaced, leading to more science days produced per year and showing that a fleet renewal is often a more cost-efficient strategy than a fleet expansion.
In this situation, coordination and synergy between fleets will become prominent and joint initiatives and EU projects will play a key role, the Eurofleets project being one of them.

4. NEW PERSPECTIVES OF OCEAN RESEARCH

One of the most important today's global drivers is the growing human population, which requires more food, water and energy. The ocean basins are a vast repository of living and non-living resources, and the tendency is to turn to them for food, energy, and the many minerals necessary to sustain a broad range of human lifestyles. This trend is favored by many rapidly evolving new technologies, which will permit a novel vision of the ocean.
The growing importance of the ocean to the global economy will simultaneously create a demand for improved understanding of the ocean, to provide resources for developing new technologies, and

[5] This number is comprehensive of one unit from Lebanon (non European country).

create a more complex political interest for addressing ocean issues. In this scenario the global oceans appears the new physical frontier on Earth.
The challenges of increasing human impact on the ocean will probably drive ocean research during coming decades. Ocean researchers must work across disciplines to provide policy makers, and the public they serve, with clear and understandable assessments of the state of the oceans and its sensitivity to climate and human influences in coming decades of change.
New forms of communication will be a key - among disciplines, across sectors, and with the public. Rapid and broadly accessible communication of the state of the ocean, and its future role in the biosphere, will be a primary justification and goal for ocean research.

4.1 New Science Objectives

The future ocean research agenda will be driven by diverse disciplinary and interdisciplinary research across a broad range of spatial and temporal observation scales. Several scientific problems (topics) include the need to understand processes with nested scales. For example, high gradient regions (fronts, surface and bottom boundary layers) are persistent areas requiring better understanding, as they are the loci of many poorly understood physical, chemical and biological processes. Their structures pose a challenge to the observing systems and numerical models. Unraveling the tough problems that really affects ecosystems will require more collaboration between biological, chemical and physical oceanographers. The advances in genetic techniques will soon permit us to produce maps of species and even population abundance using *in situ* sequencing.
The current level of ocean surveys is insufficient, as operational limitations of conventional ocean observing platforms don't permit adequate spatial and temporal resolutions. The development and operation of multi-parametric ocean monitoring is required in the context of climate change, study of marine ecosystem functioning, implement warning systems related to geo-hazards and to assess the sustainable use of marine resources. Long-term observations of fish stocks together with associated non-commercial ecosystem components and environmental parameters are essential to detect anthropogenic and climatic drivers for predicting how natural climate change, pollution-induced biodiversity loss and habitat degradation might affect fisheries. The observing capacity therefore needs to involve both *in situ* and shore-based aspects, and to include the water column as well as seafloor processes.

4.2 Technology advances

Marine research and oceanography are critically dependent on advanced technologies to observe and understand the ocean environment and related processes. Ocean science is becoming the beneficiary of several emerging technologies driven by many communities that are entirely external to the world of ocean research. They include nanotechnology, biotechnology, information technology, computational modeling, imaging technologies, and robotics.
Of particular relevance are technology advancements to produce novel miniature sensors; transfer new developments from advanced material science to marine technologies; and develop long-lived *in situ* instruments. Techniques for precise identification of species in the laboratory and detection of organisms in the field will be developed. This includes both genomic methods and other techniques which use the morphology, optical, and/or acoustic characteristics of organisms.
Methods to measure the state of organisms (e.g. photosynthetic efficiency) will be increasingly important as we attempt to characterize the rates of change of key biological indicators. Improved

sensors for directly measuring chemical properties of the ocean will become available for key nutrients and tracers. As these systems become smaller and consume less power, they will enable a much more detailed understanding of ocean processes on small space and time scales.

Robotic platforms which conduct observations and simple tasks with little or no human supervision are being rapidly adopted. Remotely Operated Vehicles (ROVs) as well as Autonomous Underwater Vehicles (AUVs) represent important ocean observing tools which have great potential for further development. Over the next decade, new and more capable platforms will be introduced. Infrastructure for delivering power and communication to remote instruments and platforms in the ocean interior will enable a continuous, interactive presence in remote locations.

A special effort to enhance the monitoring capability, as well as the implementation of observatory networks or integrated observing system aiming to include a large variety of *in situ* sensors to reduce human intervention, allowing remote control, and real-time availability of physical, geochemical and biological data is needed. Such observatories is expected to be part of an international framework, in addition to national frameworks.

Education, which aim is to create the future intellectual capital, is an important and necessary component of the novel approach to the ocean science. The needs run from researchers to electronics technicians to science managers to experts in formal and informal education and outreach.

4.3 EU Infrastructure Networks

The oceans play a range of essential roles for Europe, including providing energy resources, and the backdrop for maritime transport, and recreation. Marine research has been recognized to be of strategic significance to Europe and of importance to its citizens. The Marine Strategic Framework Directive of European Community (Directive 2008/56/EC) assigns a key role to the marine research concerning integration between industry, science, technology and society. Several European strategic fora (e.g. ESFRI) and European Commission's Communications (e.g. Communication on Joint programming – 2008) have emphasized marine research as a field where major synergistic benefits can be reached by improving the coordination of research and infrastructure investments. With this aim the SEAS-ERA project was born to facilitate the establishment of a stable and durable structure for strengthening marine research across the European Sea Basins, to optimize the capacity for experimental facilities and to facilitate open access to existing specialized infrastructures. The European strategy is to create networks and to develop dynamics of interactions between involved operators.

The European Roadmap for research infrastructures deeply involves the marine science with several projects, such as: AURORA BOREALIS (http://www.eri-aurora-borealis.eu/), the multipurpose research icebreaker with drilling capability in up to 4000 m water depth with seafloor penetration into up to 1 km; EMSO (http://www.emso-eu.org/), the European Multidisciplinary Seafloor Observatory for the long-term monitoring, mainly in real-time, of environmental processes related to the interaction between the geosphere, biosphere, and hydrosphere, including natural hazards; the Network of Excellence ESONET (http://www.esonet-emso.org); EuroSITES (http://www.eurosites.info/), an integrated European network of open sea observatories of the water column; JERICO (submitted), network of coastal observatories; ECORD European contribution to IODP (http://www.iodp.org/home), the Integrated Ocean Drilling Program and several others.

Special attention is also devoted to information infrastructures because they play a key role in every effort to model, assimilate, analyze, and broadly exchange data and information at levels frequently difficult to reach. This type of infrastructure includes the necessary requisite (hardware, software and personnel) to ensure that massive amounts of disciplinary and interdisciplinary data are available for purposes of research, decision and policy making, and public use.

Data centres are an essential infrastructure facility in support of marine research, particularly in view of the cost and relative rarity of observational data. The networking data centres in Europe is organized through: EMODNET, a network of existing and future European observation systems, linked by a data management structure covering all European coastal waters, shelf seas and surrounding ocean basins, accessible to everyone; SEADATANET (http://www.seadatanet.org), a pan-European initiative dealing with ocean and marine data management. Other relevant initiative is MYOCEAN (http://www.myocean.eu.org/), the implementation project of the GMES Marine Core Service, aiming at deploying the first concerted and integrated pan-European capacity for Ocean Monitoring and Forecasting.

5 FLEETS EXPECTATION IN RELATION TO NEW NEEDS

Today, fleets are approaching a crisis in that their role is changing while several of the vessels are aging. Notwithstanding the increasing importance of drifting and moored instrumentation, remote sensing and coastal observatories, the research vessel remains a critical part of the essential infrastructure in support of oceanographic research. While the balance of the types and roles of required vessels may be changing, fleet maintenance remains a critical need. The new vessel role involves the types of missions which might occur in the future, the equipment needed, the future cost impact.

5.1 Future vessel mission requirements

As the existing oceanographic programs and institutions consolidate, restructure, or transform themselves, there will be significant impacts on the research fleets. Observing systems will become more standardized, with a greater reliance on gliders, cabled observatories, and other autonomous systems (global drifting arrays, such as the Argo array, and open ocean buoys) that need much less, but more specialized ship support. Whereas in the past the ship itself was the primary platform for data collection, these newer technologies will greatly increase the spatial and temporal footprint of information gathering far beyond what was previously achievable with a ship alone. The role of the ship will be to deploy and service these more mobile or enduring assets, and act as a nexus for the information aggregation. Thus the ship of the future will require the utmost in maneuverability, high bandwidth communications, the ability to pick up and/or deploy heavy payloads, to host large power consumption instrumentation. New state-of-the-art ships with technically sophisticated equipment will require more highly trained and specialized personnel to provide technical support. Personnel strategies must be developed to improve the staffing and retention of experienced technical support personnel and crew.

Several technical utilities, until today optional, are coming of primary relevance: precise navigation and dynamic positioning, large bandwidth satellite communication or undersea communication, management of automated vehicle fleets, *in situ* platforms, AUV, gliders, ROV etc., remote sensing observations. Finally, the new vessels have to manage complex experiments, to acquire large amount of data, trawling and coring activity, to enlarge and/or increase their flexibility. This is particularly important for Global and Ocean vessels. The increasing cost of ship time and economies of scale associated with larger ships may lead to greater usage of vessels, which have laboratories, deck space, and berthing capabilities that can support multiple science operations.

The new vessels, planned by EU countries (paragraph 3.1), seems to satisfy these new requirements. Every vessel may host automated vehicles, has special attention to low noise levels and may provide good up to date communication facilities. Finally, vessels are designed to be able to operate over a large activity spectrum. Moreover the EUROFLEETS project is operating to improve the technical staff experience (WP6) together with the development of standardized and updated protocols for onboard operation, with a special attention towards advanced utilities (WP10-11).

5.2 Optimization of vessel usage

The optimization of vessel usage is one of the biggest challenges due to its impact on the ocean research budget, especially considering the present decrease of available resources. Ownership of research vessels, equipment and instruments in European countries are generally spread on a number of different research institutes and universities, and to some extent on private companies with different objectives and investment strategies.

There is a strong need for better and more well defined investment plans on local, regional, national and international levels, in order to ensure the best possible use of the limited available resources. An effort is required to enlarge the ocean science results toward a wider society interest to share costs with other actors.

It is necessary to act on different levels:

- Optimize single vessel investment, running cost and employment,
- Optimize the country fleet, balancing vessel classes
- Optimize the fleets on both a regional level and European level:
    a. Favor coordinated plans for new vessel on a regional level
    b. Foster exchanges of shiptime, scientific equipment, scientists and technicians
    c. Enlarge vessel access through transnational projects
- Insert ocean science costs inside a broader Global Environmental Portfolio

While the first two points are main tasks of the national funding authorities, a coherent pan-European approach with enhanced partnership in investment, development and usage of fleets, would have a significant impact to better meet the diverse needs of European marine research.
The current situation with the large diversity of Europe's marine research infrastructures needs a better co-ordination and management, together with a long-term coherent planning of infrastructure requirements and investments. Significant signals can be found for the new coming vessels scenario (see paragraph 3.1), where a tendency toward an integration at regional level seems evident. The EUROFLEETS project, by the implementation of a virtual infrastructure of European research vessels (WP2,) will provide useful instruments for a regional and European coordinated fleet management.

The access to existing marine research infrastructures for a wider community is another important need. Different cooperation schemes in Europe are possible on different levels, both formal and informal, to act effectively towards an enhanced use of available resources:

- the barter system: existing partner's infrastructures are financed and provided by the owner on loan to the partner for a certain period of time; in turn, the owner receives the right of usage of the partner's infrastructure in the future; see http://www.ofeg.org/pages/ofeg/index.php for more details on the existing European barter system for Global and Ocean class vessels,

- shared investments and running costs: system used if a single partner needs infrastructure but cannot afford, or is not willing, to pay the necessary investment and/or running costs on its own; see (http://www.eri-aurora-borealis.eu/) for one example of such a European effort,
- charter contracts: owners of infrastructures, not only public institutions but also private companies, contract their infrastructure against cash-flow;

Of particular relevance are joint projects/programs where partners agree to share infrastructure for a time period generally limited to the project's lifetime. Several projects favor this possibility, but for some of them (e.g. EUROFLEETS, JERICO) the infrastructure access is a main task. EUROFLEETS project has a specific work package (WP4) to enhance the coordination between vessels and large-scale equipment interoperability.
Finally, ocean science has to join forces with other disciplines and sectors (industry, commerce, policy) to become part of a broader Global Environmental Portfolio. This tendency appears evident if we consider that the interest in observatory datasets, scientific understanding, and the resulting predictive models has grown well beyond the scientific community to interest government agencies and private industry. The research community should enlarge its partnership in such a way that observing and monitoring systems should be conceived and planned in association with private sector commercial interests to favor a broader funding base. Interactions and synergies should be deepened so that marine infrastructures could be available to a range of users (fisheries, defense, and environment), increasing efficiency and cost effectiveness. An examination of the planned new vessels shows that the available budgets are government budgets of a single country, while the contribution of other actors is generally absent. This means that a lot of work is still necessary in order to enlarge the participation to other non academic sectors. A special attention would be devoted to develop contact with industry, both in term of developing and testing new technologies, providing high quality support to their activities, and to collaborate to extract scientific results from activity mainly addressed toward industrial/economic objectives.

6 CONCLUDING REMARKS

The need for sustainable ocean research will remain strong, including the impacts of climate change, research on green energy generation and resource exploitation. Furthermore, we are witnessing a revolution in ocean exploration, enhanced by several rapidly evolving new technologies. In this scenario the ocean exploration and investigation appears as a new challenge to science and technology developments. The economic interest for the coastal and open seas is more and more evident, as demonstrated by the progressive expansion of the economic exclusive zones from the coastal regions to the open sea. The growing relevance of the ocean to the global economy will simultaneously create a demand for improved understanding of the ocean.

The availability of marine research fleets, and associated marine equipment (e.g. underwater platforms), is essential for research at sea. The European situation seems to be satisfactory in term of number of vessels. The regional coverage needs some improvements, but for the most part it meets high standards. Nerveless a limitation is the vessel age (near the 50% of vessels is more than 20 years old) and their renewal appear more pressing than in the past, due to the striking technological advances verified during the last decade. The on-going and planned projects to build new vessels will improve the present situation to some extent, and will result in a European fleet with fewer, but more capable vessels. But in order to maintain their status as state-of-the-art facilities the vessels must be upgraded and modernized almost continuously. The prevailing interest toward regional vessels makes the necessity of an pan-European coordination even more pressing.

The renewal plan and the foreseeable scenario for the next years might be considerably improved by a joint and efficient regional policy. In this situation it appears to be a strategic requirement for scientists to advise their national agencies and the European Commission on specifications for new research vessels, in order to maximize vessel use on a pan-European scale, to improve interoperability, and reciprocal access.

It is well known that weaknesses of European marine research are the deficient joint approach (limited collaboration between national programs, fragmentation and duplication of research efforts), the imbalance in research and technological capacities among regions, and few contacts with marine industry.

European research vessel fleets may play a key role to reduce the fragmentation of the European ocean research through a more efficient use of the existing vessels and by improving co-operation and co-ordination of European fleets at a regional level. The European Commission has to foster joint initiatives through increased financial support.

The existing collaboration and coordination (e.g. the Ocean Facilities Exchange Group [OFEG], which barters access to European ships) have demonstrated that pooling resources facilitates an improved and more flexible use of specialized infrastructure for the benefit of the scientific community. Positive signals also seem to come from the under construction / planned vessels where some attention is devoted to joint vessels (few) and to synergy at regional level (almost all).

Concrete actions concerning the European fleets may be:

- to develop a common vision and common methodologies;
- to solicit Research Funding Organizations to foster synergies at regional level, mobilizing funds for ship time used by transnational coordinated or common programs;
- to foster integration and synergy among sectors (industry, marine S&T, society, policy), countries and regions.

Vessel efficiency and cost effectiveness may really improve if, at first, a common vision among countries and an enlarged partnership among marine sectors are developed. The EUROFLEETS project is deeply involved in this process and several initiatives will be developed in the frame of it. Almost all WPs are organized to enhance vessel coordination and promote their cost-effective usage. Specific activities will be developed, such as a web-based fleet information system (WP2), to organize trans-national vessel access (WP5,7,8), to promote a common inter-operability and fluidity between equipments and fleets (WP4) and to establish a standardisation of several procedures. EUROFLEETS has also created a Club of Industrial Interests, to develop more stable contacts with the marine industry. The new vessels may be a good opportunity to enhance more fruitful contacts with industry through joint working groups, or by testing specific equipments.

The experience acquired inside the different EUROFLEETS activities will be a good basis for a real integration of the European research vessel fleets. Of relevance should also be a closer connection with the existing European marine initiative through the important role of the SEAS-ERA project, specifically devoted to improving the coordination of marine research and infrastructures.

7 REFERENCES

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8 APPENDIX

This document is to be filled for each foreseeable project concerning research fleet evolution for the 10 next years (2011-2020).
Please indicate which information are confidential and could not be published, by checking boxes in regards of each question.
This information will be used and synthesized in an open report.
You can add other information of the project, some general draft or picture.
Important : For existing fleet, please update the Eurocean database.

Confidential

Country/flag ______

Owner/operator ______ ☐

Contact person ______ ☐

Project description (new vessel, vessel refitting, new equipment, equipment refitting …)

Type

☐
Global/ocean vessel ☐
Regional vessel ☐
Coastal vessel ☐
Equipment ☐
Others

Status/project maturity ☐

☐
☐
☐

Pre design
Finalised design
Order placed

Planned date of avability for cruises between 2011- 2020

Funding

National budgetary
Regional budgetary
Other national
European
Others (industrial …)

Budget (with associated equipement)

Potential partners, details, numbers

Mission

Multipurpose
Not multipurpose
Main activities

Continuous operation capability (approximatively in days)

Operating area

Length

Under 30 meters
30/40 meters
40/50 meters
50/60 meters
Over 60 meters

Scientist number on board

Below 10
10 to 20
Above 20

Fixed scientific equipment

☐

Other relevant characteristics/facilities (low noise impact, communications, navigation, …)

☐

Capacity to receive mobile equipment (piston corer, ROV, AUV, manned sub-marine …)

☐