Synthesis template for new / upgraded Research Infrastructure (RI) of pan-European relevance to be sent by the ESFRI delegations to the Executive Board for consideration

1. Descriptive title, and information on the ESFRI delegation submitting the proposal (or one of the member of EIROForum)

European Marine Biological Resource Centre (EMBRC). An infrastructure consisting of the main coastal marine laboratories in Europe with a capacity for access to genomic models, acting as a distributed infrastructure for high-level research in basic biology, marine biology and ecology including integration with modern technology and 'omics' platforms. Providing and promoting access to the infrastructure for marine biological researchers, for training the researchers of tomorrow as well as a resource for SMEs and industry. Generating and leading outreach to stakeholders (both the public and industry).

2. Synthesis description of the new RI (or major upgrade) and S&T fields involved at Pan EU level in its use. Add links to relevant data/web pages (half page max)

This proposal seeks to establish a European Marine Biological Resource Centre (**EMBRC**) designed to support the needs of the ERA in basic biology, marine biology and ecology and to foster its integration with other fields of sciences, including genomics and systems biology for the next 30 years. This infrastructure will also act as an incubator and 'spin-off' for new ideas and technologies and will work with and alongside academics, SMEs and Industry to apply these at the European level. Marine organisms are an essential component for our quality of life, for their contribution to the food chain and impact on the environment. However, given the difficulties in maintaining and culturing them they are the least well studied.

Marine models have provided experimental systems for seminal discoveries in basic science that impact on our quality of life in a concrete and lasting way (cf. Nobel prizes for Physiology or medicine **2001, 2000, 1970 1963).** Thus, it is highly likely that marine organisms with their phylogenetic diversity offer access to presently unknown biological mechanisms which can in turn be used for biomedicine or for biotechnologies. **EMBRC** will be a distributed infrastructure comprising key coastal marine laboratories with complementary expertise and equipment providing i) access to marine laboratories, which encompass a representative set of European coastal ecosystems, fully equipped with modern boats, sampling devices and platforms in sequencing, transcriptomics, proteomics, metabolomics, structural biology and bioinformatics; ii) an integrated supply of key marine microbial, algal or animal organisms, as existing and new models for interdisciplinary marine biological research; iii) services from a central DNA and cell stock centre for marine model organisms, backed by dedicated platforms for the preparation of DNA libraries, cell lines and specific genotypes for functional genomics, including transgenic and mutant lines.

This infrastructure will build on and expand on the synergies developed in FP6 between the partners (See ***Marine Genomics Europe*** and ***MarBEF*** links below) and the current activities in FP7 where we are active in the current call for Integrating Activities support (***ASSEMBLE***) and the ESFRI ***Life Watch*** infrastructure.

Access. Facilities are all currently accessible through mutual agreement and common

projects (national or European). All of these Institutes have been and are currently working together on Integrating Activities and Network of Excellence Proposals.

Potential users. Marine Biologists working on a wide range of interests from resource management, biodiversity, trophic structure to biotechnology and conservation biology. **Government and NGO Environmental Agencies**. **SMEs** with interest in biotechnology. **Researchers** using molecular biological and genomic approaches, in biomedicine, biochemistry, physiology, systematics, paleontology, ecology and research on global change and climate. **Companies** in aquaculture and those developing new materials, e.g medicines and biofuels.

3. Science case: scientific area(s) and potential and/or explicit users, how the new RI will fit into the existing and future landscape of Research and of existing RI's, at EU and World level (one page max, links to relevant documents, references).

Europe has a distinguished history in Marine Biology with its marine biological stations established in the late 19 th Century. They represented and represent a major European infrastructure that has acted to serve, enhance and develop collaborative marine research worldwide. Now, however, they have become a new breed of marine research stations, developing and applying new technologies and facilities that allow a higher quality of service, not only to the marine biological community but also to the increasing numbers of scientists that are turning to marine organisms as models with which to investigate fundamental questions in biology.

By providing access to fully equipped research laboratories next to coastal ecosystems, supplying access to living organisms and by carrying out their own in-house research programmes, marine research stations already act as research infrastructures for transnational access and, altogether, they represent a major asset for the European science community. Recent years have seen an increased interest in marine model organisms because of the emergence of cheap, rapid genome sequencing. The aim of Networking will then be to capitalize more on the complementarity and potential interoperability between marine institutes. Networking activities will primarily aim at 'de-fragmenting' this set of infrastructures, by providing increased opportunities for research, access, collaboration and training. In addition the point must be made that in many instances, facilities and technologies need to be continuously improved. Among the vast body of necessary technological improvements, a number of joint research activities will be selected with the aim of maximizing technological collaboration between sites. These actions will fall into three main categories: i) Improvement of instrumentation for access to the biodiversity of coastal ecosystems ii) Improvement of the production, maintenance, provision and utilization of key marine models for biological sciences and iii) The functional analysis of ecological or biological models, using modern, systems biology approaches.

Transfer, expansion, improvement of quality and quantity of the newly developed technologies will involve a combination of workshops, practical courses and research with shared personnel**.** At the same time the links between SMEs, Industry and research institutes will be addressed in **imaginative outreach programs**. Physical restructuring will allow industrial and institutional partners to work alongside each other in new ways to provide new products outputs and solutions.

At the global scale this Infrastructure would provide one of the largest integrated marine biology platforms in the world, providing European scientists with cutting edge tools to

address global issues. For a case pointing towards the creation of a European long-lasting, multi-site institute see the Scientific Challenges document (a position document on basic European Research in integrated Marine Biology supported by **MarBEF**, **Eur-oceans**, and **Marine Genomics Europe**).

4. Technical case: summary of results (technical specifications) of conceptual and/or technical design studies (half page, list references/links).

Additional facilities are needed to integrate marine biology and ecology with all areas of basic biological research. All the partners are arranged in a distributed infrastructure located by the sea and are equipped with model organism collection and maintenance facilities. The participants share state-of-art genomic and proteomic facilities.

- **Stazione Zoologica 'Anton Dohrn', Naples, Italy** Sanger sequencing (medium throughput), robotic picking, spotting and analysis of microarrays, Real time PCR. Typhoon imaging.
- **Sven Loven Centre for Marine Sciences** (previously KMRS and Tjarno) Sweden. Real time PCR, Proteomics (medium scale), Culture collections.
- **Scottish association for Marine Science, Oban, UK.** Algal culture collections.
- **Station Biologique de Roscoff, (France).** Algal culture collections, Sanger sequencing (medium throughput), robotic picking, macroarraying, HPLC-MS, GC-MS microarrary/macroarray reading, protein expression and crystallization, bioinformatics.
-**Observatoire Océanologique Banyuls sur mer (France).** Flow cytometry, imaging and platform for mass production of microorganisms. Access to 'omics' through Roscoff .
-**Observatoire Océanologique Villefranche sur mer (France**). Advanced Microscopy and imaging, Sanger sequencing. Access to 'omics' through Roscoff.
-**CCMAR Faro Portugal.** Fish cell lines, Sanger sequencing, Typhoon imaging, HPLC-MS, GC-MS.
-**Plymouth Marine Partnership (UK)** led by The Marine Biological Association, (Plymouth Marine Laboratory, Sir Alistair Hardy Foundation for Ocean Science, and Plymouth University). Sanger sequencing and imaging.
-**Alfred Wegener Institute for Polar and Marine Research Bremerhaven, Germany**

New partners

The proposal is not designed to be exclusive and we are seeking partnership with at least one marine station in the Baltic and another in the Eastern Mediterranean to provide a more comprehensive coverage of European Costal Ecosystems and Model Organisms.

Additional technical infrastructure.

1) **Upgrade** the capacity for holding, rearing and transporting marine model organisms, 2) **promote** the identification and establishment of new model organisms that are key players in ecosystems 3) **potentiate** the capacity to analyze genomes and gene expression profiles dedicated to marine organisms. 4) **disseminate** know- how and accessibility for these organisms and enable ecologists and basic biologists to work on them 5) **build** (where appropriate) modern adjacent laboratories and 6) **generate** new integrative departments. 7) **foster** transfer of knowledge between EMBRC and industry, including the development of science parks next to the basic research facilities.

5. e-infrastructure: what does the new RI require as far as e-infrastructure? How is it integrated with the existing EU e-infrastructure (e.g. Geant, grid, digital repositories).

This will be both a physical and virtual (e) infrastructure. It will involve the development and physical expansion of the capacities of the marine institutes (this will be achieved by national, EU and industrial funding) to house and carry out research. This network will complement but not overlap with LIFEWATCH and ELIXIR (e-science and technology infrastructures for biodiversity data, observatories and data depositories) already on the ESFRI Roadmap and with which we will be seeking partnership. EMBRC ***will not*** emphasise the compilation and production of long-term data series and complex biodiversity data, instead it will seek to carry out strategic and basic high level research which will underpin the EU knowledge base with the specific directive of addressing issues of improved quality of life and production. The data generated will feed into infrastructures (such as LIFEWATCH, ELIXIR and EBI (European Bioinformatics Institute), to unite the relevant systems biology information. However the main point to stress is that the objectives and outcomes of this distributed infrastructure will be essentially *practical* and *productive* with a strong emphasis on research, training and industrial partnership. In this sense EMBRC should be seen as complementary and completely compatible with other ESFRI Research Infrastructures.

6. Other expected socio-economic impacts: development of new technologies, effects on training, involvement of industries, local impact, other (one page, references).

From the point of view of socio-economic benefits, marine organisms are of enormous interest, for two major reasons. First, the sea provides amazing biological diversity (of 34 fundamental phyla, 17 occur on land, whereas 32 occur in the sea and 13 are exclusively marine). The diversity of marine species, together with the relatively large number of species that are exclusively marine, are the reasons why the sea is an important new source of biotechnology materials, chemicals and processes. Second, marine organisms often possess unique structures, metabolic pathways, reproductive systems, and sensory and defence mechanisms because they have adapted to extreme environments ranging from the cold polar seas at -2° C to the great pressures of the ocean floor.

Many marine products are currently commercialized or in development (see http://www.marine-genomics-europe.org/index2.php?rub=a&pid=23). Many more are in development, and more importantly many more are waiting to be discovered. A concerted action with production in mind would have an enormous social impact. At the local level an increased synergism between academia and industry should lead to greater opportunities for employment and productivity. Many of the regions where marine laboratories are located are in areas of medium to high unemployment. More than this, the exploitation of marine organisms for food and industrial processes, has an impact on one of the other main uses we make of the marine environment – ***leisure and recreation***. Scaling up these processes will have a direct and tangible impact on marine ecosystems and will certainly change the way we perceive this environment. One major objective of this infrastructure will be to develop a dialogue with industry and stakeholders through research to arrive at a common consensus on how to use, ***and not to abuse***, this resource.

Training and recruitment

We are presently recruiting people for environmental genomics, metagenomics and bioinformatics. We plan to continue recruiting more people in these areas. We need to train and recruit the Marine Biologists of the future, integrating training in organismal biology, ecology, biostatistics, modelling, and "omics" sciences. This needs long term

planning and integration. This will be achieved by concerted recruitment in the key 'omics' areas, targeted PhD programmes and workshops. This is highly realistic, for example the partner SZN Naples runs an integrated PhD programme which trains Marine biologists in both ecology and basic biology. This type of research school would become pan-european and targeted towards these high-throughput sciences. In particular, an international PhD programme in "Marine systems biology and biodiversity", currently involving 3 partners of EMBRC, is in preparation.

7. *Commitments / maturity: which States / Organizations have demonstrated interest / commitment in supporting and/or funding the proposal?*

This proposal builds on the already highly developed synergy between the partners of FP6 networks of excellence, Marine Genomics Europe and MarBEF. There are current partners in EMBRC (listed in section four) All the institutes have been and are currently working on joint network proposals and they have indicated a possible funding interest though national schemes. At a recent meeting of the partners, it was estimated that, collectively, around 50 M€ from national funds is planned for capital investment (mostly building labs and facilitates) within the next 5 years.

Fitting the planned RI into existing facilities

The current infrastructure, through the process of convergence created by activities in current FP6 and proposals for FP7, is already carrying out collaborative research in the area aimed at by the requested RI. However, we require upgrading of facilities (e.g., the ever decreasing cost of sequencing requires major investment in new technology). And we need to increase the functional capacity. This process in itself opens up higher through-put and greater volumes of data which need to be handled by computational biology techniques. No completely new facility is planned but the construction of new laboratories and of installations adjoining existing sites is envisaged. A great deal of economy of effort and cost would be achieved by upgrading major facilities at a pan- European rather than at national levels (e.g high through-put sequencing, mesocosms, culture facilities, imaging and proteomics facilities). Such facilities will be operated locally and managed by EMBRC. These services will be accessed though a unique entry point and will provide the core European facility that EMBRC will be built around.

A history of sharing and networking to be augmented by the RI

There is a tradition of sharing facilities and access in marine laboratories which has been explicit since their inauguration in the 1880s'. Traditionally also, oceanographers have been used to close cooperation and collaboration because of the sheer size of their projects). Until recently, however, the community of marine biologists had remained very fragmented. Now we are seeing a reawakening of this spirit of cooperation with the advent of the 'omic' sciences, which requires equipment and analyses that are beyond the reach of single teams or even institutes. So this and earlier initiatives have fallen on fertile ground. However there is still a lot of room for improving this cooperation, particularly between biomedical scientists, biological marine biologists and ecologists. This is where we feel the new frontier in Marine Science is, and this is here the major impact of this infrastructure would be.

Summary of Objectives

It would seem that the application of genomics and systems biology to biomedical

Sciences, marine biology, and ecology will create the long awaited 'marriage' between large scale global considerations and biological systems (environment and human impact on it and human health and sustainable exploitation). Marine model organisms have a historical and future role in basic cutting edge biological research and in the future models should be selected which will also be representative of the wealth of traditional marine organisms used in ecological research. We see this dynamic as the front where the main future development of marine biology should be. This process needs resource channeling by close but foresighted management. We do not see this process as exclusive, though we do not see it fostering non cutting edge research either (such research would be positively transformed in this infrastructure).

8. Costs for construction, operation and decommissioning, indications on project financing (half page, with references/links). Give budget info in M€

The key European marine laboratories involved are probably collectively worth more than 1000 M€ in patrimonial value, and they are spending a total on annual operating costs of ca. 30 M€. With perspectives for higher and sustained funding, EMBRC will seek to markedly upgrade and improve the level of access to research facilities, and provide and coordinate the supply of marine models and improve transnational access to coastal ecosystems. It will thus boost the efficiency of this unique infrastructure and further integrate the community of marine biologists. The costs indicated below are to be considered real costs for an effective upgrade.

Total preparatory cost	Total construction cost	Operation cost /year	Decommissioning cost
€ 10 M €,	€ 100 M €	€ 60 M €	€ 1 M €

9. Timetable for construction, operation and decommissioning (half page, with references/links) with duration and possible starting dates.

Preparatory phase. Setting up management and governing board, identification of needs, strategic areas, concerted actions for the major capital initiatives required. Proposal construction, consultation with stakeholders. We expect consultancy and planning of the Infrastructure to take three years. To set up and run the EMBRC infrastructure would cost 7-10 M€. EMBRC will be managed by a governing scientific board representing all partners. In Naples a dedicated management team with an e-interface for the exchange and acquisition of data and information will be built to provide a unique access point for the distributed infrastructure. The interface will include management of and inventories of available services, and the modality of use of the infrastructure. Access will be in 'open-mode'.

Construction. Assembling network, construction/reconstruction/refurbishment of physical infrastructure. The construction phase will last 5 years and will involve the major costs of refurbishing physical infrastructure, and the purchase of new equipment. We calculate the costs as 20 M€ a year for 5 years from National/local and EU funds. (Part of this capital investment is already explicit in the forward plans of several partners.)

Operation. Full implementation of the infrastructure for ten year operation period. Beginning during the construction phase and tailing off during the decommissioning phase. Operation costs are estimated as a fraction of current operating costs (ca. 30 M€/year). Hence if the national contributions to the operation of this network is currently 30 M€/year then a step-up in the activity level would require an additional turnover of 30

M€ (15 M€ supplied by EU sources and 15 by national funding). This would lead to a network operating cost of 60 M€ /year for the time course of the operation phase.

Decommissioning. It is envisaged that once the networking mechanisms have been demonstrated to be functional and productive the long term function of the Infrastructure will be mainlined by national funding and Industrial sponsorship, with a relatively small input from the EU. The current network has grown and been maintained for almost 140 years and thus in the future we would not expect there to be any major decommissioning costs.

Preparatory phase	Construction phase	Operation	Decommissioning
2008-10	2010-15	2013-33	2020-2040

10. Reference: Person who has submitted the proposal, and will follow up in ESFRI

Prof. R Di Lauro Stazione Zoologica Anton Dohrn, Villa Comunale, 80121 Napoli, Italia.
Tel 0039 0815833, Fax 0039 0817641355 Email: dilauro@szn.it