











"It is a major challenge to bring marine science to the public due to the fact that the underwater world is difficult to experience and communicate."

Europe today

- The closer people live to the coast, the more literate about seas and
- oceans they are [1]. Most people associate the sea primarily with tourism and recreation and are unaware of other numerous goods and services provided by the sea [1]
- Marine science, as well as maritime activities, development and growth are restricted due to limited availability of interested students, trained scientists and staff, etc [2]

Europe tomorrow

Marine research and technology could be

- a critical driver towards: Improving marine science education in curricula inspired by successful experience [3]; ▶Increasing ocean literacy, and raising
- the awareness of the public at large Turning vocations into qualifications of the highest standards for marine scientists and maritime professionals

manage the Consequences of human impact."

'An improved understanding of

ecosystem dynamics and

functioning is critical to predict and

MARINE ECOSYSTEM

FUNCTIONING

FUNDAMENTAL KNOWLEDGE

FOR THE SUSTAINABLE

MANAGEMENT OF

THE SEAS

Europe today

 It is estimated that less than 5% of all marine species are known to science [1].

Marine microbial communities account for a substantial part of the primary production (base of the food chain) in the marine environment and represent more than 90% of the marine biomass.

 Marine microorganisms play a critical role in regulating the cycle of carbon and nutrients in the sea, vet almost nothing is known about their biodiversity and variability over space and time [2].

 Marine ecosystems in Europe are increasingly influenced by human activity. In the Mediterranean Sea more than 600 invasive species have been introduced in the past 100 years with potentially significant impacts on marine ecosystems [3]

Europe tomorrow

Marine research and technology could be a critical driver towards:

 A deeper understanding of the functioning of marine ecosystems and the influence of human impact and environmental change;

the implementation of the Marine

Strategy Framework Directive and the

achievement of Good Environmental

Status in all European marine waters

Greater knowledge of marine microbial species and communities, their role in ecosystem functioning and biogeochemical cycling, and other critical goods and services they provide; New modeling approaches through integration of traditionally distinct

including plankton, corals, snails models for examples ocean circulation and clams. CO2, chemistry and fish; Climate change has already affected The implementation of an ecosystem narine ecosystems significantly. In the approach to management of human North Sea for example, nearly twoactivities in the marine environment, and thirds of the fish species have shifted

Europe tomorrow

the consequences of changing oceans."

influenced by, climate change.

Only knowledge generated through

research will unlock the complexity

of this relationship and allow us

to predict and adapt to

CHANGING OCEANS IN A CHANGING CLIMATE

Marine research and technology could be a critical driver towards:

- Advanced systems of ocean observations providing long-term time series data for predictive models, trend analysis and measuring the effectiveness of climate change policy;
- More reliable predictive modeling approaches, with down-scaled models providing information on local and
- regional impacts of climate change; marine environment and the know-
- Accurate predictions of the potential socio-economic consequences of changing marine environment to allow for adaptation, mitigation and planning to protect society and economy.

include offshore wind, wave, tidal range and currents, the salinity gradient, the thermal gradient and biomass sourced from microalgae and

seaweeds. Europe's binding objective to source 20% of its energy from renewable resources by 2020, means that 35% of electricity has to be generated from renewable energy sources: Marine Renewable Energy can and should

Europe today

Marine Renewable Energy resources

contribute substantially [2].

France, Portugal and Spain.

Offshore winds are stronger and

present) produces 0.54 TWh/y

[1 terawatt = 1012 watt] [4]

Wave energy converter demonstration

and pre-commercial test sites are

oastline of Ireland, UK, Norway,

currently being developed off the

- The understanding of the real rate and scale of environmental change in the ledge to distinguish between natural and anthropogenic forcing;
 - steadier than on land as there are no obstacles to disrupt the flow; offshore turbines can generate electricity 70% to 90% of the time The world' largest tidal barrage. the French La Rance Barrage (1966-

FOR A NEW ENERGY ERA.

"A 100% renewable energy supply system by 2050 (...) is not a matter of technology, but rather a matter of making the right choices today to shape tomorrow.

Prof. Arthouros Zervos, President, European Renewable Energy Council [1]

Europe tomorrow

- Improving energy security and reducing dependence on foreign imports: > by 2050 15% of European electricity could be provided by wave, tidal, thermal and osmotic resources (5
- ➤ In 2021, offshore wind power would avoid the emission of 100 Mt of $C0_2$,
- The creation of new economic and employment opportunities:
- > 10 to 12 direct and indirect jobs would be created for each megawat
- Planning for improved management
- offshore platforms for Marine range of other potential uses including aquaculture, marine observations and environmental monitoring.

Marine research and technology, together with industry and policy actors, could be a critical driver towards:

- The reduction of CO₂ and other green-
- and possibly 292 Mt in 2030 [6]
- (10⁶ watt) of ocean energy installed (5) The implementation of Marine Spatial
- > Facilitating the use of multi-purpose Renewable Energy generation and a



EurOCEAN 2010 poster series - Blue Energy



Poster series illustrating a selection of ten grand challenges and priorities for marine research in the next decade identified during the Marine Board Navigating the Future IV Preparatory Workshop (March 2010).

Prepared by the Marine Board and Flanders Marine Institute (VLIZ) on the occasion of EurOCEAN 2010.

InnovOcean site Wandelaarkaai 7 8400 Oostende Belgium













Europe today

Olobally the mean temperature of the

impacts on the coastal seas [1

Sea level rise has accelerated from

coastal erosion and flooding [2].

2mm/y to 3mm/y putting coastal

Each year the ocean absorbs approxi-

mately 25% of all CO₂ emissions

resulting in a 30% increase of sea

water acidity since the beginning of

the industrial revolution [3]. This will

have severe consequences for marine

organisms with calcareous skeletons

their mean latitude and/or depth over

the last 25 years [4].

zones at higher risk from increased

sea surface has increased by 0.1°C

over the last 50 years, with significant

⁴ Perry AL, Low PJ, Ellis JR, Reynolds JD (2005). 70 Impacts of Climate Change on the European Marine and Coastal Environment Climate change and distribution shifts in marine fishes. Science 308, 1912-1915















Eurocean 2010 Conference Grand Challenges for Marine Research

in the next decade

Thermae Palace, Ostend 12 & 13/10/2010

70% of our planet. A largely

undiscovered wealth,

closer look!

a major driver of our

climate... Worth a



"Scientific knowledge, advice and innovation are critical for the future sustainability of fisheries and aquaculture in Europe, supporting protecting coastal communities and providing safe and healthy seafood products.

Europe today

- Europe is a major consumer (22 kg/ person/year) and a world's top three importer of fishery and aquaculture on terms of value, the annual output of
- the European fish processing industry is €23 billion, or three times that of the catch sector [1] The EU aquaculture industry produced
- 1.3 million tonnes of fish, shellfish and crustaceans in 2006, generating a turnover of €3.2 billion and supporting 65,000 jobs [2]. Olobally, marine and inland aquacul-
- ture production is fast catching up with fisheries, representing 47% of food-fish output in 2006 [3]. EU aquaculture production, however, is static. Science programmes are beginning to
- focus on the significant opportunitie for discovery and extraction from marine organisms of food and functional food ingredients for human consumption and animal feeds

Europe tomorrow Marine research and technology could be a critical driver towards:

- The management of European fisheries according to the best available science. utilising an ecosystem approach at elevant local and regional scales and supported by integrated and dynamic policies at EU and national level: A European aquaculture sector producing high quality, high value food
- products, utilising science-based man agement and advanced technologies and occupying marine space according to the best principles of marine spatial Europe achieving the status of world leader in aquaculture technologies.
- exporting knowledge and services to a globally expanding aquaculture sector; A coordinated, sustainable and ethical framework for bioprospecting for bioactive molecules and compounds rom marine organisms for delivery of new food additives and ingredients creating commercial opportunities and nealthy food products.
 - Seafood is an important component of a healthy balanced diet, e.g. providing a vital source of omega-3 fatty acids.











EurOCEAN 2010 poster series - Oceans and Human Health

EurOCEAN

OCEANS AND **HUMAN HEALTH FOR HUMAN HEALTH**

AND WELL-BEING "Life on earth is fundamentally and inextricably linked to the oceans. Oceanic processes affect climate, influence the Spread of pathogens and determine food and material resource upon which we depend. How we use the sea can influence those

processes to our benefit or detriment. John Stegeman, Director, Woods Hole Center for Oceans and Human Health (USA)

a critical driver towards:

Europe tomorrow

Marine research and technology could be

The reduction of the health risks and

approach combining disciplines as

disparate as physical oceanography,

chemistry, genomics, epidemiology and

social science and focus inter alia on:

> Retter identification and prediction of

the occurrence, distributions, toxicity

and other deleterious effects of HABs

Development of novel diagnostics.

> Securing supply of healthy and safe

marine food from fisheries and aqua-

> Better understanding of-and pre-

paration for current global changes

which will affect the health benefits

and risks of the marine environment.

Better understanding of the positive

(therapeutic) impacts on people of the

drugs and treatments for human

and pathogenic organisms;

This would require an integrated

identification of new resources and

benefits from the oceans and seas;

Europe today

- Narmful Algal Bloom (HAB) events have increased over the past decades along the European coasts, leading to an increase of related diseases and economic losses in the fisheries and aquaculture sector [1] with a total cost estimated at €64 million/year in the U.S and more than €627 million/year
- in the EU [2]. € More than 100,000 chemicals are currently on the EU market: some of which eventually end up in the marine environment as a micro-pollutants. The effects of this chemical cocktail on the marine ecosystem and human health remain largely unknown [3]
 - Around 15 natural products from marine organisms are currently in clinical development for novel drugs [mainly for treatment of cancers] with several already on the market [4] The oceans and seas – although hardly explored – have a high potential for discoveries of bioactive compounds, given the rich marine biodiversity (5)





EuroCEAN 2010 poster series - Marine Observations and Information

OBSERVATIONS AND

INFORMATION

EUROPEAN OCEAI

OBSERVING SYSTEM

Europe today

defenses [3].

coastal areas.

The annual costs of ocean observations

Marine observations and data are

scale of environmental change.

reduction in uncertainty in future

Marine observations are limited to a

small number of parameters (mainly

physical) and have large spatial and

Some components of the global ocean

through large international research

efforts whilst others rely on uncoordi-

nated national initiatives, resulting in

mobilising and coordinating the marine

data management field, and developing

common standards and protocols for

quality control procedures, metadata

formats and descriptions, and data

Numerous European initiatives aim at

observing system are addressed

a very fragmented picture.

temporal gaps especially at shelf and

sea-level rise alone would save €100

million annually in European coastal

in Europe amount €1 billion for *in situ*

data and €0.4 billion for space data [2].

essential for monitoring the rate and

For instance it is estimated that a 25%

"We need Sustained

observations because today's

tomorrow "

Europe tomorrow

a critical driver towards:

for Europe [4]

maritime activities:

Marine research and technology could be

The establishment of an end-to-end.

systems of European marine obser-

vations and data communications,

management and delivery systems

supported by a comprehensive user-

oriented toolkit to enable implementa-

The development of mutually compatible

and multi-dimensional mapping of

The production of information and

services required at local, regional,

European and global scales that meet

identified commercial, societal and

environmental needs in a cost efficient

way. Stakeholders in need of information

sector, researchers and the general

The development of necessary support

identified observation and data gaps.

ing technologies (e.g. deep sea obser-

ratories) and new sensors to help fill

products include policy makers, private

Member State waters and of a European

Atlas of the Seas, as tools for managers

and stakeholders to sustainably develop

tion of the Integrated Maritime Policy

integrated and inter-operable network of

observations cannot be taken



MARINE SPATIAL

OF HUMAN ACTIVITIES IN THE MARINE **ENVIRONMENT**

"Marine Spatial Planning has emerged as a means to address growing competition for finite marine space and reducing human pressure on marine ecosystems and habitats "."

Europe today

Seas and oceans represent over 50% of the territory of the European Union

- In 2008, the European Commission produced a roadmap for Marine Spatial Planning (MSP) which provides the framework for Member States to implement management strategies of human activities [2]
- Some coastal Member States have al ready implemented MSP strategies and practices (e.g. UK, Greece, Poland, France, and Germany) [1
- Despite the growing interest of Membe States to implement MSP, the scope to do so is limited in international waters (beyond 200 nautical miles) [1]. Improving MSP could generate up €1.3 billion of revenue by 2020 [3]

Europe tomorrow

a significant driver towards:

- The effective implementation of flexible and adapted MSP processes supported by a strong data and knowledge base (e.g. EMODNET); The use of new tools and integrated
- decision-making to take into account the rtant interactions between human activities and marine ecosystems [4]: An extensive knowledge of how ecological systems (e.g. food webs) are
- services which benefit to humans (5) The implementation of a coherent network of Marine Protected Areas in EU waters [4];
- The enhanced competitiveness of the EU maritime economy: improved cross-border cooperation, enhanced legal certainty and improved coherence of sectoral approaches and planning

Eur OCEAN



Eurocean 2010 poster series - Marine Spatial Planning

Marine research and technology could be

- assessments to improve the ability of
 - expenditure on R&D in one year [1] ▶ The average age of regional research vessels is more than 20 years in Furone Without decisive planning and investment, the regional research leet will decline significantly in
 - holding centres, monitoring agencies. governmental and private organisations are engaged in oceanographic and marine research activities, data acquisition and information management (3)

MARINE RESEARCH INFRASTRUCTURES MARINE RESEARCH

INFRASTRUCTURES

IN EUROPE "As a research arena, the ocean is special in two distinct ways: it is costly to access, and highly variable and unpredictable.

Marine Research Infrastructures provide unique facilities to the international scientific community to address major marine scientific challenges.

Europe tomorrow

Europe today

- Marine Research Infrastructures (MRI Continued European scientific excellence include research vessels and associand competitiveness on a global scale ated equipment, satellites, observing and monitoring networks, data, Technological innovations including computer centres and laboratories
- e-infrastructure and observing The total construction costs of all the research infrastructures listed in The alignment of national and European the European Strategic Forum for strategies towards the sharing and joint Research Infrastructures (ESERI) made management of existing and new MRIs: map represent 70% of EU-27 capital The use of dedicated legal framework (e.g. European Research Infrastructure
 - Consortium ERIC) facilitating the joint development and operation of MRIs; The use of innovative funding mecha nisms for the delivery and flexible operation of new MRI of strategic
- ♠ Almost 2,000 research institutes, data
 ♠ Effective coordination between differ ent MRIs such as observing systems (e.g. observatories) and platforms (e.g. research vessels).

Europe today Almost 90% of external freight trade in the EU is carried by sea. 40% of

- internal trade is by short sea shipping Around 3,500 million metric tonnes of cargo (2) and 350 million passengers (3) pass through Europe's ports each year. The maritime transport sector in
- Europe employs 303,000 people directly and 88,000 in related services (3). Emissions from maritime transport -Carbon dioxide (CO₂). Nitrogen oxides (NOx). Sulfur oxides (SOx) - represent 4.5% of global emissions [4].
- European investment in maritime research amounts to €1.5 billion each



"As a major European industry, sustainable shipping should meet new transport needs, deliver and use innovative technologies, and minimise environmental impacts.

Europe tomorrow

SHIPPING

Marine and maritime research and technology could be a significant driver towards:

- The development of safe, sustainable and efficient waterborne transport operations, of crashworthy vessels, with low emissions and enhanced maritime security.
- A competitive European maritime construction sector producing innovative vessels and equipment, new floating structures and materials for a global The implementation of an innovative
- maritime transport system management including new port infrastructure facilities, new interoperability models, use of intelligent transportation technologies and integrated ICT solutions.







EurOCEAN 2010 poster series - Maritime Transpo





the next decade [2]

EurOCEAN 2010 poster series - Marine Research Infrastructure

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EurOCEAN 2010 poster series - Food

Eur OCEAN