DECEMBER 2012
DG FISHERIES AND MARITIME AFFAIRS

Study to support Impact Assessment of Marine Knowledge 2020

INTERIM REPORT

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APPENDICES

Executive summary

This is the interim report of "Study to support Impact Assessment of Marine Knowledge 2020".

The study includes 7 components covering a set of 18 individual questions to be answered. The study components are:

1 Marine data in the licensing process
2 Costs of data for Marine Strategy Framework Directive
3 Cost of data for offshore wind farms
4 Legal basis of Regulation or Directive
5 Innovation from marine data
6 Reductions in uncertainty
7 Options for governance of EMODNet

The study is being undertaken by COWI A/S in cooperation with Ernst & Young. COWI has been main responsible for prepared components 1 to 4 and 7, while Ernst & Young has been main responsible for components 5 and 6.

Based on data collection exercise with questionnaires and interviews on key issues combined with literature review, we have assessed the different components and answered the specific questions that were required by the Terms of Reference. Table 1 includes summary answers to each of the study questions.

Table 0-1 Summary of findings by each study question

	Study question	**Findings**
(1)	Do potential operators of licensed activities mentioned in point 2.2 pay for meteorological, bathymetric or geological data when preparing their application for a licence?	It seems that in about half the Member States data have to be purchased. Their costs are however relatively minor compared to overall licence costs.
(2)	Would they request more data (i.e. higher resolution in time or space) if it were substantially cheaper or easier to access.	The replies indicate that the licensees only collect the data necessary for the preparing the application so there is no indication that further data would be requested if data where either cheaper or easier to access.
(3), (4)	Is the licensee obliged to hand over to public authorities the data collected or	No general answer can be given on this question. The obligation to hand over to public authorities, marine data

	Study question	Findings
(5)	acquired in order to plan, develop or engage in the licensed activities mentioned in point 2.2.?	collected or acquired in relation to licensed activities varies greatly across sectors and Member States. Of the ten countries for which information was received, in 7 there is an obligation to hand over marine data in at least some of the marine sectors. In most cases this obligation covers all phases of marine projects, i.e. siting, planning, construction and operation.
(6)	How much effort will Member States spend up to 2020 on data acquisition, management and dissemination (including enabling access to the Commission and the European Environment Agency) in meeting the requirements of the Marine Strategy Framework Directive?	A scale up of the reported costs for existing and new monitoring programmes in seven Member States indicates a total costs for all EU coastal states plus Croatia of 64 Million € for the period 2014-2020.
(7)	How much of this cost is assembling existing data (i.e. data already collected, or being collected for other purposes)?	The total data costs in relation to the initial assessment and reporting under the Marine Strategy Framework Directive lie at around 19 million € for the 22 EU coastal states and Croatia (based on a scale up of reported costs from 7 Member States).
(8)	How much will be spent on collecting new data (i.e. data from new monitoring and survey programmes that would not have been collected without the Marine Strategy Framework Directive needs)?	Four Member States have provided estimates of the costs for new monitoring/surveying programmes for collecting data under the MSFD. These costs lie in the range of 1.7 Million to 10 Million €.
(9)	What marine data will be required for planning, building and operating offshore wind farms in Europe up till 2020?	Based on consultation with the off shore wind sector supplemented by literature reviews and expert assessments, the different types of data are described in chapter 4.
(10)	How much will be spent collecting, purchasing, assembling and processing these data?	Using the same approach as for Question 9, the costs of data have been estimated. For an "average" offshore wind farm of 200 MW, the total data costs for planning, construction and operation could amount to 5-6 million €. With projections of new capacity in the order of 36-39 GW in the period up to 2020, total data costs for the sector could amount to 1 to 1.2 billion €.
(11)	What legal basis could be used for a Directive or Regulation on marine knowledge that meets several objectives? Are there any examples?	Both the issues of legal basis and legal instruments have been assessed and key aspects are present in this interim report. No clear options and recommendations have been identified and the assessment will continue.
(12) (13) (14) (15)	Assuming that historic and real-time data were available on parameters such as chemical pollution, non-native species, coastal erosion, storm intensity etc what services based on these and other data: › Might reduce risks for aquaculture producers? › Might enable insurance companies in coastal regions to provide a better assessment of risk? › Could support a longer season for coastal tourism? › Could help the bio-economy discover new products (pharmaceuticals, enzymes, cosmetics etc)	In total 10 case examples have been identified and assessed with regards to: description of problem/opportunity, the effect of additional data and the link to Knowledge 2020 and finally a description of the innovative service and an estimate of the potential economic benefits. The 10 case studies covering the four sectors demonstrate that additional marine data can promote innovation and suggests that there are significant economic benefits.
(16)	The contractor should provide three more examples of the economic benefits of reduced uncertainty in the behaviour of the sea or the state of the seabed and marine life.	In total 5 examples of reduced uncertainty have been identified and assessed. They demonstrate that there could be significant economic benefits from reduction in uncertainty of the state of the oceans and seas.
(17)	How would such an arrangement work? Are there any examples (other than EU Agencies)?	Different organisation options have been assessed including descriptions of examples from other areas.
(18)	Could it be done through the Joint	The organisational options have been assessed and the

	Study question	Findings
	Programming Initiative on Healthy Seas and Oceans? Or through the Joint Research Centre? Or through an executive agency? Or through a public-private partnership? What would be the costs and benefits in each case?	advantages and disadvantages of alternative options are presented and described.

1 Introduction

This report constitutes the interim report on the Study to support the forthcoming IA on Marine Knowledge 2020. The report is submitted in accordance with the reporting schedule stated in the Terms of Reference.

The interim report includes findings on all the issues that the study covers. In some cases the findings are preliminary results. The data collection and validation process will continue and within the next three month the final report including the final results and findings will be issued.

This introduction section describes firstly the background and the objectives of the study. Secondly, the data collection process is described.

1.1 Study background

The improvement of marine knowledge is one of the main objectives of the European integrated maritime policy. In 2010 the European Commission in its Communication on Marine Knowledge 2020 presented a strategy on improving marine knowledge as a "key element to achieve smart growth in the European Union in line with the 'Europe 2020' strategy". The objectives of the Marine Knowledge 2020 strategy are to reduce operational costs related to data use, increase competition and innovation from marine knowledge and to reduce uncertainty on the state of the oceans and seas.

A central aspect of the strategy on improving marine knowledge is the integration of the fragmented regional and national systems for collecting and assembling marine data. In this context the European Commission in 2010 launched an Impact Assessment on the European Marine Observation and Data Network (EMODNet). The purpose of this Impact Assessment was to contribute to the setting up of a common European network for the sharing of marine knowledge. As a preparatory action projects for the establishment of EMODNet pilot portals were created for the sharing of hydrographical, geological, physical, chemical and biological data.

1.2 Purpose and delineation of the study

Against the background described above the present study aims at gaining a deeper understanding of the current practices as well as opportunities and benefits of future marine knowledge sharing. It will use the Impact Assessment on EMODNet and the other work that has been undertaken as a starting point and take these activities further. It will supplement the current knowledge level and focus on benefits from improved marine knowledge as well as the role of the private sector in gathering and providing marine data.

The study has analysed current practices in the Member States regarding the gathering of marine data by the private sector in the process of applying for licensed activities and a possible re-use of this data by public authorities. It has collected information on the data collection, management and dissemination cost up to 2020 borne by the Member States for complying with the Marine Strategy Framework Directive and on the cost of data for offshore wind farms in Europe until 2020. Regarding benefits from improved marine knowledge the study provides examples of innovation from marine data in the aquaculture, insurance, tourism and bio-economy sectors. Additional benefits could arise from reductions in uncertainty in the behaviour of the sea or the state of the seabed and marine life. The study therefore provides examples of economic benefits from such reduced uncertainty.

Additionally to benefits from improved marine knowledge and the role of the private sector in data gathering the study assesses the legal basis for a Regulation or Directive on marine knowledge. Finally, the study provides examples of governance options for the European Marine Observation and Data Network as well as costs and benefits of the proposed governance options.

In summary the study includes seven components:

1 Marine data in the licensing process
2 Costs of data for Marine Strategy Framework Directive
3 Cost of data for offshore wind farms
4 Legal basis of Regulation or Directive
5 Innovation from marine data
6 Reductions in uncertainty
7 Options for governance of EMODNet

A possible structure for the full impact assessment on an EU initiative on Marine Knowledge 2020 is shown below. We have marked the inputs that are provided by this study and where each of the seven components contributes. Hence, this interim report can not be read as draft impact assessment but as a study that provides input to several elements of an impact assessment.

Text box 1-1 Outline of impact assessment and the contribution from the current study

- *Problem definition and baseline: Lack of coordination of marine data*
  - ***Current use and sharing of data (1)***
- *Defining the objectives*
- *Options: Alternative measures to improve coordination and use of marine data*
  - ***Legal basis (4)***
  - ***Legal instrument (Regulation or Directive)(4)***
  - *Content of measures (Collection or Assembling)*
  - ***Organisation set-up (7)***
- *Impacts of options*
  - ***Reduced costs to data users (2, 3 and 4)***
  - ***Innovations (5)***
  - ***Reduced uncertainty (6)***
- *Comparison of options*

1.3 Status of the interim report

This interim report includes an assessment of all seven components. It has been based on an intensive data collection phase. It relies on the responses from the consulted stakeholders and in some cases the consultation has taken longer than expected. Therefore, the collection of data and validation of the findings is still ongoing.

2 Marine data in the licensing process

2.1 Introduction

Commercial activities in marine and coastal aquaculture, renewable energy, minerals extraction, oil exploration and exploitation, port harbour and marina development and pipeline and cable laying are all subject to marine licences or permits.

This section covers two aspects of marine data in the licensing process

› Private operators costs of purchasing marine data for their licence or permit applications

When applying for such licences or permits potential operators need bathymetric, metrological and hydrological data to use for modelling in connection with preparations of EIAs and environmental permits. Marine data used by operators in the preparation of licence or permit applications is either obtained from public authorities or other third parties or collected by the operators themselves. This component of the study aims at investigating whether operators pay for marine data obtained from public authorities and whether they would request more data if marine data was cheaper or easier to access.

› The obligations by private operators to hand over data gather in relation to the licence/permit applications

Besides the data obtained from public authorities operators also collect their own marine data for planning, developing and engaging in marine licensed activities. This data collected by the private sector could be of use for public authorities in the Member States. A study on the "Use of industrial monitoring data for MSFD reporting purposes" by the European Commission found that many Member States wish to explore the use of industrial monitoring data, among others for data collection for the MSFD. Obligations for the private sector to disclose data collected and assembled in connection with licensed activities however differ across the European Union. This section therefore also aims at investigating to which extent such obligations exist in the Member States.

2.2 Facilitation of use of marine data

2.2.1 Private sector data collection

The inquiry about costs of publicly available marine data for licence applications focused on private operators in the seven marine sectors of aquaculture, renewable energy, minerals extraction, oil exploration and exploitation, port, harbour and marina development and pipeline and cable laying and covered questions 1 and 2 of the Terms of Reference.

The study started with the assumption that the degree to which operators have to pay for different types of data is likely to depend on the country and not on the sector and that the difference in data needs for licensing across sectors however might imply that there is variation across sectors in costs for data. To cover all countries as well as all sectors the relevant European industry associations were contacted. The list below presents the contacted associations.

Stakeholder	Sector
Federation of European Aquaculture Producers (FEAP)	Aquaculture
European Wind Energy Association (EWEA)	Renewable Energy Cable and pipeline laying
European Aggregates Association (UEPG)	Minerals extraction
International Association of Oil & Gas producers (OGP)	Oil & gas exploration and exploitation Cable and pipeline laying
European Sea Ports Organisation (ESPO)	Port, harbour and marina development

The industry associations distributed the questionnaire among their members and collected the answers before submitting them to COWI/E&Y. The questionnaire covered questions 4a) through q) as well as an inquiry on potential economic benefits and innovation from improved marine knowledge.

The consultation with the industry association is still ongoing as there is a need for further elaboration of the provided answers.

2.2.2 Costs for marine data in licence applications (Question 1)

There seems to be no clear picture across the European Union regarding data costs to be borne by operators when preparing applications for marine licences or permits.

The answers to Question 1 of the Terms of Reference, namely whether operators pay for marine data when preparing their application for a licence, as presented below are based on inquiries sent to the licensing authorities in the Member States and to European Associations in the relevant marine sectors.

Of those countries that replied to the survey on data costs to licence applicants in about half potential operators in the seven marine sectors of aquaculture, renewable energy, minerals extraction, oil & gas exploration and exploitation, port, harbour & marina development and in cable and pipeline laying have to pay for meteorological, bathymetric and geological data when preparing applications for licences.

Bulgaria	Licence applicants have to pay for marine data
Denmark	Licence applicants have to pay for marine data
Cyprus	Marine data free of charge (information from the ports sector)
France	Licence applicants have to pay for marine data (information from the ports sector in La Rochelle)
Germany	Licence applicants have to pay for marine data products, but not for data sets (information only available for renewable energy and cable and pipeline laying)
Norway	Licence applicants have to pay for marine data
Romania	Marine data free of charge (unless the marine data comes from research institutions/agencies)
UK	Marine data free of charge

Additionally to the Member States answers regarding costs for marine data in licensing processes were received from the European Aggregates Association, the International Association of Oil and Gas Producers (OGP) and the European Sea Ports Organisation.

The European Aggregates Association reported that costs vary between Member States. However, in most countries operators pay for marine data and undertake additional studies for their licence applications. The text box below provides an example of the cost for bathymetric data from the British Geological Survey (BGS).

DigBath250

The British Geological Survey offers a vector attributed digital bathymetry of United Kingdom (UK) and adjacent European waters with a scale of 1:250000. Its purpose is to provide a regional scale digital bathymetry as a primary dataset for geographic information systems (GIS), mapping and modelling of the sea bed and sub sea bed. It may also be useful for regional scale tidal, current and water column modelling. It has been produced to a specification for non-navigation applications only. The cost of DigBath250 is 300 GBP per sector (North-West Scotland, Northern North Sea, Southern North Sea, English Channel, South West Approaches and Irish Sea).

According to the British Marine Aggregates Producers' Association (BMAPA), a minimum standard of prospecting survey investigation is defined as part of the tender process, including the need to obtain high quality data using a range of techniques. Seabed exploration is challenging, involving acoustic, seismic and seabed sampling techniques. The cost of surveying necessary for obtaining a marine licence however varies greatly between Member States and their specific regulations as well as between sites.

This finding was confirmed by the information provided by the International Association of Oil & Gas Producers. The OGP reported that it is very difficult to make a general statement regarding costs for marine data since much will depend on site to site factors and locations. However, meteorological, hydrographical, bathymetric and geological data compiled for the EIA do not look to represent a significant part of the EIA related costs. The precise ratio will also fluctuate from country to country depending on their domestic requirements and legislations.

The OGP also reported that the Oil and Gas Producers community already has an extensive experience on harmonising seabed data. The OGP has developed "Guidelines on Seabed Survey Data Model" that describe the Seabed Survey Data Model (SSDM), which is a specification used in the industry for handling the delivery of various seabed survey datasets in GIS data format.

The European Sea Ports Organisation (ESPO) provided replies from Bulgaria, Cyprus, Denmark and the port of La Rochelle in France. The answer from Bulgaria was received from the Bulgarian Ports Infrastructure Company, a state-owned ports infrastructure company. The Bulgarian Ports Infrastructure Company reported it does not pay for marine data that and that new port projects require an Environmental Impact Assessment to be prepared according to EU regulations. Repair, rehabilitations and modernizations require permits under the water act regulations of the Bulgarian legislation. In Denmark marine data required for undertaking port development activities has to be acquired by operators, usually from consultancies and/or state owned institutions. Regarding Cyprus the ESPO reported that operators of ports do not have to pay for marine data needed in relation to e.g. port development projects. The port of La Rochelle reported that marine data required for undertaking EIAs are provided by the consultants commissioned to undertake that assessment. Possible costs for collection and purchase of data are typically included in the overall price for the EIA.

2.2.3 Request for more marine data (Question 2)

Question 2 concerns the potential request for more data (i.e. higher resolution in time or space) if marine data was substantially cheaper or easier to access. Answers to this question were received from operators in the offshore wind, the minerals extraction and the oil exploration and exploitation sector via the respective industry associations.

Offshore wind operators reported that publicly available data is often not requested by operators because very specific data is not available and because the quality of the available data is not high enough. Generally the kind of data operators need for project development and impact assessment are not available from other sources, and therefore are collected by operators in the context of the individual project. Only one operator reported that more data would be requested if it was cheaper or easier to access.

The European Aggregates Association reported that companies often go beyond what is required in licensing conditions regarding marine data collection and produce high quality data during impact studies. Reduced costs for marine data acquired from public authorities would however be welcomed.

The International Association of Oil & Gas Producers reported that meteorological, hydrographical, bathymetric and geological data compiled for EIA does not represent a significant part of EIA related costs in the sector relative to overall EIA costs. As EIA procedures are lengthy and costly the absolute costs for marine data are however high despite only representing a small share of overall costs.

Offshore wind	Publicly available data is often not requested by operators because very specific data is not available and because the quality of the available data is not high enough.
Minerals extraction	Companies are driven by acquiring the data necessary for the permits but, nevertheless, often go beyond what is required. In some cases, high quality data is produced by companies during impact studies. However, reduced costs of data available would be welcomed.
Oil exploration and exploitation	Meteorological, hydrographical, bathymetric and geological data compiled for the EIA do not look to represent a significant part of the EIA related costs. Absolute costs are however considerable.

2.3 Re-use of marine data assembled for undertaking licensed activities

2.3.1 Public Sector data collection

The inquiry on public sector re-use of data aimed at collecting answers to questions 3 to 5 of the Terms of Reference and focused on the competent licensing authorities in the Member States and in Croatia, Iceland and Norway.

Question 3 inquires about the obligation for handing over to public authorities marine data gathered in order to plan, develop or engage in licensed activities in the seven marine sectors. In case such obligations exist the sub-questions under Question 4 inquire further into the details of this obligation. For those countries

that do not oblige licence applicants and holders to hand over data Question 5 inquires whether there are plans to introduce a data hand-over obligation.

To obtain a first overview of the existence of obligations to hand over data an introductory survey was sent out to all licensing authorities. For those countries that reported that they do not have an obligation for handing over data additional information was only gathered on potential plans to introduce such an obligation. The other countries received a follow-up questionnaire covering question 4 of the Terms of Reference. The table below presents the licensing authorities that were contacted through the questionnaires.

Stakeholder	Country	Response received
Management Unit of the North Sea Mathematical Models and the Scheldt estuary	BE	
Ministry of Economy, Energy and Tourism Executive Agency for Fisheries and Aquaculture Executive Agency Maritime Administration	BG	x
Department of Fisheries and Marine Research	CY	x
Danish Coastal Authority	DK	x
Centre for Economic Development, Transport and the Environment	FI	
Ministry of Ecology, Energy and Sustainable Development	FR	
Landesamt für Bergbau, Energie und Geologie, Lower Saxony	DE	x
Hellenic Ministry of Environment, Physical Planning & Public Works	EL	
Marine Environment Department	EE	x
Department of Environment, Community and Local Government	IE	
Institute for Environmental Protection and Research	IT	
Environment protection division, Marine and Inland Waters Administration, State Environment Service	LV	x
Environmental Protection Agency	LT	
Malta Environment and Planning Authority	MT	
Ministry of Infrastructure and the Environment	NL	
Ministry of Infrastructure	PL	
Portuguese Environment Agency	PT	
National Institute for Marine Research and Development	RO	(x)

Stakeholder	Country	Response received
Ministry of Environment	SI	
Division for the Protection of the Sea, Ministry of Agriculture, Food and Environment	ES	x
Swedish Agency for Marine and Water Management	SE	
Welsh Government - Marine Consents Unit,	UK	
Marine Scotland	UK	(x)
Marine Management Organisation	UK	(x)
Department of Environment Northern Ireland, Marine Division	UK	x
Ministry of Environmental Protection and Nature	HR	x
National Energy Authority, Environment Agency	IS	x
Norwegian Hydrographic Service	NO	(x)

Please note: (x) means that only replies to the introduction survey were received

The answers to all questions in section 2.3 were received from the authorities listed above.

2.3.2 Obligation to hand over marine data (Question 3)

Question 3 of the Terms of Reference inquires about the existence of obligations for operators to hand over to public authorities the data collected or acquired in order to plan, develop or engage in licensed activities. For those countries in which such an obligation exists, sub-questions 4a) to 4 q) investigate further into the details of the hand-over obligation.

The table below presents an overview of the current status in a number of Member States and Croatia, Iceland and Norway.

Bulgaria	Obligation to hand over data varies between sectors and phases of operations (siting, construction, operation)
Croatia	Obligation to hand over data
Cyprus	Obligation to hand over data in the aquaculture sector
Estonia	Extensive obligation to hand over data
England	No obligation to hand over data
Germany	Information only available for renewable energy and cable and pipeline laying: Obligation to hand over certain marine data
Iceland	Obligation to hand over data for all sectors
Latvia	Obligation to hand over data from monitoring activities for all sectors (Aquaculture n/a)

Northern Ireland	Information only available for renewable energy, mineral extraction, port, harbour and marina development and cable and pipeline laying: Obligation to hand over marine data
Norway	Obligation to hand over data (no information available for oil exploration and exploitation)
Romania	Obligation to hand over data (n/a for renewable energy and minerals extraction as there are no such offshore activities in Romania)
Scotland	No obligation to hand over data

The conclusion is that in 9 countries there is a obligation, at least in some sectors, while in the UK expect for Northern Ireland there is no such obligation.

2.3.3 Special circumstances (Question 4a)

Question 4a concerns special circumstances (e.g. closeness to marine protected areas or economic value of the activities) upon which the obligations to hand over data as inquired in Question 3 might depend.

In most countries the obligation for operators to hand over marine data does not depend on any special circumstances. However, in Bulgaria and Iceland the hand over obligations depend on special circumstances, such as the nature of the activity or assumed sensitivity of the area. The table below illustrates the situation in the respective countries.

Does the obligation depend on any special circumstances?		
Bulgaria	Port, harbour and marina development	No
	Port, harbour and marina development	No
	Minerals extraction	
	Cable and pipeline laying	No
	Aquaculture	
	Renewable Energy	
Cyprus	Aquaculture	No
Estonia	All sectors	The data for economic, transversal, technical and biological variables was collected when the enterprises are active.
Germany	Oil exploitation	Yes
	Aquaculture	No specific conditions or circumstances, data are delivered to the permit issuer as required in the water permit.

2.3.4 Marine data concerned (Question 4b)

Question 4b aims at establishing an overview of the types of data concerned by the obligation to hand over marine data from licensed activities. For this purpose COWI in its questionnaire on licensing practices in the public sector established 11 categories of marine data that might be concerned by the hand over obligation. These 11 categories are those most commonly needed for preparing Environmental Impact Assessments in the marine sector. Only licensing authorities from a certain number of countries were able to provide information on the exact type of data included in the obligation to hand over data. The table below presents the findings for those 8 countries that provided details of the types of data concerned by the hand-over obligation. In those sectors/countries in which all marine data is concerned no additional information is provided regarding the types of data required as all marine data collected according to the licence conditions needs to be handed over. For the countries/sectors for which the table specifies that not all marine data is concerned by the hand-over obligation the specific columns illustrate which data needs to be handed over. The x) in the table indicate that the respective data have to be handed over.

A general finding based on the collected information is that in those countries that provided replies to the questionnaire there seems to be an extensive obligation to hand over data that depends on the sector/activity concerned.

		All marine data	Meteorological data	Oceanographic data	Water quality data	Bathymetric data	Sediment/geology data	Plankton data	Benthic vegetation data	Benthic fauna data	Fish data	Bird data	Marine mammal data
Aquaculture	Bulgaria	Yes											
Renewable Energy	Bulgaria	No	x		x			x			x	x	x
Minerals extraction	Bulgaria	No					x						
Oil exploration	Bulgaria	No					x						
Oil exploitation	Bulgaria	No					x						
Port, harbour and marina development	Bulgaria	Yes											
Aquaculture	Croatia	No	x	x	x	x	x	x	x	x	x		
Renewable Energy	Croatia	No	x		x		x					x	
Minerals extraction	Croatia	No	x	x	x		x					x	
Oil exploration	Croatia	No	x	x	x	x	x	x	x	x			
Oil exploitation	Croatia	No	x	x	x	x	x	x	x	x			
Port, harbour and marina development	Croatia	No	x	x	x	x	x	x	x	x			
Cable and pipeline laying	Croatia	No	x	x	x	x	x		x	x			
Aquaculture	Cyprus	No		x	x		x	x	x	x			
Port, harbour and marina development	Estonia	No		x	x	x	x		x	x	x	x	

		All marine data	Meteorological data	Oceanographic data	Water quailty data	Bathymetric data	Sediment/geology data	Plankton data	Benthic vegetation data	Benthic fauna data	Fish data	Bird data	Marine mammal data
Aquaculture	Estonia	No			x								
Minerals extraction	Estonia	No		x	x	x			x	x	x		
Cable and pipeline laying	Estonia	No			x	x	x				x		
Renewable Energy	Germany	No					x			x	x	x	x
Cable and pipeline laying	Germany	No					x			x	x	x	x
Aquaculture	Iceland	No	x	x	x	x	x		x	x	x	x	x
Minerals extraction	Iceland	No		x		x	x	x	x	x	x		x
Oil exploration	Iceland	No	x	x	x	x	x	x	x	x	x	x	x
Oil exploitation	Iceland	No	x	x	x	x	x	x	x	x	x	x	x
Cable and pipeline laying	Iceland	No				x	x			x	x		
All sectors	Latvia	Yes											
Renewable Energy	N.Ireland	Yes											
Minerals extraction	N.Ireland	Yes											
Port, harbour and marina development	N.Ireland	Yes											
Cable and pipeline laying	N.Ireland	Yes											

2.3.5 Coverage of data acquired from third parties (Question 4c)

Question 4c aims at establishing an understanding of whether the obligation to hand over data only covers data collected by the project or also data acquired from third parties.

As the table below shows the obligation to hand over data covers data acquired from third parties only in a few sectors in Bulgaria, Iceland and Northern Ireland.

Does the obligation cover data acquired from third parties?		
Bulgaria	Aquaculture	No
Bulgaria	Renewable Energy	No
Bulgaria	Minerals extraction	No
Bulgaria	Oil exploration	No
Bulgaria	Oil exploitation	No
Bulgaria	Port, harbour and marina development	Yes
Cyprus	Aquaculture	No

Estonia	All sectors	No
Germany	Renewable Energy	No
Germany	Cable and pipeline laying	No
Iceland	Aquaculture	No
Iceland	Minerals extraction	Yes
Iceland	Oil exploration	Yes
Iceland	Oil exploitation	Yes
Iceland	Cable and pipeline laying	No
Latvia	All sectors	No
N.Ireland	Renewable Energy	Yes
N.Ireland	Minerals extraction	Yes
N.Ireland	Port, harbour and marina development	Yes
N.Ireland	Cable and pipeline laying	Yes

2.3.6 Coverage of project phases (Question 4d)

Question 4d: inquired in the different project phases covered by the obligation to hand over data. The assumption of the questionnaire designed to gather information on this question was that there are differences in the coverage of project phases not only across countries, but also across sectors.

As presented in the table below the answers received confirmed this assumption. In Croatia, Estonia, Germany and Northern Ireland the obligation covers activities in all phases in all of the relevant marine sectors. In Bulgaria and Iceland however, there are big differences across sectors regarding the hand over of information from different project phases.

Obligation covers:		Siting	Design	Construction	Operation
Bulgaria	Aquaculture				x
Bulgaria	Renewable Energy		x		x
Bulgaria	Minerals extraction	x	x	x	x
Bulgaria	Oil exploration	x	x	x	x
Bulgaria	Oil exploitation	x	x	x	x
Bulgaria	Port, harbour and marina development		x	x	x
Croatia	All sectors	x	x	x	x
Cyprus	Aquaculture	x	x	x	x
Estonia	All sectors	x	x	x	x
Germany	Renewable Energy	x	x	x	x
Germany	Cable and pipeline laying	x	x	x	x
Iceland	Minerals extraction	x			x
Iceland	Oil exploration	x	x	x	x
Iceland	Oil exploitation	x	x	x	x
Iceland	Cable and pipeline laying	x			

Obligation covers:		Siting	Design	Construction	Operation
N.Ireland	Renewable Energy	x	x	x	x
N.Ireland	Minerals extraction	x	x	x	x
N.Ireland	Port, harbour and marina development	x	x	x	x
N.Ireland	Cable and pipeline laying	x	x	x	x

2.3.7 Legal bases for obligations (Questions 4e, 4f)

Questions 4e and 4f inquire into the legal bases for the obligation to hand over marine data from licensed activities. The table below provides an overview of the legal basis in the seven countries that provided information on it.

What is the legal basis for the obligation?		
Bulgaria	Aquaculture	Council Regulation (EC) No 199/2008 and Council Regulation (EC) No 861/2006
Bulgaria	Renewable Energy	Environmental protection Act, Protected areas Act, Waters act, Biodiversity Act and related environmental legislation
Bulgaria	Minerals extraction	Subsurface Resources Act
Bulgaria	Oil exploration	
Bulgaria	Oil exploitation	
Bulgaria	Port, harbour and marina development	Law on the maritime spaces, inland waterways and ports of the Republic of Bulgaria; Regulation on the requirements for port operational suitability and Regulation on the scope and content of master plans for port development.
Cyprus	Aquaculture	National Aquaculture Law and Regulations 2010.
Estonia		Water Act, Maritime Safety Act; Other relevant legal acts regulating data acquisition: Environmental Impact Assessment and Environmental Management System Act; Integrated Pollution Prevention and Control Act; Environmental Register Act; Public Information Act
Germany	Renewable Energy	The legal basis of the obligation to hand over data and information is given by the Environmental Impact assessment Act and is part of the licensing conditions by BSH.
Germany	Cable and pipeline laying	
Iceland	Aquaculture	Environmental Impact Assessment Act, Hygienic and Pollution Act, Act on Prevention of Marine and Coastal Pollution
Iceland	Minerals extraction	For EIAs the Environmental Impact Assessment Act No. 106/2000 and for license applications the Act on Icelandic National Ownership of Seabed Resources No. 73/1990, outside the netting limits, i.e. 115 metres from the Mean Low Water Springs, and the Act on the survey and utilisation of ground resources No. 57/1998, within netting limits.
Iceland	Oil exploration	Act on prospecting, exploration and production of hydrocarbons No. 13/2001, see the link: http://www.nea.is/media/olia/Act-No-13-2001-03102011.pdf
Iceland	Oil exploitation	
Iceland	Cable and pipeline laying	Environmental Impact Assessment Act, Hygienic and Pollution Act, Act on Prevention of Marine and Coastal Pollution

What is the legal basis for the obligation?		
Latvia		Environmental Protection Law; Law of On Environmental Impact Assessment; Cabinet Regulation No. 1082 "Procedure by Which Polluting Activities of Category A, B and C Shall Be Declared and Permits for the Performance of Category A and B Polluting Activities Shall Be Issued"; Cabinet Regulation No. 595 "Regulations regarding the Protection of the Environment during the Works of Exploration and Extraction of Hydrocarbons in the Sea"; Cabinet Regulation Nr.475 "Procedures for the cleaning and deepening of surface water bodies and port basins"
N.Ireland	Renewable Energy	Marine and Coastal Access Act 2009, Part 4 Marine licensing
N.Ireland	Minerals extraction	
N.Ireland	Port, harbour and marina development	
N.Ireland	Cable and pipeline laying	

Additionally to the information provided above the table below shows to which extent the legal bases cover the entire national territories. The coverage of regulations typically concerns all national territory. In the case of the renewable sector in Bulgaria and renewable and cable and pipeline laying in Germany the specific requirements for data hand over are dependent on the respective region the marine activities are based in.

Does the legal basis cover all national territory in the same way?		
Bulgaria	Aquaculture	Yes
Bulgaria	Renewable Energy	There are specific requirements depending on the specific of the regions.
Bulgaria	Minerals extraction	Yes
Bulgaria	Oil exploration	Yes
Bulgaria	Oil exploitation	Yes
Bulgaria	Port, harbour and marina development	Yes
Croatia		Yes
Cyprus	Aquaculture	Yes
Germany	Renewable Energy	The legal base is the same, but in Germany the obligations and conditions for handing over data may vary among the licensing authorities with responsibilities in the EEZ and in territorial sea.
Germany	Cable and pipeline laying	
Iceland	Aquaculture	Legal requirements cover land, territorial sea and EEZ.

Does the legal basis cover all national territory in the same way?		
Iceland	Minerals extraction	The Act on Icelandic National Ownership of Seabed Resources No. 73/1990 covers resources on, into or beneath the seabed outside the netting limits, i.e. 115 metres from the Mean Low Water Springs. The Act on the survey and utilisation of ground resources No. 57/1998 covers resources in the ground, at the bottom of rivers and lakes and on seabed within netting limits.
Iceland	Oil exploration	Covers offshore area (outside the 115 m zone), i.e. territorial waters, exclusive economic zone and continental shelf.
Iceland	Oil exploitation	
Iceland	Cable and pipeline laying	Legal requirements cover land, territorial sea and EEZ.
Latvia		Yes
N.Ireland	Renewable Energy	Yes
N.Ireland	Minerals extraction	
N.Ireland	Port, harbour and marina development	
N.Ireland	Cable and pipeline laying	

2.3.8 Plans to modify obligations (Question 4g)

Question 4g inquires whether there are plans to modify the obligations and legal bases for handing over marine data.

In most countries there are no plans to modify the legal obligation to hand over marine data from licensed activities. The only countries that communicated plans to change their obligation are Bulgaria where only the port, harbour and marina sector is concerned and Estonia where there are plans to reduce the burden on private operators.

Are there plans to modify the obligation?		
Bulgaria	Port, harbour and marina development	Yes, there are plans to simplify this obligation, but still in compliance with the EU legislation in force.
Croatia		No
Estonia		Development projects of information systems for permitting and reporting are ongoing to reduce the burdensome of enterprises on permit application, reporting (monitoring, fees and taxes) and later data management. After the finalization of the abovementioned project KESE it might necessary to modify the data input and output forms for different users.
Germany	Renewable Energy	Not to our knowledge.
Germany	Cable and pipeline	

Are there plans to modify the obligation?		
	laying	
Iceland		No
Latvia		No
N.Ireland		Not in the near future.

2.3.9 Data transfer (Questions 4h, 4i, 4j)

Questions 4h, 4i and4 j inquire into the details of the transfer of data from license holders to public authorities. While there often seem to be no general timetables according to which data needs to be transferred, a yearly or half-yearly data report seems to be common. In many of the reported cases the time frame according to which data is to be transferred is stated in the licensing agreement.

Regarding the format according to which data needs to be transferred there seems to be no consistency across countries and sectors. Only Germany and Estonia reported that (meta-) data is consistent with the INSPIRE guidelines

Do the data need to be transferrred to any particular				
		Timetable?	Format?	Format consistent with INSPIRE?
Bulgaria	Aquaculture	Yes. Collection of the Information for the current year shall be made in the next.	Defined in Council Regulation EC/199/2008 , Council Regulation EC/861/2006 and DCR appendixes I to XIX	We not have information on whether the data comply with INSPIRE.
Bulgaria	Renewable Energy	1) For availability and estimated potential resource data: before concludion agreement for access with an operator of the transmission or the distribution electricity grid 2) For the other marine data: during the operational period		
Bulgaria	Minerals extraction, oil exploration & exploitation	Within a time period: upon a contractual agreement.		
Bulgaria	Port, harbour and marina development	No particular timetable; the transfer of data is regulated by legislation which allows certain flexibility		
Croatia		No		
Cyprus	Aquaculture	Obligation to send to the Department of Fisheries and Marine Research of Cyprus (DFMR), twice a year, monitoring reports according to the impact in the marine environment		
Estonia		Yes, different activities have different timetables for data transferring.	Monitoring data are site-specific, i.e. coordinates of the monitoring sites are included into the permit as well as later into the reports (consistent with INSPIRE).	Yes
Germany	Renewable Energy and Cable and pipeline laying	The deadlines for data and information submission are set by the licensing authority. Deadlines may depend on the project-phase as well as on the project- and area specific characteristics.	The licensing authority BSH specifies the requirements dealing with data formats. These requirements are published on webpage of BSH.	Metadata information complies as far as possible with existing guidelines of INSPIRE for the marine sector.
Iceland	Aquaculture	No	Not specified. GIS coordinates are generally required.	
Iceland	Minerals extraction	Operators are obliged to hand over data for EIA according to particular timetable, based on chapters III and IV in the Environmental Impact Assessment Act No. 106/2000, see the link: http://www.skipulagsstofnun.is/media/pdf-skjol/MAUlogm2005br.pdf	Most of the data for EIA and license applications are hand over at paper format (reports), but small part at CD ROM.	This format is not consistent with INSPIRE.
Iceland	Oil exploration & exploitation	Minimally a yearly report. Timetable to be determined in EIA.	Has not been decided.	The goal is that it will be consistent with INSPIRE.
Iceland	Cable and pipeline laying	No	Not specified. GIS coordinates are generally required.	
Latvia		Timetable for data application is included in permit or licence.	Information format for data application is	
N.Ireland		No particular timetable in general but monitoring activities may have time bounded conditions.		Not all data supplied is in a format that is consistent with INSPIRE, some would need to be formatted.

2.3.10 Management of data in public authorities (Question 4k)

The table below presents an overview of the authorities responsible for the management of handed-over data in response to question 4k. In most cases the responsible public authority is the licensing authority.

Who manages the data one in has been passed to a public authority?		
Bulgaria	Aquaculture	National Agency of Fisheries and Aquaculture (NAFA)
Bulgaria	Renewable Energy	Ministry of regional development and public works and Ministry of Environment and Waters
Bulgaria	Minerals extraction, Oil exploration & exploitation	National Geological Fund, Directorate National Resources and Concessions, Ministry of Economy, Energy and Tourism
Bulgaria	Port, harbour and marina development	The Bulgarian Maritime administration manages the handed over data.
Cyprus	Aquaculture	The Department of Fisheries and Marine Research (DFMR) makes an assessment of submitted reports and no data management.
Estonia		Environmental Board – issuer of the permits and all the reporting from permits is handed over to EB, Estonian Environment Information Centre – manages data and environmental register, Estonian Maritime Administration
Germany	Renewable Energy	Data sampled by licensees of renewable energy, cables and pipelines in the German EEZ are managed by the licensing authority BSH. Still, it should be strictly distinguished between two basic classes of data: › data and information in form of EIA reports and technical reports with data tables of analysed data in annexes › raw-data, quality proved data, metadata, extracted and analysed data, comprehensive data tables and GIS-layers.
Germany	Cable and pipeline laying	
Iceland	Aquaculture	The relevant licensor (party issuing the relevant license).
Iceland	Minerals extraction	The handed over data are filed in the Orkustofnun's archive system and the archive administrator is responsible for the system and the manager of mineral resources is responsible for the data.
Iceland	Oil exploration	Orkustofnun responsible for managing all geological data. Various other institutes responsible for other data depending on field, e.g. Marine Research Institute, Iceland Maritime Authority, Environmental Agency of Iceland, etc.
Iceland	Oil exploitation	
Iceland	Cable and pipeline laying	The relevant licensor (party issuing the relevant license).
Latvia		Data from licensed activities are handled by State Environmental Service and Latvian Environmental, Geological and Meteorological Centre.
N.Ireland	Renewable Energy	The Marine Assessment and Licensing Team of Northern Ireland Environment Agency.
N.Ireland	Minerals extraction	
N.Ireland	Port, harbour and marina development	
N.Ireland	Cable and pipeline laying	

2.3.11 Restrictions on re-use (Question 4l)

Question 4l inquires about possible restrictions placed on the re-use of marine data handed over from operators to public authorities, i.e. whether there are any distinctions made between academic use, public authority use or commercial use.

A general conclusion that can be drawn from the received answers is that in most countries and sectors there are no general restrictions placed on the re-use of data. Usually only data that is commercially confidential cannot be re-used.

Are there any restrictions on the re-use of data?		
Bulgaria	Aquaculture	No
Bulgaria	Minerals extraction	There is restriction for information, handed by licensees with activities in exploration and exploitation. This data are considered a property of and are handed over by the Ministry of Economy, Energy and Tourism with their consent and agreement
Bulgaria	Oil exploration	
Bulgaria	Oil exploitation	
Bulgaria	Port, harbour and marina development	The re-use of these data which are trade secret is restricted, regulated under the Law on the access to public information.
Croatia		No
Cyprus	Aquaculture	The reports (data) are not being reused for a different purpose by the Department of Fisheries and Marine Research.
Estonia		Generally data and information have no restrictions and are available for everyone. But specific and detailed information might not be publicly available. Restrictions on data publicity are given in the Public Information Act (ie data on protected species or their habitats, proprietary information etc.)
Germany	Renewable Energy	Data and information handed over by licensees of offshore uses are declared as commercial and trade secrets of the companies. This is not applicable for all information which has been published in the framework of public participation in the licensing procedure.
Germany	Cable and pipeline laying	
Iceland	Aquaculture	Data delivered to public authorities are generally publicly available, unless specially notified as “confidential”.
Iceland	Minerals extraction	The handed over data in the license application papers are open for re-use at the Orkustofnun’s website http://www.os.is, but if you need the basic data from the applicant database, it will be necessary to have permission from the applicant. It is also common that government research institutes, as the Marine Research Institute, write an overview research report for the applicant, based on the institute’s database, which is open for public use.
Iceland	Oil exploration and exploitation	Depends on nature of data involved. Proprietary data to be handled confidentially by Orkustofnun for a certain period prior to opening, but can use data internally. Environmental data may be released to public as a part of monitoring in situ conditions.
Iceland	Cable and pipeline laying	Data delivered to public authorities are generally publicly available, unless specially notified as “confidential”.
Latvia		Environmental Protection Law (21 June 2007) Section 7. Rights of the Public to Environmental Information (1) The public has the right to receive environmental information from the authorities (..) in a written, audio, visual, electronic or any other fo
N.Ireland	Renewable Energy	No restrictions on re-use unless a prior case for commercial in confidence has been accepted.
N.Ireland	Minerals extraction	
N.Ireland	Port, harbour and marina development	
N.Ireland	Cable and pipeline laying	

2.3.12 Availability of data and feedback by users (Questions 4m, 4n)

Questions 4m and 4n inquire in the availability of marine data for re-use and in the feedback provided by users.

In most countries and sectors the marine data is made available upon request. However, some countries also publish some of their marine data on the Internet, either through their own websites or e.g. on the website of the Joint Research Centre of the European Commission (for the case of aquaculture data from Bulgaria).

How are data made available?		
Bulgaria	Aquaculture	On the web site of Joint Research Centre (JRC), EC.
Bulgaria	Renewable Energy	A written request
Bulgaria	Minerals extraction	For access to the data a written request to the Ministry of Economy, Energy and Tourism is needed
Bulgaria	Oil exploration	
Bulgaria	Oil exploitation	
Bulgaria	Port, harbour and marina development	By request
Croatia		By request
Estonia		Both, by request and through Internet.
Germany	Renewable Energy	The licensing authority may make information available upon request based on the conditions by the Freedom of Information Act or Environmental Information Act. The information depending on the subject may be available either as a technical report, GIS-layer or compact tables. Some standard products (like GIS-layers) are developed by experts in the framework of assessment- projects ordered by the licensing authority.
Germany	Cable and pipeline laying	
Iceland	Aquaculture	Generally by request. However, there is a trend towards making data available on the internet.
Iceland	Minerals extraction	The handed over data in the license application papers are available for re-use through the Orkustofnun's website: http://www.os.is.
Iceland	Oil exploration	By request, on the Orkustofnun's websites: http://www.os.is and http://www.nea.is, and through the online Iceland Continental Shelf Portal, http://www.icsp.is
Iceland	Oil exploitation	
Iceland	Cable and pipeline laying	Generally by request. However, there is a trend towards making data available on the internet.
Latvia		Information will be available through Internet and/or in the form or format indicated in the request for information.
N.Ireland	Renewable Energy	By request.
N.Ireland	Minerals extraction	
N.Ireland	Port, harbour and marina development	
N.Ireland	Cable and pipeline laying	

What feedback has been provided by users?		
Bulgaria	Aquaculture	All the variables and the data is aggregated. Collecting information about number of enterprises, quantity of fish, turnover for the year, subsidies, other revenue, total income, wages, value of unpaid labor, energy costs, raw material costs, repair and maintenance, other operating costs, interest costs, net financial costs, unforeseen costs, total assets, investment, capital, debt at the end of fiscal year, volume of raw materials.
Bulgaria	Minerals extraction	Feedback has been received and it differs according to the data, but mostly it is positive.
Bulgaria	Oil exploration	
Bulgaria	Oil exploitation	
Estonia		Currently we are carrying out an environmental monitoring data survey project (project KESE) about usage, availability and quality of all monitoring data. So far all the permits conditions and state environmental monitoring data are available to the public. Main concerns have been that information is hard to find, is in inappropriate form for the user, doesn't contain all necessary or relevant data, info is too general in order to solve local problems. Also the lack of most recent data has been mentioned sometimes.
Germany	Renewable Energy	The data and information is used by authorities and scientists with positive feedback.
Germany	Cable and pipeline laying	
Iceland	Minerals extraction	Orkustofnun has received feedback on the data from the public. The feedback is positive for the open data from licensed activities on the Orkustofnun's website: http://www.os.is.
Iceland	Oil exploration	Geological information provided by Orkustofnun, e.g. in the Iceland Continental Shelf Portal has been positively received by users.
Latvia		There are no offshore activities (excepting dumping of dredged material) in the territorial sea and EEZ of Latvia for the time being. Therefore only data from dumping places of dredged material has been provided (sediment sampling and measurements of content of heavy metals (Cu, Cd, Ni, Zn, Pb, Cr, Hg), oil products, macrozoobentos). There were no requests for this information.

2.3.13 Exceptions for SMEs (Question 4o)

Question 4o inquired into possible exceptions for SMEs from the obligation to hand over marine data from licensed activities.

Only Iceland reported the existence of such exceptions in two sectors, namely the aquaculture and the minerals extraction sector. In both sectors there are exceptions for smaller projects in the licence procedures and the obligation to hand over data. In all other sectors and countries there are no exceptions for SMEs.

Are there any exceptions for SMEs?		
Bulgaria	Aquaculture	No
Bulgaria	Minerals extraction	No
Bulgaria	Oil exploration	No
Bulgaria	Oil exploitation	No
Bulgaria	Port, harbour and marina development	There are no exceptions for SMEs but the procedure for marina development is considerably simpler compared to port and harbour development procedure.
Croatia		No
Estonia		No exceptions for SMEs; large enterprises must have an integrated permit (IPPC) and deliver their data according to the permit.
Germany	Renewable Energy	No exceptions in the German EEZ. General statement: Projects in German coastal water may have other obligations depending on the licensing authority of the federal state like Niedersachsen, Schleswig-Holstein and Mecklenburg-Vorpommern.
Germany	Cable and pipeline laying	
Iceland	Aquaculture	Yes, small aquaculture projects (less than 200 tonnes/year) are subject to less requirements and simpler license procedures.
Iceland	Minerals extraction	Yes, there are some exceptions for smaller projects, both in handing over data for EIA and for license applications.
Iceland	Oil exploration	No exceptions all licensees have to fulfil all requirements, involves deep, offshore drilling.
Iceland	Oil exploitation	
Latvia		No
N.Ireland	Renewable Energy	No
N.Ireland	Minerals extraction	
N.Ireland	Port, harbour and marina development	
N.Ireland	Cable and pipeline laying	

2.3.14 Burdens and costs (Questions 4p, 4q)

Question 4p inquires into the burdens and costs connected with the obligation to hand over marine data.

Regarding burdens on private operators in connection with the obligation to hand over marine data from licensed activities, answers from five countries were received. There seems to be no general answer to the question whether burdens exist.

Northern Ireland reported that anecdotally larger operators find it easier to collect and hand over data than small operators. Iceland reported that in the oil sector there are burdens connected to the requirements of the Hydrocarbons Act and licenses but that these burdens are accepted part of the business. Bulgaria reported burdens in the aquaculture and port, harbour and marina development sector.

Is it burdensome to comply with the legistlation?		
Bulgaria	Aquaculture	Yes. It is burdensome for operators to comply whit the obligation to hand over the data.
Bulgaria	Renewable Energy	The date collection is from other institutions and organisations – No information for burdens
Bulgaria	Minerals extraction	No burdens
Bulgaria	Oil exploration	No burdens
Bulgaria	Oil exploitation	No burdens
Bulgaria	Port, harbour and marina development	Yes, it is burdensome with regards to the environmental impact assessment.
Estonia		It might be burdensome (eg high costs of different activities) to carry out data collection activities (monitoring). But once it is done, it is not so burdensome to hand over the data.
Germany	Renewable Energy	It is definitely burdensome for operators of offshore facilities to hand over data to fulfill responsibilities in the licensing procedure. The main issue is to distinguish between data sampled for impact assessments and data sampled in the frame of national monitoring activities: - All investigations for impact assessments of offshore projects in the German EEZ are carried out according to standard procedures. The standard procedures take into account the specific purpose of the studies regarding spatial design, frequency of sampling and observations and data analysis methods. Otherwise the licensing authority is not in the state to decide on the project application. - Since an operable national monitoring programme exists data from licenses may be used to some extend additionally to gain some specific indications on effects of uses and facilities or even to fill investigation and data gaps of the national monitoring.
Germany	Cable and pipeline laying	
Iceland	Aquaculture	Requirements are highly variable according to the size of projects, locations and conditions. Additionally, much of the information is needed by the operators for their own purposes. The answer to this question is therefore highly dependent on the operator and the nature of the project.
Iceland	Minerals extraction	It isn't burdensome for operators.
Iceland	Oil exploration	To ensure public safety and the safety of the environment the operators have to fulfil all requirements of Hydrocarbons Act and license. This is burdensome but accepted part of the business.
Iceland	Oil exploitation	
N.Ireland	Renewable Energy	Anecdotally larger operators find it easier to collate and hand over data.
N.Ireland	Minerals extraction	
N.Ireland	Port, harbour and marina development	
N.Ireland	Cable and pipeline laying	

Question 4q aimed at gaining an overview of the costs incurred by the licensee in provision of the data and the public authority in the management of the data. The

answers received by the six countries that provided information on this question should be seen with some caution. While most respondents were not able to quantify the costs incurred by licensees and licensers, Bulgaria reported costs of 100.000€ yearly and Cyprus of 5.000€ per monitoring report in the aquaculture sector. Since the source of these figures and the underlying assumptions are not known, these figures should be taken very cautiously. For the oil sector Iceland reported a yearly fee of 1.000.000 ISK (~6.100 €) to be paid by licensees for the management of data. Additionally to this licensees pay the costs of collecting and providing data to the licensing authority. In the other countries and sectors the costs for both public authorities and licensees are not known.

What are the costs incurred by the licensee in provision of the data and the public authority in the management of data?		
Bulgaria	Aquaculture	The costs are 100 000 euro yearly.
Bulgaria	Renewable Energy	These costs are not calculated
Bulgaria	Minerals extraction	
Bulgaria	Oil exploration	
Bulgaria	Oil exploitation	
Bulgaria	Port, harbour and marina development	Licensees incur direct costs related to the data
Cyprus	Aquaculture	Each monitoring report costs the licensees around € 5,000. The cost to the public authority in assessing the reports is about 3 man hours per report.
Estonia		Handing over data to public authority is free of charge. The costs for licencee are related to working hours for fulfilling the reporting forms. Reporting is done via Internet (no major costs) or by ordinary mail. Data management by the public authority is covered by state budget – personnel for controlling the data, input to the database, management and maintenance of the database as well as soft- and hardware costs.
Germany	Renewable Energy	The costs of data sampling, data analyses and preparing of reports for the authorities are high and covered by the licensees. The costs include i.e. ship and plane capacities for offshore surveys, scientists and technicians, data analysts. Additional costs for further scientific analysis and products are covered by the licensing authority in the frame of assessing project applications dealing with issues of concern, i.e. sound emissions, benthos. Standard products (GIS-layers) or technical reports of the assessments are then available for further scientific and public use. Specific requirements on products and reports may be available depending on the issue of concern, the costs and the priority of the issue.
Germany	Cable and pipeline laying	
Iceland	Minerals extraction	The licensees incur no costs when providing data to the public authority.
Iceland	Oil exploration	Each licensee pays 1.000.000 ISK yearly to Orkustofnun for managing data. Cost by licensee of providing data is not know, but they are required by the license to bear that cost.
Iceland	Oil exploitation	
N.Ireland	Renewable Energy	Unable to estimate licensees costs or public authorities costs.
N.Ireland	Minerals extraction	
N.Ireland	Port, harbour and marina development	
N.Ireland	Cable and pipeline laying	

The answers to the questions about the obligations to hand over data have indicated many different practises across Member States. Also the replies do not cover all Member States. Further consultation with the relevant stakeholders will hence aim to provide more clarity of the obligations and to increase the coverage of Member States.

3 Cost of data for Marine Strategy Framework Directive

3.1 Introduction

The Marine Strategy Framework Directive includes a number of requirements where there is need for collection of marine data.

The table below presents the reporting requirements of the Member States under the MSFD. They all require data to be collected and analysed.

Reporting requirement	Deadline
Initial assessment report	15th October 2012
Determination of Good Environmental Status (GES)	15th October 2012
Establishment of environmental targets and associated indicators	15th October 2012
Establishment and implementation of a monitoring programme for ongoing assessment and regular updating of targets	15th July 2014
Programme of measures designed to achieve or maintain Good Environmental Status	2015
Entry into operation of the programme to achieve or maintain GES	2016
Interim report on the implementation of the programme of measures	Every 3 years

The Member States are currently in the process of finishing the first assessment on the Marine Strategy Framework Directive that was due on the 15th of October and that includes a mapping of the current marine status and reporting on the indicators in a set of reporting sheets.

The initial assessment report of the Member States will be delivered together with a report on the determination of Good Environmental Status and a report establishing environmental targets and associated indicators.

With regards to the effort and costs of the initial assessment, the respective competent authorities should hence have a good understanding of the data gaps and experienced costs. For the next elements in the MSFD, setting up additional monitoring programmes and other data collection for developing the programmes of measures to achieve compliance with GES, Member States have not necessarily yet defined the necessary data collection activities.

The necessary data is to a large extent also based on existing marine surveying and monitoring activities. Therefore, the estimation of the future resources spend on the MSFD is subject to some uncertainty.

3.2 Questionnaire based survey

The collection of information regarding data costs for the Marine Strategy Framework Directive was based on a questionnaire that was submitted to the national DIKE representatives in the EU coastal Member States and Croatia through the Working Group on Data, Information and Knowledge Exchange. On October 30th COWI furthermore presented the questionnaire at the 6th meting of the WG on Data, Information and Knowledge Exchange that was held in joint session with the Marine Observation and Data Expert Group.

The questionnaire was structured in three parts and contained a survey on the data used for the initial assessment and reporting, on future data collection and on data gaps.

3.3 Results

The results obtained in relation to costs of data for the Marine Strategy Framework Directive are presented in four sections. Section 3.3.1 gives an overview of the costs for the initial reporting under the MSFD in a number of Member States. Section 3.3.2 provides answers to the question of effort to be spent by Member States until 2020 and sections 3.3.3 and 3.3.4 provide additional insight into the split of costs between existing and new monitoring/surveying programmes.

3.3.1 Efforts for MSFD initial assessment

According to the requirements of the Marine Strategy Framework Directive the Member States are obliged to make an initial assessment of their marine waters to be used for establishing a set of characteristics for Good Environmental Status and a comprehensive set of environmental targets to achieving Good Environmental Status.

For this initial assessment Member States either used existing marine data or collected additional new data. The table below shows the costs for assembling and

reporting marine data under the initial assessment of the MSFD for 8 Member States.

	Assembly of existing data		Collection of new data			
	Public authority staff costs	Contracted work by research institutes	Public authority staff costs	Contracted work by research institutes	Reporting of data	Total MSFD implementation costs up to now
1						700.000 €
2	3 man years (estimate)	250.000 (estimate)	0,3 my/year (project management)	1.000.000 per year	Public authority staff costs: 0,8 my (estimate) Contracted work by research institutes: 25.000 (estimate)	1.275.000 €
3						1.385.000 €
4						145.000 €
5						571.574 €
6	0 (No new staff has been hired)	140.000 €	0 (No new staff has been hired)	140.000 €	20.000€	300.000 €
7	815.000 €	815.000 €			465.000 €	2.095.000 €
8						112.400 €

The total costs reported by the Member States are however difficult to compare.

County one only reported costs of work contracted to research institutes. Also for the second country the total costs only include contracted work. The estimates for public authority staff efforts (3 man years for assembly of existing data, 0.3 years for collection of new data and 0.8 years for data reporting) however give an indication of the effort within the concerned public authorities. The figure for country three also only includes the costs of contracts with public research institutions and private consultants (for the period 2010-2012) and no public authority staff costs. For the figures for country four and five it is not clear whether public authority staff costs are included or not. The figure for country six does not include public authority staff costs since no new staff was hired for the initial assessment and costs for the staff occupied with the assessment is not known. In country seven only existing data was used for the initial reporting and there are hence no costs reported for the collection of new data.

3.3.2 Effort until 2020 (Question 6)

Question 6 inquires into the efforts to be undertaken by Member States until 2020 on data acquisition, management and dissemination in meeting the requirements of the Marine Strategy Framework Directive.

For the purpose of this study and in order to obtain comparable estimates from Member States the total effort to be borne by Member States in meeting the MSFD requirements was assumed to consist of existing monitoring programmes, new monitoring/surveying programmes and other new activities. The table below provides estimates for the total cost of existing and new activities under the MSFD between 2013 and 2020 for three Member States

Annual costs of new monitoring/surveying programmes	Annual costs of other new activities	Annual costs of existing monitoring programmes	**Total cost for existing and new activities 2013-2020 (estimates)**
800.000 €	200.000 €	400.000 €	**11.200.000 €**
At present 800.000/year allocated (Sum allocated may be subject to changes. Marine survey programmes are at present expected to continue feeding in to multiple purposes)	Cannot be estimated at present (Development of new and existing tools depends on availability of funds and parallel international activities)	8.000.000/year (this sum includes the man power costs)	**70.400.000 €**
150.000€ (2013 only. Yearly costs can be increased by approx. 10% per year)	100.000€ (Data management and reporting in 2013 only)	425.000€ (including WFD monitoring, except ichtiological monitoring)	**5.915.383 €**

The estimated annual costs between the three Member States differ greatly. This is however likely to be due to different standards regarding the reporting of monitoring programmes as well as the differing size of their marine waters. In the second country the new and most likely also existing monitoring programmes feed into multiple purposes and the annual costs related only to the MSFD are hence likely to be much lower.

3.3.3 Cost of assembling existing data (Question 7)

Question 7 aims at establishing an overview of the costs of assembling existing data. As marine data needs to be collected constantly the term existing data in this context hence refers to existing monitoring programmes that deliver the current status of existing data. The table below illustrates the total annual costs as well as the total costs for the period 2013 to 2020 for existing monitoring programmes in 7 Member States.

Annual man power costs	Annual costs of monitoring equipment	Other annual costs	Total annual costs of existing monitoring programmes	**Total cost 2013-2020**
100.000 €	250.000 €	50.000 €	400.000 €	**3.200.000 €**
			8.000.000 €	**64.000.000 €**
700.000 €	1.500.000 €		2.200.000 €	**17.600.000 €**
			2.200.000 €	**7.200.000 €**
189.178 €	57. 265 €	246.954 €	436.132 €	**3.489.056 €**
215.000 €	130.000 €	80.000 €	425.000 €	**3.400.000 €**
			4.400.000 € (2012)	**35.200.000 €**
			3.000.000 €	**24.000.000 €**

Two of the Member States reported very high yearly costs of existing monitoring programmes (8.000.000€ and 4.400.000€ respectively). This is likely to be due to these monitoring programmes not only providing data for the Marine Strategy Framework Directive, but also feeding into other purposes. MSFD-related monitoring costs can hence be expected to be lower.

Two countries reported figures for the cost of implementation of Articles 8, 9 and 10, i.e the initial assessment of the state, formulation of criteria for GES and of environmental targets for the marine environment. Both countries have access to one sea and a relatively small Exclusive Environmental Zone and reported costs of 145.000€ and 135.442€ respectively.

3.3.4 Cost of collecting new data (Question 8)

A second part of the total effort to be borne by Member States for the implementation of the MSFD are new monitoring/surveying programmes that will provide marine data to meet reporting requirements.

The table below presents the estimates provided by four Member States for annual costs of new monitoring/surveying programmes to meet the requirements of the Marine Strategy Framework Directive.

Annual man power costs	Annual costs for monitoring equipment	Other annual costs	Total annual costs of new monitoring/surveying programmes	**Sum monitoring/surveying costs 2013-2020**
200.000 €	550.000 €	50.000 €	800.000 €	**6.400.000 €**
Not known at present (Cannot be estimated as a total reorganisation of the national marine monitoring programme is required. There will also most likely be a coordination with other monitoring programmes (fisheries, joint with other member states etc))			At present 800.000€ /year allocated (Sum allocated may be subject to changes. Marine survey programmes are at present expected to continue feeding in to multiple purposes)	**6.400.000 €**
100.000 €		50.000 €	150.000€ (2013 only. Yearly costs can be increased by approx. 10% per year)	**1.715.383 €**
			2.500.000	**10.000.000 €**

Two countries reported yearly costs of 800.000€ for new monitoring/surveying programmes while a third country reported 150.000€ for 2013 with a yearly increase of approximately 10% thereafter and country four reported yearly costs of 2.500.000€.

While not many replies were received regarding the costs of new monitoring programmes ten Member States provided a ranking of expected costs for additional monitoring/surveying programmes in areas with current data gaps. The table below presents a summary of the ranking of costs obtained from ten countries. Respondents were asked to rank data areas by expected costs in the future, with a 1 indicating highest costs and 5 indicating lowest costs (the same rank could be given to several areas). The list below is sorted by expected costs, from highest to lowest.

Average ranking of expected future costs	
Physical features (8A01)	1,4
Habitats (8A02)	1,9
Functional groups (8A03)	1,9
Ecosystems (8A05)	2,3
Species (8A04)	2,4
Nutrients and organic matter enrichment (8B08)	2,7
Contamination by hazardous substances (8B06)	2,8
Underwater noise (8B03)	2,9
Microbial pathogens (8B09)	3,0
Marine litter (8B04)	3,1
Non-indigenous species (8B10)	3,2
Extraction of species (fish, shellfish) (8B11)	3,3
Other features (8A07)	3,5
Interference with hydrological processes (8B05)	3,6
Non-indigenous species inventory (8A06)	3,7
Physical loss (8B01)	3,7
Marine acidification (8B12)	3,8
Use of marine waters: ecosystem services and other approaches (8C02)	3,9
Cost of degradation (8C03)	4,1
Acute pollution events (8B07)	4,2
Use of marine waters: human activities and marine water accounts approach (8C01)	4,2
Physical damage (8B02)	4,5
Extraction of species (seaweed, maerl, other) (8B11)	5,0

3.3.5 Data gaps

In relation to the MSFD data collection that Member States are planning up till 2020 and its expected costs, COWI's questionnaire also inquired into the areas in which most data gaps exist. The table below shows the replies of 10 countries to the question whether no, few, some or many gaps exist in the following data categories.

Number of countries that reported:	No gaps	Few gaps	Some gaps	Many gaps
Underwater noise	0	0	0	10
Habitats	0	0	2	8
Marine litter	0	0	2	8
Cost of degradation	0	0	2	7
Species	0	2	1	7
Functional groups	0	1	3	6
Ecosystems	0	1	3	6
Use of marine waters: ecosystem services and other approaches	0	0	3	6

Number of countries that reported:	No gaps	Few gaps	Some gaps	Many gaps
Marine acidification	0	1	2	6
Physical loss	1	1	3	5
Interference with hydrological processes	1	1	3	5
Non-indigenous species	1	1	3	5
Non-indigenous species inventory	0	3	2	5
Physical damage	0	2	4	4
Use of marine waters: human activities and marine water accounts	0	1	5	3
Contamination by hazardous substances	0	5	2	3
Microbial pathogens	1	3	2	3
Extraction of species (seaweed, maerl, others)	2	1	2	3
Extraction of species (fish, shellfish)	1	2	5	2
Other features	0	1	5	1
Physical features	1	4	4	1
Acute pollution events	0	6	2	1
Nutrients and organic matter enrichment	0	5	5	0

3.4 Overview/summary

The estimate of the overall costs related to the MSFD is somewhat difficult to make since only some Member States provided data. Furthermore the Member States' estimates are difficult to compare as it is not always clear which costs are included and which are not. However, the estimates 8 Member States that provided information represent a good sample of all EU coastal states (location, population, GDP level, coastline, geography).

In order to provide answers to questions 6, 7 and 8 of the Terms of Reference the estimates from the respondent countries needed to be scaled up. The reported costs however showed no or only weak correlation with GDP level, coastline length or size of the monitored sea area. Due to the diverse geography, economic and social properties of the respondent countries, an up scaling approach based on the average of the reported costs provided the best results. This approach was hence used to generate the following total estimates:

- Estimates of the data related to the initial assessment in the 22 coastal Member States and Croatia: 19 million €
- Estimate of costs for existing and new monitoring programs for the period 2013-2020 in the 22 coastal Member States and Croatia: 64 million €/year

4 Cost of data for offshore wind farms

4.1 Introduction

4.1.1 Background

At present offshore wind farms with a total capacity of about 4.3GW have been built across 56 wind farms in ten European countries. The Member States projected an installed offshore wind farms capacity of 43GW for the year 2020 in their National Renewable Energy Action Plans. The European Wind Energy Association (EWEA) expects an installed capacity of about 40 GW for the same year. Regardless of which projection will show to be more precise, Europe will see major growth in offshore wind capacity. A big share of this growth will come from Member States that currently have no or only very few operational wind farms. Industry trends also show that offshore projects will increasingly be built in deeper waters and further away from shore.

Moving into new geographical areas and into deeper waters with offshore wind projects will require an increased knowledge of the marine environment. Operators will need to collect or purchase marine data and further assemble and process it for preparing licence applications and for planning, building and operating wind farms. With many projects being planned in new areas this will result in considerable costs as data might not be existent or difficult to access.

4.1.2 Objective of task

The aim of this task is to collect information on the costs related to data collection and usage for offshore wind farms in the EU coastal countries plus Croatia, Norway and Iceland until 2020. The objectives of this task are to be able to answer questions 9 and 10 of the ToR:

- What marine data will be required for planning, building and operating offshore wind farms in Europe up till 2020?

› How much will be spent collecting, purchasing, assembling and processing these data?

4.2 Method

4.2.1 Outline of component

The study on this component has been carried out as follows:

› Initially information of the types of marine data that are needed for planning, building and operating offshore wind farms in different European countries has been collected.

› The information on data needs has then served as a basis for the estimation of costs for collection, purchase, assembly and processing of this data for a 200 MW wind farm in different European countries

› Information estimates on the offshore wind capacity to be planned, built or operational in Europe by 2020 has been collected.

› Estimations on data needs, capacity growth and data costs has been used to project the total costs related to marine data of the growth in offshore wind farms until 2020.

Two methodologies have been used to collect information on data needs and data costs:

› Submission of questionnaires to European wind farm operators on data needs and typical costs for a 200 MW offshore wind farm.

› Own assessments based on review of EIAs, monitoring reports and guidelines and knowledge of costs of different types of investigations

4.2.2 Questionnaire

A questionnaire on data needs and costs of data for planning building and operating offshore wind farms has been prepared in cooperation with EWEA in Brussels. EWEA submitted the questionnaire to their members (wind farm operators in Europe)

So far (by 03 December 2012), we have received filled questionnaires from six operators of which only three have been filled with all requested information on data costs (two from Germany and one from UK). The remaining three include data needs but only costs for meteorological data

4.2.3 Own assessment of data need and costs

In light of the somewhat meagre result from the questionnaires we have carried out an alternative approach to supplement the information from the questionnaires. We have carried out our own assessments based on review of EIAs, monitoring reports and guidelines from different member states and knowledge on costs of different types of investigations. The assessment has included:

- Detailed review of existing EIAs, monitoring reports and guidelines on offshore wind farms from different member states in order to:
  - Get information on marine data usually required for planning, building and operating offshore wind farms in Europe
  - Get detailed information on types of investigations, methodology and scope of investigations required in the different Member States (such as number of samples of different, number of sampling sites etc.)
- Estimation of typical costs of different investigations in different countries based on this and our own knowledge of expenditure of time and typical costs of different types of investigations and knowledge on differences in salaries and costs in different countries.

The results of the review and estimates of costs of data for EIA and monitoring are presented in Appendix B.

4.3 Data requirements

4.3.1 Project phases

Establishment of an offshore wind farm usually includes the following project phases:

- Planning phase, which includes:
  - Site screening, the purpose of which is to identify sites where locations for offshore wind farms would be feasible and have the least possible environmental impact on nature and humans
  - Conceptual design which aims at selecting the best suited technical foundation solution for each wind farm location and characteristics. A basis for the economic assessment of an offshore wind farm is established in terms of construction costs and operation and maintenance costs
  - Feasibility study aiming at assessing the economical feasibility of the project
  - Environmental Impact Assessment (EIA) of the wind farm

› Construction phase, which also includes monitoring of environmental impacts

› Operation phase, which also includes monitoring of environmental impacts

› Decommissioning phase

4.3.2 Data requirement planning

Data needed for site screening, conceptual design and feasibility study

Wind studies are required in order to make reliable assessment of the economic viability of planned wind farms. Such wind studies can normally only be made using wind data measured at the actual sites.

Wind data can be measured by met masts on which a number of sensors for measuring meteorological parameters are installed. Another method is using a Lidar system where the wind speed is measured by laser interference technology.

The wind data are typically measured for a period of *minimum one year*. Minimum one year measurement period is necessary to cover the annual wind speed variation. The wind measurements are made at *several heights* above ground level in order to determine the vertical wind speed gradient. The minimum measuring height is the hub height of the wind turbine planned for the project. The hub height of future off shore wind turbines will be in the order of 120m - 140m. The *number of wind measurement* positions required depends on the size of the wind farm area, the complexity of the surface and the wind speed gradient across the area.

Detailed information on bathymetry, geophysical/geotechnical conditions at the potential wind farm sites are required for the site selection and conceptual design in order to:

› Provide sufficient geological knowledge of the area to be able to select the best location and the most cost efficient foundation design.

› Provide safety to the project in terms of knowledge of potential hazardous objects on the seabed and subsurface which might represent a risk for following stages of the project.

The following site specific surveys are usually carried out:

› Survey using Single Beam Echosounder (SBES) or Multibeam Echosounder in order to measure the water depths

› Survey using Side Scan Sonar (SSS) in order to generate an acoustic image of the seabed

› Survey using magnetometer in order to detecting ferromagnetic material in th subsurface. A special case of a magnetometer survey is an Unexploded Ordnance survey (UXO) in order to assess if there is a risk of presence of unexploded ordance

- Survey by Reflection Seismics in order to study the vertical layering of the seabed
- Geotechnical survey

Baseline data needed for the EIA

In order to obtain permission to establish an offshore wind farm, the operator must carry out an assessment of the environmental consequences of the project and prepare an Environmental Impact Assessment (EIA) report that has to be approved by the Authorities. Marine data needed for the preparation of the EIA are outlined in Table 4-1, Table 4-2 and Table 4-3 below.

Table 4-1 Metocean data, bathymetrical data and geophysical data needed for the preparation of the EIA and methodology for obtaining data

Data needed for the preparation of the EIA	Methodology applied for obtaining data
Metocean data	
The following Metocean data are needed for the preparation of the EIA: › Wind direction and force › Atmospheric pressure and Air temperature › Water level, › Salinity › Water temperature › Water quality › Currents (direction and velocity) › Wave height › Wave amplitude and Wave direction	Existing metocean data are normally used for scoping of the EIA. Data from site specific metocean will also be used for the EIA if such a survey is carried out. Metocean data are mainly used for hydrological modelling.
Bathymetrical and geophysical data	
The following bathymetrical and geophysical data are needed for the preparation of the EIA: › Bathymetry data › Sediment data › Composition of sediments (geochemical properties, grain size distribution, organic content loss on ignition) › Contaminants in sediment (nutrients, heavy metals, other hazardous substances)	Existing data are normally used for scoping of the EIA. Data from the detailed geophysical/geotechnical survey carried out for assessing the suitability of the seabed for wind farm foundations are usually used for preparing the EIA.

Table 4-2 Data on benthic fauna and vegetation and fish and shellfish needed for the preparation of the EIA and methodology for obtaining data

Data needed for the preparation of the EIA	Methodology applied for obtaining data
Benthic fauna and vegetation	
The following benthic fauna data are needed for the preparation of the EIA: › Abundance of different species of infauna › Coverage/abundance of different species of epifauna and vegetation › Extension of different benthic fauna associations	Existing benthic fauna and vegetation data are normally used for scoping of the EIA. The following field investigations are usually carried out for obtaining site specific baseline data on benthic fauna and vegetation for the EIA: › Quantitative sampling of benthic infauna and sediment by grab or core sampler. In the laboratory the fauna is sorted, animals identified and enumerated. Particle size and organic matter content of sediment are determined. Patterns and trends in the data are analysed using uni- and multivariate statistical analyses in order to identify benthic fauna associations. › Videosurvey and photosampling of extent and coverage of epifauna and benthic vegetation by SCUBA diver along transects. Drop down video-survey are also sometimes conducted. › Sampling of epibenthic species by trawling or by dredge. The samples are sorted and animals are identified and enumerated. Patterns and trends in the data are analysed using uni- and multivariate statistical analyses. › Sampling of epibenthic fauna by dredge. The samples are sorted and animals are identified and enumerated. Data are subject to multivariate statistic analysis. Patterns and trends in the data are analysed using uni- and multivariate statistical analyses. › Maps of the extent of different benthic fauna and flora associations are usually produced based on data collected during these investigations
Fish and shellfish	
The following fish data are needed for the preparation of the EIA: › Species composition and abundance of different species in the project area › Location of spawning grounds, nursery grounds, feeding grounds and overwintering areas for different species of fish and shellfish › Migration routes for fish	Information on location of spawning grounds, nursery grounds, feeding grounds overwintering areas and migration routes has for the EIAs reviewed all been based on compilation and of existing data. The species composition and abundance of fish and shellfish species are usually investigated by the following methods: › Test trawling along transects using otter trawl or beam trawl in order to sample demersal fish and shellfish species. Fish and shellfish are identified to species and counted (length, weight, sex, maturity and otholits may be determined as well). Catch per unit effort for each species for numbers and biomass are determined and the data subject to statistical analysis › Pelagic trawl sampling of pelagic fish species. Catch per unit effort for each species for numbers and biomass are determined and the data subject to statistical analysis › Hydro-acoustic survey of pelagic fish and trawling for validation › Test fishing using gill nets or fyke nets. Catch per unit effort for each species for numbers and biomass are determined and the data subject to statistical analysis

Table 4-3 Data on birds, marine mammals and human use needed for the preparation of the EIA and methodology for obtaining data

Data needed for the preparation of the EIA	**Methodology applied for obtaining data**
Birds	
The following data on birds are needed for the preparation of the EIA: › Overall distribution, density and population size of birds in the project area › Migration routes and movements in/around or through the project area › Relative importance of the project area to each species	Existing bird data are normally used for scoping of the EIA. The following field investigations are usually carried out for obtaining site specific baseline data on birds for the EIA: › Aerial surveys of the distribution, density and population size of birds › Ship based surveys of the distribution, density and population size of birds › Radar and visual observations of bird migration
Marine mammals	
The following data on marine mammals are needed for the preparation of the EIA: › Overall distribution, density and population size of cetaceans and seals in the project area › Migration routes and movements by cetaceans and seals in/around or through the project area › Relative importance of the project area to each species	Existing data on marine mammals are normally used for scoping of the EIA. The following field investigations are usually carried out for obtaining site specific baseline data on marine mammals for the EIA: › Aerial surveys of the distribution, density and population size of seals and cetaceans (mainly harbour porpoise) › Ship based surveys of the distribution, density and population size of seals and cetaceans (mainly harbour porpoise) › Acoustic monitoring of cetaceans using so-called T-PODs that detects and logs echolocation clicks from harbour porpoises and other cetaceans. › Tagging with satellite transmitters and satellite monitoring of seals
Human use data	
Data on the following human use issues are usually needed: › Commercial fisheries › Shipping and navigation › Aviation and military operations › Telecommunications and interference › Archaeology and cultural heritage › Landscape, seascape and visual › Infrastructure and other users/activity › Air quality › Airborne noise	Usually existing data are used. Site specific field surveys on archaeology may be carried out. However, the scope of such an investigation varies considerably between sites and coasts are difficult to estimate.

4.3.3 Data requirement during construction and operation

Wind data are routinely collected during operation

Geotechnical surveys are often carried out after construction in order to assess whether the wind farm affects seabed conditions (such as generation of scour holes).

Following the approval of the EIA for a wind farm, the Authorities stipulate in the environmental permits that a monitoring programme is carried out to monitor the positive and negative effects of the windmill. The monitoring programmes stipulated for European wind farms so far have included:

- Monitoring of impacts on and recovery of impacted habitats and organisms arising from construction activities (especially excavation and dredging operations during the installation of foundations and cable laying (mainly impacts on benthic fauna and vegetation and fish)
- Monitoring of impacts on marine organisms and habitats due to altered current patterns and sediment transport resulting from the presence of turbines.
- Monitoring of behaviour of marine mammals – porpoises and seals – and their reaction to presence of wind farms (for instance reaction to underwater noise from piling during the construction phase and from the turbines noise during the operation phase)
- Monitoring of noise and disturbances on birds during construction
- Monitoring of colonisation of epifauna, vegetation and associated fish fauna on turbine piles, foundations or scour protection
- Monitoring of risk of collisions between birds and wind turbines
- Monitoring of barrier effect and displacement effects on birds due to the presence of the wind turbines
- Monitoring of impacts on fish migration due to electromagnetic fields around the power cables.

The monitoring data and the methodology that have been applied to obtain these data are shown in Table 4-4 and Table 4-5.

Table 4-4 Monitoring data for benthic fauna and vegetation and fish and shellfish and methodology applied for monitoring

Impacts and recovery of impacted organisms that are monitoring during the construction and operation phase of the Wind farm	**Methodology applied for monitoring**
Benthic fauna and vegetation	
The following impacts on benthic fauna resulting from construction and presence of windturbines and cable are usually monitored: › Impacts on and recovery of soft bottom benthic fauna › Impacts on and recovery of benthic epifauna and vegetation › Colonisation of epifauna and vegetation on piles, foundations and scour protection	The following methods has been applied for monitoring impacts on benthic fauna and vegetation from wind farms: › Monitoring of impacts on and recovery of soft bottom benthic infauna by quantitative sampling using grab or core sampler. › Monitoring of impacts on and recovery of epifauna and benthic vegetation by videosurvey, photosampling and quantitative sampling by diver or by the use of trawl or dredge › Monitoring of colonisation of organisms on monopiles, foundations and scour protection layers by videosurvey, photosampling , visual observation and quantitative sampling of epifauna and benthic vegetation by SCUBA diver Sampling of epibenthic species by trawling or by dredge.
Fish and shellfish	
The following impacts on fish and shellfish resulting from construction and presence of windturbines and cable are usually monitored: › Impacts on the composition of fish fauna in the area › Attraction of reef/hard bottom associated fish fauna at piles, foundations and scour protection. › Monitoring of impacts on fish migration due to electromagnetic fields around the power cables.	The following methods has been applied for monitoring impacts on fish and shellfish from wind farms: › Monitoring of pelagic fish by hydro-acoustic survey and trawling for validation › Monitoring of demersal fish and shellfish by trawling with otter trawl or beam trawl sampling › Monitoring of attraction of fish at turbine piles, foundations and scour protection by underwater census of fish by SCUBA divers, static hydroacoustic survey, line fishing, gill nets fishing › Tagging and telemetry experiments to monitor the potential effects of wind farms on fish migration and behaviour › Monitoring of changes of fish diet at wind farm by stomach analyses of fish caught at the wind farm › Test fishing with fyke nets deployed on both sides of the cable from the wind farm in order to assess any impacts on fish migration from electromagnetic fields around the cable.

Table 4-5 Monitoring data for birds and marine mammals and methodology applied for monitoring

Impacts and recovery of impacted organisms that are monitoring during the construction and operation phase of the Wind farm	**Methodology applied for monitoring**
Birds	
The following impacts on birds resulting from construction and presence of windturbines and cable are usually monitored: › Risk of collisions between birds and wind turbines › Barrier effect and displacement effects on birds due to the presence of the wind turbines	The following methods are usually applied for monitoring impacts on birds from wind farms: › ›Ship based counts of bird numbers and distribution › Aerial surveys of bird numbers and distribution › Monitoring of flight paths of birds flying through the wind farm by radar and/or visual observation. Acoustic observations of migrating birds has also been carried out in a few cases.
Marine mammals	
The following impacts on mariner mammals resulting from construction and presence of windturbines and cable are usually monitored: › Behaviour of marine mammals – porpoises and seals – and their reaction to presence of wind farms (for instance reaction to underwater noise from piling during the construction phase and from the turbines noise during the operation phase)	The following methods has been applied for monitoring impacts from wind farms on marine mammals: › Aerial monitoring of the distribution, density and population size of seals and cetaceans (mainly harbour porpoise) › Ship based monitoring of the distribution, density and population size of seals and cetaceans (mainly harbour porpoise) › Acoustic monitoring of cetaceans using so-called T-PODs that detects and logs echolocation clicks from harbour porpoises and other cetaceans. › Monitoring of seals by tagging with satellite transmitters › Monitoring of acoustic underwater noise before, during and after construction

4.4 Costs of data for one offshore wind farms

4.4.1 Physical data

Table 4-6 show estimated costs of physical data for an offshore wind farm of around 200 MW.

The table will be further elaborated in the next version of the report.

Wind data

An off shore wind measurement station consists of a foundation for the measuring equipment and the measuring equipment itself. In general the foundation concepts for offshore wind measuring equipment are similar to the foundation concepts for wind turbines. The type of foundation depends on the water depth at the position

where the measurement station shall be installed. At water depth up to 10 m a monopole foundation concept is suitable. At water depth above a jacket foundation concept is more suitable.

The construction costs for offshore wind measuring stations can be divided into two parts: costs for the foundation and costs for the measuring equipment.

The major cost of offshore wind measuring stations is the foundation cost which depends on the water depth. For water depths in the range between 6-10m the costs will be in the order of 1.3 million €. At water depths above 10 m and up to approximately 40m the foundation costs are in the order of 2.6 million €. The relative high costs for the foundations are mainly due to the sea operation costs.

The measurement equipment costs (met masts or Lidar) are in the order of 0.26 million €.

The operation activities include regular collection and analysis of data. This activity will require say a man day per week corresponding to DKK 0,3 mill per year.

The maintenance activities include planned maintenance and ad hoc maintenance. The planned maintenance will typically include visits to the masts for cleaning/check of power supply system. Ad hoc maintenance includes repair of equipment, e.g. sensors. The maintenance costs can roughly be estimated to be at the same level as the operation costs.

The costs for one off shore wind measurement station are:

Construction	1.6 million € (water depths 6 - 10m) 2.9 million € (water depths 10-40m)
Operation and maintenance	0.07 million €/year

Hydrographical data

This section will be elaborated in the next version of the report

Bathymetry/geophysics and geotechnical data

This section will be elaborated in the next version of the report

Table 4-6 *Estimated cost of collecting, purchasing, assembling and processing marine physical data needed for planning, building and operating a wind farm of 200 MW in different European countries.*

Data needed	Denmark €	Germany 1 €	Germany 2 €	UK €
Planning Phase				
Metorological data 1) Existing data	15,000	-	-	-
Metorological data 2) Site pecific measurements shallow water 6-10 m	1,700,000			
Metorological data 2) Site pecific measurements deeper water 10 - 40 m	3,140,000			
Oceonography data	70,000-140,000	-	-	-
Total Metocean data		55,000	65,000	300,000
Bathymetri/geophysics		1,600,000	250,000	700,000
Construction phase				
Metocean		3,000	115,000	55,000
Bathymetri/geophysics		12,800,000	100,000	400,000
Operation phase				
Metocean		200,000	65,000	
Bathymetri/geophysics		80,000	500,000	

4.5 Biological data

Estimated costs of biological data for a wind farm of around 200 MW for different countries are shown in Table 4-7.

The numbers will be commented and discussed in the next version of the report.

Table 4-7 Estimated cost of collecting, purchasing, assembling and processing marine biologicaldata needed for planning, building and operating a wind farm of 200 MW in different European countries.

Data needed	Denmark 1 €	Denmark 2 €	Germany 1 €	Germany 2 €	UK 1 €	UK 2 €	UK 3 €	Belgium €	Netherlands €	Sweden €	Mean €
Planning phase											
Benthic flora and fauna	190,000	190,000	1,200,000	425,000	260,000	80,000	90,000	No data	200,000	180,000	310,000
Fish	25,000	145,000	210,000	75,000	90,000	80,000	120,000	No data	200,000	180,000	125,000
Birds	180,000	250,000	2,250,000	500,000	315,000	270,000	300,000	No data	200,000	660,000	550,000
Marine mammals	150,000	No survey	630,000	500,000	315,000	270,000	300,000	No data	650,000	530,000	370,000
Total planning phase	**545,000**	**585,000**	**4,290,000**	**1,500,000**	**980,000**	**700,000**	**810,000**		**1,250,000**	**1,550,000**	**1,355,000**
Construction phase											
Benthic flora and fauna	No survey	No survey	600,000	210,000	No survey yet	No survey yet	85,000	340,000	No survey	No data	175,000
Fish	No survey	No survey	105,000	40,000	No survey yet	No survey yet	90,000	250,000	No survey	No data	70,000
Birds	30,000	125,000	750,000	250,000	No survey yet	No survey yet	250,000	750,000	No survey	No data	300,000
Marine mammals	110,000	160,000	300,000	250,000	No survey yet	No survey yet	300,000	275,000	No survey	No data	200,000
Total building phase	**140,000**	**285,000**	**1,755,000**	**750,000**	**-**	**-**	**725,000**	**1,615,000**	-	-	**745,000**
Operation phase											
Benthic flora and fauna	280,000	230,000	1,200,000	425,000	No survey yet	No survey yet	No survey	No survey yet	200,000	No data	390,000
Fish data	150,000	75,000	210,000	75,000	No survey yet	No survey yet	No survey	No survey yet	190,000	No data	115,000
Bird data	410,000	460,000	2,250,000	500,000	No survey yet	No survey yet	No survey	No survey yet	575,000	No data	700,000
Marine mammal	265,000	280,000	600,000	250,000	No survey yet	No survey yet	No survey	No survey yet	325,000	No data	285,000
Total operation phase	**1,105,000**	**1,045,000**	**4,260,000**	**1,250,000**	**-**	**-**	**-**		**1,290,000**		**1,490,000**

4.6 Cost of data for development of offshore windmills till 2020

4.6.1 Number of wind farms planned to be built till 2020

The Member States and the European Wind Energy Association have projected an installed offshore wind farm capacity of 43 GW and 40 GW by 2020, respectively. The present capacity is 4.3 GW. Consequently a capacity of 36-39 GW corresponding to 180-195 wind farms each with a capacity of 200 MW is assessed to be constructed by 2020.

This section will be further elaborated in the next version of the report, i.e. including details of construction for different member states. The estimated costs presented here are averages based on the review of both operator's replies and literature information.

4.6.2 Costs of data

Estimated data costs for establishing 36-39 GW wind farm capacity in Europe by 2020 are shown in Table 4-8.

The table will be elaborated further in the next version of the report. If data are available the costs will be assessed for different countries. The variability will also be assessed leading to an estimated range of costs instead of only the average costs.

The estimates for the costs related to metocean data and bathymetry/geotechnical data are based on the replies presented in Table 4.6 above. We are in the process of making expert assessment of the costs of these elements based on our experience of undertaking these actives. Hence, these elements might be revised and they will any case be presented as ranges instead of only the average.

The preliminary estimation indicates that data costs of an offshore wind farm of 200 MW are in the order of 5 to 6 million € and with projected new capacity to be installed in the order of 36-39 GW, the total data costs in the sector could be in the order of 1 to 1.2 billion €.

Table 4-8 Estimated costs of establishing 36-39 GW wind farm capacity in Europe by 2020

	Mean cost 200 MW Wind farm €	Costs till 2020 for establishing 36-39 GW Million €
Planning Phase		
Metocean data	920,000	166-179
Bathymetri/geophysics	850,000	153-166
Benthic flora and fauna	310,000	56-60
Fish	125,000	23-24
Birds	550,000	99-107
Marine mammals	370,000	67-72
Total planning phase	**3,125,000**	**563-609**
Construction phase		
Metocean data	58,000	10-11
Bathymetri/geophysics	167,000	30-33
Benthic flora and fauna	175,000	32-34
Fish	70,000	13-14
Birds	300,000	54-59
Marine mammals	200,000	36-39
Total construction phase	**970,000**	**175-189**
Operation phase		
Metocean data	132,000	24-26
Bathymetri/geophysics	290,000	52-57
Benthic flora and fauna	390,000	70-76
Fish	115,000	21-22
Birds	700,000	126-137
Marine mammals	285,000	51-56
Total operation phase	**1,912,000**	**344-373**
Grand total costs	**6,007,000**	**1,081-1,171**

5 Legal basis

5.1 Legal Assessment

The legal analysis has progressed by the following actions since the 3 November Progress Report:

- Interview with DG MARE Iain Shepherd and Mr Staffan Ekwall 9 November
- Interview with DG CNECT, Unit G3 (Data Value Chain), Szimon Lewandowski (Team of Richard Swetenham negotiating the revised PSI directive)

Friday 9 November a conference call was held on aspects in relation to the choice of legal basis and how to take this part further when the other components of the project were still quite preliminary awaiting more data from questionnaires and consultations as well as initial framing of possible options by DG MARE. It was agreed to look further into the possibilities of linking the legal initiative with any of the existing EU instruments, such as the INSPIRE Directive, the Access to Information Directive or the PSI Directive, as further described below, recognizing that it would only be feasible to lay down the final recommendations for the legal basis once the different options have been formulated in more details by DG MARE following the closure of the public consultation.

Further, an interview with DG CNECT has been held which has helped the team in understanding the potential impacts of the revised PSI Directive for the area of marine knowledge data.

The results received from the public consultation provide input on the public opinion on the scope of EMODnet and thus what a legal initiative on Marine knowledge should entail. This again will influence the choice of legal basis – whether or not a multiple legal basis will be feasible or a single legal basis must be used and whether or not the objectives of a new instrument can be reached through amending an existing legal instrument. This is further discussed in the preliminary analysis presented below.

Another input coming from the public consultation is on exceptions from making data publicly available. Public privacy considerations are one of the main reasons for disclosing information or not making it publicly available and this must be considered for any new information sharing instrument. The public consultation gathers information on other reasons for exempting marine data from being freely available and interoperable. The preliminary results indicate that the main other reasons are commercial sensitivity and national security but also highlight other reasons. This will be further analysed when we have more information as the public consultation progresses.

Once we have more results from the public consultation this will supplement the analysis.

5.2 Objective of the initiative

The TORs for this study ask what legal basis could be used for a Directive or a Regulation on marine knowledge that meets several objectives, and whether there are any similar examples. The background for this separate analysis is that the Maritime Policy does not have an explicit legal basis under the Lisbon Treaty. It has so far been assumed by DG MARE that a Regulation or a Directive on marine knowledge meets the objectives for environment, research, industry, transport, fisheries, etc., implying that justification for legal action may be found also within other policy areas.

The Marine Knowledge 2020 Communication pointed to data bottlenecks preventing investments in marine data and the need for multiple uses of marine data. The underlying problem to be addressed by the study is that Member States are generally not bound by a legal obligation to give wider access to data and information submitted by a private sector actor, which often leads to inefficient use of the existing data, resources and mechanisms to deliver a blue economy. Marine knowledge is needed both in licensing, design, construction and operation of offshore installations. The Green Paper currently in consultation has now opened a debate on the best strategy forward for reducing costs, stimulating innovation and reducing uncertainty. The Marine Knowledge 2020 strategy is thus fully aligned with the Commission’s policy towards the re-use of public sector information (PSI) and the Commission's overall Digital Agenda for Europe.

According to the TORs, this study should focus on what legal basis could be used for a Directive or a Regulation on Marine Knowledge. Ongoing considerations in DG MARE are thus whether a multiple legal basis could be used for a Directive or a Regulation on Marine Knowledge due to the cross cutting nature of such an initiative.

Alternative options to a legal action presented solely by DG MARE have been considered as well. Considerations have thus been ongoing on whether an amendment to existing legislation would be a possible option forward, e.g. through amendments to the INSPIRE Directive (Dir. 2007/2/EC), the Public Access to Environmental Information Directive (Dir. 2003/4/EC, the Aarhus Directive) and the Re-use of Public Sector Information Directive (Dir. 2003/98/EC, the so-called

PSI Directive), complementing the Access to Information Directive. The alternative options are described further below.

DG MARE has also considered whether a possible legal basis in the Treaty could be the same as the ones used as legal bases in the proposal for a Regulation on European Maritime and Fisheries Fund (EMFF), COM (2011) 804 final, notably Article 42, Article 43(2), Article 91(1), Article 100(2), Article 173(3), Article 175, Article 188, Article 192(1), Article 194(2) and Article 195(2) TFEU According to information received from DG MARE; the Legal Service has indicated to the DG in the internal legal service process that the legal basis used in the EMFF would not be sufficient for a legal basis, as the EMFF only create a right but does not impose legal obligations.

The study seeks in its recommendations to point to the most appropriate legal basis for a Directive or a Regulation, depending on the more exact framing of the final recommendations for action and the options that the Commission decide to take forward following the public consultation on the Green Paper.

For later impact assessment purposes, an impact assessment will traditionally have to look at the options for legal action:

- 1) the 'do nothing approach' meaning no changes to existing legislation
- 2) amending existing legal instrument(s)
- 3) new legislation
- 4) An additional option to be considered could be soft law measures, e.g. guidance or technical formats, recommended licensing provisions or guidance on price calculations. A fifth option could be one combining the above options.

5.3 Initiatives with multiple legal bases

5.3.1 The main rule on legal bases

In the EU law, the clear main rule is that any new legislative initiative needs to be based on a single legal basis of the Treaty. In view of the consequences of the legal basis in terms of substantive competence and procedures, the choice of the correct legal basis is of constitutional importance.

Further, in accordance with case-law of the Court of Justice, the choice of legal basis for a Community measure must rest on **objective factors amenable to judicial review, including in particular the aim and the content of the measure**.

As regards multiple legal bases, if examination of a EU measure reveals that it pursues a twofold purpose or that it has a twofold component and if one of those is

identifiable as the main or predominant purpose or component, whereas the other is merely incidental, the act must be based on a single legal basis, namely that required by the main or predominant purpose or component. [1]

On the other hand, where a measure has **several contemporaneous objectives or components** which are indissolubly linked with each other without one being secondary and indirect in respect of the others, the measure must be based on the various relevant Treaty provisions.[2]

Examples of related legislative measures with single legal basis are:

Legal instrument	**Legal Basis**
Maritime Strategy Framework Directive (Dir. 2008/56/EC)	Article 175(1) TEC
Recommendation on EU Integrated coastal zone management (ICZM)	Art 175(1) TEC
Access to Information Directive (Dir. 203/4/EC)	Article 175(1) TEC
INSPIRE Directive (Dir. 2007/2/EC)	Article 175(1) TEC
Re-use of Public Sector Information Directive (Dir. 2003/98/EC, the so-called PSI Directive	Article 95 TEC New proposal for amendment under Article 114 TFEU

As described above, certain exemptions from the main rule can be made in situations with multiple and equal purposes of the relevant instrument. A few examples are:

Legal Instrument	**Legal Basis**
Regulation (EU) No 1255/2011 of the European Parliament and of the Council of 30 November 2011 establishing a Programme to support the further development of an Integrated Maritime Policy	Articles 43(2) - Fisheries, 91(1) and 100(2) - Transport, 173(3) - Industry, 175 –Territorial Cohesion, 188 – Research, 192(1) - Environment, 194(2) –Energy and 195(2) – Tourism of the TFEU
Proposal for a Regulation on European Maritime and Fisheries Fund (EMFF) under the 2014-2020 framework COM (2011)804 final	Article 42, Article 43(2), Article 91(1), Article 100(2), Article 173(3), Article 175, Article 188, Article 192(1), Article 194(2) and Article 195(2) TFEU

[1] Case C-42/97 Parliament v Council [1999] E.C.R. I-868, paras. 39-40; Case-C 36/98 Spainv Council [2001] E.C.R. I-779, para. 59; Case C-211/01 Commission v Council [2003] E.C.R.I-8913, para. 39

[2] Case C-165/87 Commission v. Council [1988] E.C.R. 5545, para. 11; Case C-178/03 Commission v. European Parliament and Council [2006] E.C.R. I-107, paras. 43-56.

5.4 Alternative options

Alternative options to a legal action presented solely by DG MARE have been considered e.g. through other existing legal instruments. Considerations have thus been ongoing on whether an amendment to existing legislation would be a possible option forward, e.g. through amendments to the INSPIRE Directive (Dir. 2007/2/EC), the Public Access to Environmental Information Directive (Dir. 2003/4/EC, the Aarhus Directive) and the Re-use of Public Sector Information Directive (Dir. 2003/98/EC, the so-called PSI Directive), complementing the Access to Information Directive.

The **INSPIRE** Directive only regulates the exchange, sharing, access and use of interoperable spatial data and spatial data services across the various levels of public authority in their performance of their public tasks; thus not the sharing of data between the public and the private sector. Subject to certain conditions, the Directive may also apply to spatial data held by natural or legal persons other than public authorities, provided that those natural or legal persons request this. By way of derogation, MSs may limit public access to data, e.g. due to intellectual property rights; or the confidentiality of personal data and/or files relating to a natural person where that person has not consented to the disclosure of the information to the public, where such confidentiality is provided for by national or Community law.

The **Aarhus Directive** and the **PSI Directive** allow in principle for the private sector to get access to the data publicly available. However, uneven practical implementation of the Directives by the Member States and lack of harmonisation amongst Member States regarding the re-use of public data have so far hindered a better sharing of data.

The aim of the PSI Directive (2003/98/EC) is to facilitate the re-use of PSI by harmonising the basic conditions for reuse and removing major barriers to re-use in the internal market. The original Directive thus contains provisions on non-discrimination, charging, exclusive arrangements, transparency, licensing and practical tools to ease and facilitate the discovery and re-use of public documents.

The PSI Directive does not contain an obligation to allow re-use of documents, thus the decision whether or not to authorise re-use remains with the Member Sates or the public sector body concerned. At the same time, the Directive builds on national rules on access to documents. Some Member States have expressly linked the right of re-use to this right of access, so that all generally accessible documents are re-usable. In other Member States, the link between the two sets of rules is less clear and this is a source of legal uncertainty.

The Communication COM(2009) 212 and the following 2011 Commission proposal for amending the PSI Directive clearly pointed to existing barriers such as the lack of information on available PSI, and public sector bodies failing to realise the economic potential linked with re-use of data. Thus, a need for a re-enforcement of the PSI Directive was identified to overcome these barriers, e.g .lack about what data are actually available, restrictive or unclear rules governing access and re-use conditions, discouraging, unclear and inconsistent pricing where

the re-use of information is chargeable, and the overall excessive complexity of the process for obtaining permission to re-use PSI. The proposal for an amended Directive clearly states the need for an optimal legal framework to facilitate and stimulate the commercial and non-commercial re-use of public open data removing regulatory and practical borders for re-use, so that the same types of data are available on similar, if not the same, terms and conditions irrespective of their national origin.

As pointed out by the Proposal text, currently in first ordinary legislative reading in the Parliament, the intention of the amendment to Directive 2003/98/EC is thus to lay down a clear obligation for Member States to make all generally available documents re-usable. As it constitutes a limitation to the intellectual property rights held by the authors of the documents, the scope of such a link between the right of access and the right of use should be narrowed to what is strictly necessary to reach the objectives pursued by its introduction. In this respect, documents on which third parties hold intellectual property rights should be excluded from the scope of Directive 2003/98/EC. If a third party was the initial owner of a document that is still protected by intellectual property rights, that document should, for the purpose of this Directive, be considered as a document for which third parties hold intellectual property rights. The revision of the Directive is thus not to regulate the right of access to public documents, which remains the sole and exclusive competence of Member States, but the revised provisions would apply to the re-use of documents where these are generally accessible, also under national access rules.

Amendments to the INSPIRE and Access to information Directive will thus have to be based on Article 192 TFEU whereas the new proposal for amendment of the PSI Directive is based on Article 114 TFEU (Internal Market).

5.5 Tentative conclusions and possible way forward

The following scheme shows at this early stage of the process the possible ways forward, following the consultation on the Green Paper. Further detailed analysis in relation to the legal basis will depend on the more exact framing of options, as indicated below.

Option	Impacts (positive/negative)	Legal basis
1. A 'do nothing approach' meaning no changes to existing legislation	Increasing uneven implementation at MS level regulatory uncertainty and no reduction of costs/ continued distortion of competitive conditions/Internal Market and thus not sufficient stimulation of innovation	As before
2. Amending existing legal instrument(s)	Depends on clearer framing of options on legal measures. The assumption is that a legal initiative will lead to greater legal certainty, reduction of costs due to the economic importance of open data including	Changes to the existing legislative acts will have to be made within the same legal basis of the Treaty.

Option	Impacts (positive/negative)	Legal basis
	reduction of competitive market hindrances as well as increased stimulation of innovation.	
3. New legislation	Depends on clearer framing of options on legislative or non-legislative acts. The assumption is that it will bring about enhanced legal certainty, lowering barriers for re-use of data and thereby reducing costs.	Legal basis for horizontal measures needs to be identified and agreed, either within existing legal Treaty basis for EU maritime policy or within the legal basis for horizontal environmental measures, depending on the framing of the exact option. In the case the options will identify legislative acts according to Art 288 TFEU (Regulations, Directives or Decisions) the ordinary legislative procedure in Art 294 TFEU shall be applied. Non-legislative acts will either have to be based on the Treaties or based on secondary legislation/implementing acts based on implementing powers procedure - 'comitology'- (Art 291 TFEU) or through adoption of delegated acts through delegated power to the Commission (Art. 290 TFEU)
4. Soft law measures	May to some extent facilitate application of the rules of the PSI Directive on licencing and charging. Will however not necessarily improve the uneven implementation at MS level to the same degree as with a legal action, so regulatory uncertainty and distortion of competitive conditions may still occur at the same scale.	Legal basis can be found within existing legal basis for EU maritime policy, as before.
5. One to more combinations of the above options ("package solution").	Depends on clearer framing of options on specific package. The assumption is that combining legal amendments with soft law measures will bring together the benefits from options 3 and 4 above and thus provide enhanced legal certainty, removal of barriers for promoting re-use of data, reducing costs and stimulating innovation.	Legal basis for horizontal measures needs to be identified and agreed, either within existing legal basis for EU maritime policy or within the legal basis for horizontal environmental measures, depending on the framing of the exact option.

6 Innovation from marine data

One of the key objectives of improving marine knowledge is to increase competitiveness and innovation amongst users and re-users of marine data by providing wider access to quality-checked, rapidly available, coherent marine data. Knowledge is a key component of the EU's plan to integrate marine and maritime research and a contribution to the Digital Agenda.

The Impact Assessment of 2010 demonstrated that the current inability of researchers and private companies to access marine data to develop new products, services, processes or commercialisation techniques is blocking innovation, at an estimated worth of between €60 and €200 million annually.[3]

The objective of this study is to identify examples of innovation in products, services, processes and/or commercialisation techniques that will be positively impacted by improved marine knowledge. It relates to questions 12 to 15 in the Terms of Reference, outlined below:

> *"Assuming that historic and real-time data were available on parameters such as chemical pollution, non-native species, coastal erosion, storm intensity etc what services based on these and other data:*
>
> *a) might reduce risks for aquaculture producers?*
>
> *b) might enable insurance companies in coastal regions to provide a better assessment of risk?*
>
> *c) could support a longer season for coastal tourism?*
>
> *d) could help the bio-economy discover new products (pharmaceuticals, enzymes, cosmetics etc)"*

[3] European Commission, *Marine Knowledge 2011-2013: Background Document for Maritime Policy Member States' Expert Group on Marine Knowledge*, 23 February 2011

Three examples of possible services in each of these four cases will be provided, in addition to three more examples for a fifth case chosen by the contractor.

This section presents a number of case studies developed to provide specific examples of potential innovations that would benefit from improve knowledge.

The structure of these case studies has been organised as follows:

- Case presentation: problem definition and opportunities : explanation of context and situation in Europe and internationally
- The need for marine knowledge in Europe: explanation of the current state of knowledge in the area, any existing knowledge/research initiatives, the types of data that may be needed to realise the benefits, and the connection to Marine Knowledge 2020
- Innovative service/product and benefits: explanation of the current/future service/product to be developed, the economic benefits, other examples of benefits linked to the same type of data
- Data sources, bibliography, and list of potential interviews to undertake

The case studies have been produced following a thorough documentary review of existing and past initiatives, projects and research papers; and where possible, the opinion of an identified expert in the field to validate the analysis and provide feedback.

The table below summarises the case studies. It provides an indication of the level of completion for each example, as well as the next steps required to achieve finalisation. Some examples are yet to be identified, and these are mentioned later in this section.

Furthermore, some additional examples have been identified beyond what is required in the Terms of Reference. Based on feedback and interviews with experts we will determine at a later stage which cases will be further developed and retain in the final report.

Table 6-1 Case studies of examples of innovation

Area	Title	Status	Next steps
Aquaculture production risk	Early warning device for jellyfish blooms	Case study fully developed, interview made, currently being reviewed by expert	Obtain written feedback from expert and make final changes
	Offshore aquaculture: new sea-cage design	Case study fully developed, expert identified and contacted	Organise telephone call with expert to obtain feedback and make final changes
	Observation network on ocean acidification	Case study largely developed, interview made	Make final changes to case study
Insurance	Insurance discounts	Case study in	Organise telephone

Area	Title	Status	Next steps
companies	through improved marine safety information	progress, experts identified and contacted	call with expert to obtain feedback, and complete case study
Coastal tourism	Development of eco-tourism in protected areas	Case study largely developed, expert identified and contacted	Organise telephone call with expert to obtain feedback and complete case study
	Artificial reefs: surf and diving opportunities	Case study largely developed, expert identified and contacted	Organise telephone call with expert to obtain feedback and complete case study
	Protection against coast erosion	Case study largely developed, expert identified and contacted	Organise telephone call with expert to obtain feedback and complete case study
Bioeconomy	Development of seaweed based products	Case study fully developed, interview made	Make final changes to case study
	Innovation aquatic pharmacy products	Case study largely developed, expert identified	Organise telephone call with expert to obtain feedback and complete case study
Other (mineral resources)	Sea-bed mining, mineral resources	Case study largely developed	Identify expert, organise telephone call and complete case study

Summary of findings

Detailed case studies for the examples identified are provided in the subsequent sections. The table below summarises the findings of these case studies, in terms of the importance of marine knowledge/data and a demonstration or estimation of the economic benefits. Improved marine knowledge, whether it be through better sharing of datasets on past and present events, improved coordination of research efforts, or other types of specific phenomena, can bring potentially significant economic, social and environmental benefits. These benefits can be realised through the creation of innovative services and encourage the growth of emerging sectors, through the mitigation of risks and negative impacts, or through a reduction in uncertainty regarding the state of the oceans and seas.

Table 6-2 Case studies of examples of innovation

Area	Title	Importance of marine knowledge	Economic benefits
Aquaculture production risk	Early warning device for jellyfish blooms	Need to have baseline data on distribution and typical abundances as well as environmental oceanographic data, both broad and fine scale. There is also a need to coordinate research at a regional level at least.	Understanding jellyfish behaviour is one step towards mitigating against impacts of blooms. Mitigating impact of blooms and major fish kills could assist in avoiding losses of € 192 million to production.
	Offshore aquaculture:	Hydrographcial and topographic data to	New cage design could lower production costs

Area	Title	Importance of marine knowledge	Economic benefits
	new sea-cage design	optimise cage location, meteorological data to predict waves, currents, and extreme weather in order to make efficient cages.	through fewer visits. EU offshore market has the potential to create annual economic output of €900 million and 26,200 jobs.
	Observation network on ocean acidification	Data is needed on behaviour of flora and fauna to changes in acidity, comparable paleo-data (past events and impacts), time-series data	Mitigating impacts of ocean acidification is no easy task, however it has been estimated that the economic costs of reduced mollusc production due to ocean acidification in the EU 15 and Eastern Europe is 543 million USD (total net loss assuming no income rise).
Insurance companies	Insurance discounts through improved marine safety information	Improved quality nautical charts – including topographic data, seabed features, and navigational hazards – as well as better coverage of open sea through hydrographical surveys	Economic benefits in terms of reduced insurance costs: agreement between US marine system software company and insurance provider resulted in 20% discount in customers whose vessels are equipped with the marine system.
Coastal tourism	Development of eco-tourism in protected areas	Meteorological data, water quality, coastal erosion to mitigate negative imoact of increased tourism flow	Birdwatching tourism sites can create between USD 2.4 million and USD 40 million in economic impact. Furthermore, potential income earned by a regional whale watching industry has been estimated at about US$24 million a year.
	Artificial reefs: surf and diving opportunities	Bathymetry and topography, marine currents and meteorology, quality of water and salinity: to optimise location and reduce impacts on environment	Popular surfing spots have been valued as multi-million USD assets. Artificial reefs can double the number of 'good surfing days' and increase tourism revenues.
	Protectection against coast erosion	Data is needed on past observations, currents, wind, water temperature, topography and bathymetry to prepare an appropriate response to coastal erosion.	Coastal protection is essential to protect both the beach and coastal infrastructure. Landslides in Isle of Wight have cost on average GBP 1.4 million from 1980 to 2000 in terms of structural damage, insurance costs, etc. On the Polish coast, in no measures are taken to sea-level rise, estimated value of lost assets is € 90 billion.
Bioeconomy	Development of seaweed based products	Data on cultivation of algae is needed, as well as data on location and availability of natural	A more stable cultivation process will maximise the benefits from the growing potential markets that are

Area	Title	Importance of marine knowledge	Economic benefits
		stocks.	bioenergy and biomaterials.
	Innovation aquatic pharmacy products	Data needed on biobanks, screening facilities, common set of standards for the preparation of extracts and libraries, common format for data exchange.	Lower healthcare costs through societal benefits of effective drug therapy to treat human diseases, improved accessibility of treatments to population.
Other (mineral resources)	Sea-bed mining, mineral resources	Data on seabed substrata, deep sea life, currents, etc to plan extraction, design instruments and understand behaviour of lifeforms	Benefits through sustainable exploitation of the sea-bed: estimations difficult to determine

Focus for next month

The coming months will focus on identifying additional examples to meet the requirements of the Terms of Reference. To date, examples need to be identified and/or case studies developed for:

Area	Example	Status
Insurance companies	• Potential to reduce to reduce insurance premiums for offshore installations through reduced uncertainty/better data	• Case study to be developed
	• Not yet identified	• Identification of a third example required
Bioeconomy	• Not yet identified	• Identification of a third example required
Other sectors	• Innovation in offshore wind structures	• Case study in early stages of development
	• Not yet identified	• Identification of a third example required

Furthermore, we will validate and finalise the case studies already developed through interviews and written feedback from experts identified during discussions and the documentary review phase. A strong focus will be made on quantifying the economic benefits for each case study where possible, primarily based on extrapolation of small scale impacts that have been measured through existing studies.

Finally, any feedback from DG MARE following review of this interim report will be considered and taken into account where possible and relevant.

Limitations and mitigation strategies

The themes of innovation and reduction in uncertainty pose a number of challenges, as pointed out in our inception report. Now into the data collection phase, we wish to draw attention to the following challenges which remain relevant to this study.

- Identifying appropriate experts and contributors

Considering the innovation theme covers at least 4 sectoral areas, and reduction in uncertainty does not require examples to be drawn from a particular sector, the scope of our search is indeed very wide.

We have adopted an approach whereby the initial list of examples will be developed into case studies, that can be shared with identified experts. This alternative approach will enable us to better target experts and determine whether or not they are in a position to provide value.

- Potential barriers to providing concrete information

Potential lack of availability and knowledge to provide information, or potential reluctance to divulge information (particular for private sector actors).

We will undertake a continual process of identifying experts and potential contributors so that alternative interviewees can be identified in the event additional sources are required.

- Impact of better marine knowledge unknown

Identification of innovative products and services may be possible, however it may be challenging to identify the impact that better marine knowledge (a theme difficult to quantify) would have on the innovation. The industries might not have developed ideas related to improved access to high quality data and are therefore not able to estimate any benefits

With interviewees we will strive to understand impacts of better marine knowledge through making reasonable assumptions, and stating these clearly in our analysis.

- Difficulties associated with the quantification of benefits

It is worth reiterating that this exercise will necessarily be quite speculative and hypothetical – the benefits derived from improved marine knowledge may be largely indirect, and therefore difficult to define and quantify.

Furthermore, in terms of examples of economic benefits of reduction in uncertainty, it is expected to be very difficult to quantify the monetary benefits.

Finally, in terms of quantifying monetary benefits, the extrapolation of collected data will be challenging and should therefore be handled and interpreted with

caution since data collection and processing costs vary significantly between Member States and sites.

Where possible we will seek to identify past examples where better marine knowledge would have had positive impacts – this may be more concrete to quantify than future developments.

The output for this question will be largely qualitative case study examples, with quantitative estimates where possible. Economic modelling is not feasible within the context of this study and its timeframe.

In terms of reduction in uncertainty, the focus will be on providing concrete examples of the (in-kind) benefits of improved marine knowledge. We will seek to quantify where possible, however the ability to do so will be limited by the data available and assumptions that need to be made.

6.1 Case studies on examples of innovation

6.1.1 Risk for aquaculture producers

Case 1: Jellyfish blooms

1. Case presentation: problem definition & opportunities
Overall context
The study of jellyfish blooms is a topical issue, due to an apparent increase in the size and frequency of jellyfish blooms in coastal and estuarine waters around the world in recent decades. These blooms have taken the interest of scientists, as there is limited knowledge regarding the reasons for the phenomena, its impacts and potential mitigation strategies. Undoubtedly there are associated ecological ramifications on the food web and biogeochemical pathway alterations. Moreover, there are socio-economic impacts including damage to aquaculture production, fisheries, industry and tourism. However to date, studies have tended to be local or regional in scope, and there has been no concerted effort to monitor. As a result, a broad understanding of the extent of the problem in different geographical areas is still lacking. There is a need for collaborative effort and the exploitation of existing infrastructure in order to turn efforts towards better understanding the phenomena and mitigating its impacts.
Situation in Europe and internationally
Jellyfish blooms have caused many problems in Europe in recent years. They have been known to clog fishing nets, cause mass mortalities of farmed salmon, or block the cooling water intake of power stations. They are also suspected to prey on certain fish eggs and larvae, thus limiting the potential recovery of already weakened fish stocks. Blooms have been observed in the Mediterranean sea, the Baltic sea and the North East Atlantic sea, especially in the Celtic Seas. A few examples of European jellyfish bloom phenomena have caused large-scale destruction: - The entire Irish salmon industry was wiped out in 2007 after a plague of billions of mauve stingers – covering an area of 10 sq miles (26 sq km) and 35ft (11m)

deep – attacked the fish cages.

- In the Mediterranean basin, jellyfish blooms have become a regular phenomenon over the last ten years[4], negatively impacting fishermen and aquaculture producers.

In the Mediterranean basin, the main threat is to shellfish production. In 2009, Mediterranean mussels represented in volume a quarter of the total aquaculture production in the European Union and 6% in value (Eurostat).

In the North Sea, the most threatened species are rainbow trout and salmon, which in 2009 represented 29% of the total production in volume and 37% in value (Eurostat).

The problem is also significant in regions outside Europe. As an illustration, perhaps the most extraordinary blooms have been those occurring in waters off Japan. Giant jelly fish called Nomuras, weighing over 220 kg and measuring 2m in diameter, have swarmed the Japan Sea annually since 2002, resulting in an economic loss to the Japanese fisheries industry in 2005 of 30 billion yen.[5]

2. The need for marine knowledge in Europe

Current knowledge

The causes of these jellyfish blooms are not well known, and there are a number of potentials causes cited in various studies. Some believe that population explosions result from overfishing of their dining competitors and predators, which include more than 100 species of fish, and animals such as turtles. Other researchers believe the blooms are due to a global warming of some seas, which lead jellyfish to a faster reproduction cycle. Finally, some believe that higher water pollution is indirectly linked to jellyfish blooms, as jellyfish feed off smaller crustacean who feed off algae generated in polluted waters.

Because of the magnitude and the impact these jellyfish blooms can have on all human activities, there have been many studies on the drivers of, and impact of jellyfish blooms

[4] CIESM (Mediterranean Science Commission), CIESM JellyWatch Program http://www.ciesm.org/marine/programs/jellywatch.htm

[5] Stone, R. (2011), "Massive Outbreak of Jellyfish Could Spell Trouble for Fisheries", http://e360.yale.edu/feature/massive_outbreak_of_jellyfish_could_spell_trouble_for_fisheries/2359/?utm_source=feedburner&utm_medium=feed&utm_campaign=Feed\%3A+YaleEnvironment360+\%28Yale+Environment+360

on pelagic environments. There have been fewer studies to assess the impact of jellyfish detritus on pelagic and benthic ecosystems. Unfortunately, ground fish surveys through fishery observer programmes and assessments have not tended to collect data on jellyfish that are caught in the process. This is a lost opportunity to collect data.

Because this problem is global, many studies have been done in Europe (Ireland, Scotland, Norway), the United States, Japan and Korea (see bibliography).

Existing initiatives

A number of data collection projects have been established with a view to increase the understanding of the jellyfish bloom phenomena, potentially develop an early warning system, and then establish real mitigating measures. There could be benefit in sharing the outcomes of these studies, and also through undertaking research in a more coordinated manner.

A few examples of initiatives in Europe and the United States include:

- *The EcoJel project*: this project involving the Swansea University (Wales) and University College Cork (Ireland) was undertaken between 2008 and 2012, and financed by ERDF INTERREG. Its objective was to assess the opportunities and detrimental impacts of jellyfish in the Irish Sea. It allowed the development of a user-friendly application for users to report sightings of jellyfish around Ireland.

- *CIESM Jelly Watch programme:* the Mediterranean Science Commission set up this programme in 2008 to gather for the first time baseline data on the frequency and extent of jellyfish outbreaks across the Mediterranean Sea. Because the pilot phase proved successful in 2009, it is now being extended to the whole of the Mediterranean Basin.

- The Crown Estate in Scotland funded a study in 2010 called *Developing the capacity to monitor the spatial and temporal distributions of jellyfish in western Scottish waters.* In this survey, aquaculture production industry actors were interviewed in order to establish the sightings they had of jellyfish.

- The *Jellywatch programme* was started in the United States in 2009, it went public in 2010. This project aims to create a scientifically coordinated global jellyfish and environmental database based on already identified datasets from coastal, estuarine and open-ocean regions: the data collected is from all around the world. This two year project was started by the Monterey Bay Aquarium and Monterey Bay Aquarium Research Institute. It involves data acquisition and statistical analyses, global synthesis of trajectory maps of regional jellyfish blooms, generation of conceptual diagrams of the role of jellyfish in biogeochemical cycles and food webs, and discussions relating to the socio-economic ramifications of jellyfish blooms.

Other initiatives may include studies on cage design optimization, through potentially producing a bubble curtain around a cage, to keep jellyfish out whilst avoiding environmental impacts. Other types of early warning systems are being investigated, so that the alarm is raised when jellyfish are present in nearby waters.

Attempts have been made to develop an Atlantic Jellyfish Monitoring programme to pool data through the INTERREG programme, however this proposal was not pursued.

Type of data need

There is a need to better understand the phenomena to be able to then mitigate against its impacts. To have a basic understanding of the behaviour of jellyfish, baseline data is

needed on distribution and typical abundances, as well as environmental oceanographic data. This data needs to be both broad scale and fine scale. Following blooms in the Mediterranean, models were developed to predict the occurrence of blooms; however these lacked "at sea" data.

Data on jellyfish sightings needs to be widely available and accessible to all actors - decision takers, aquaculture production actors – across geographies. Then it is important to understand the causes of blooms in order to think about strategies to potentially prevent them. Finally, there is also a need for more information on a more sustainable approach on how to treat these blooms: so far, the choice has been for systematic destruction in order to avoid the nuisance.

Baxter et al have effectively summarized the research and data needs: "widespread routine monitoring of jellyfish around aquaculture sites is necessary and will be fundamental if the links between their blooms and detrimental effects on the fish are to be fully understood. Widespread monitoring will be vital to obtain site-specific information jellyfish populations, including their seasonal occurrence and abundance. As yet, no reliable and cost effective mitigation methods exist to prevent small hydrozoan jellyfish from entering the cages (Rodger 2007, Hay & Murray 2008) and this should also be the focus of future studies". [6]

Marine knowledge 2020

Based on the directive EC 2008/56 (MSFD), European countries Member States shall establish and implement coordinated monitoring programmes for the ongoing assessment of the environmental status of their marine waters. Therefore, coordinated monitoring programmes of jellyfish blooms should be feasible to integrate into those programs. The data on jellyfish sightings is not integrated yet into the MSFD reporting database.

Because some studies have demonstrated that remote satellite observation is helpful in anticipating jellyfish blooms, the marine service of the European Earth monitoring programme (GMES) could be a strong tool in favour of developing a better understanding of jellyfish blooms and in developing an early warning system. Under the GMES programme, a marine service has been progressively developed and implemented by 60 organisations. This processes and analyses information from in-situ and space measurements to deliver two classes of information: (1) ocean observations and (2) monitoring and forecasting."

3. Innovative services and benefits

Current/ future services to be developed

Objective of the services:

With improved knowledge sharing and research, an early warning system could potentially be developed to address the following objectives:

- Anticipate the risk of jellyfish blooms : establish the movements and origin of

[6] Baxter, E., Rodger, H., McAllen, R., Doyle, T. (2011), "Gill disorders in marine-farmed salmon: investigating the role of hydrozoan jellyfish", Aquacult Environ Interact, Vol. 1: 245–257, 2011

jellyfish through the development of innovative tracking technologies

- Create eco-friendly response mechanisms for the jellyfish blooms, in order to channel them away from aquaculture production sites.

Types of services

- A coordinated platform between all existing databases of jellyfish sightings that would help relay alerts to relevant observation centres
- A unified database of jellyfish sightings
- European-wide research programmes to address mitigating measures

Existing/ ongoing initiatives

So far all projects seem to have been launched on a limited scale. Although there are many monitoring initiatives, these are at an early stage, and there is still a large amount of uncertainty regarding reasons for, and impacts of, jellyfish blooms. One limitation for monitoring was raised by the study in Scotland in 2010 - many blooms go unreported because aquaculture producers fear the insurance companies might set up a premium if their production is considered at risk

Economic benefit

Hypothesis

A number of studies have attempted to quantify the impact of jellyfish blooms. In Irish and UK waters, the 2007 major fish kill (approximately 250 000 fish) by the mauve stinger wiped out Northern Ireland's only salmon farm, resulting in an economic loss of more than €1 million.[7]

The Irish salmon aquaculture industry is worth € 60 million annually. A study[8] has revealed a 12% mortality rate due to gill disorders. It is believed that a key cause of this is through small jellyfish entering aquaculture cages and being inhaled by fish. On inhalation, they pass over the gills and inflict serious injuries. Using this logic, jellyfish blooms could represent a € 7.2 million annual lost to the salmon aquaculture industry. However due to insufficient data it is difficult to identify small jellyfish as the causative agents of the more common and chronic problem of gill disorders.

In Peru, jellyfish display strong seasonal fluctuations, with peak abundances during summer. Off southern Peru and during the austral summer 2008–2009, C. plocamia were >30% of the catch in 5% of the hauls, which was enough to cause economic losses of more than USD 200,000 in only 35 days of fishing.[9]

[7] Bastian, T., Stokes, D., Kelleher, J., Hays, G., Davenport, J., and Doyle, T. (2011), "Fisheries bycatch data provide insights into the distribution of the mauve stinger (Pelagia noctiluca) around Ireland", ICES Journal of Marine Science (2011), 68(3), 436–443.
[8] Baxter, E., Rodger, H., McAllen, R., Doyle, T. (2011), "Gill disorders in marine-farmed salmon: investigating the role of hydrozoan jellyfish", Aquacult Environ Interact, Vol. 1: 245–257, 2011
[9] Quinones, J., Monroy, A., Marcelo Acha, E., Mianzan, H. (2012), "Jellyfish bycatch diminishes profit in an anchovy fishery off Peru", Fish. Res. (2012)

In addition, a study in Korea[10] in 2012 estimated the damage cause to the Korean aquaculture production as between 2,1% and 25% of the annual production value, i.e. up to USD 204,6 million.

Extrapolation

Due to limited information on the impact of jellyfish in Europe, we can only do very gross approximation. Size of the market: in 2009, the aquaculture production in EU27 was of EUR 3,2 billion. Assuming that jellyfish blooms affect mostly Mediterranean mussels, as well as northern rainbow trout and salmon production, this represent a € 1,4 billion market in 2009. If jellyfish are as damaging to the European production as they are to Korean production, the estimated cost could be from EUR 29 million (2,1% of 1,4) to EUR 345 million (25% of 1,4).

Furthermore, if we assumed that half of the 12% mortality rate due to gill disorders could be attributed to jellyfish, **addressing jellyfish impacts would assist in avoiding losses of € 192 million**.

Other examples of services and benefits linked to the same type of data (other sectors, other services….)

Increased knowledge of the jelly fish bloom phenomena could lead to many more services that could be used by public or private players in some other sectors such as tourism, energy or bioeconomy:

Tourism

Tourism could benefit from an improved water quality: jellyfish diminish the quality of water and can present a risk for bathers, as many jellyfish species sting. A tool was conceived by a Hong Kong team to keep jellyfish away from swimming areas. Called "Ocean Guard", it takes the form of a vertical pole surrounded by a lifesaver ring. This enables it to bob on the surface of the sea and remain visible from the beach, informing lifeguards and the public of its presence. Ultra low-frequency sound waves are emitted from the Ocean Guard that encourages jellyfish to stay away.

Industry

Power plants and desalinisation plants have also suffered from jellyfish blooms: in Tunisia and in Israel, jellyfish blooms have caused significant financial damage in the last few years.

Bio-economy

Jellyfish have their uses: in collagen preparations (to treat rheumatoid arthritis, for example), they are popular attractions in aquaria, and their fluorescent proteins have been instrumental in biomedical discoveries. And, of course, they are a source of food: Jellyfish are 80% protein and very low in fat although the high sodium content probably outweighs their health benefits. In Japan and other parts of Asia, jellyfish are dried and chopped into noodle-like strips to be added to soups, for example.

[10] Do-Hoon Kim, Ju-Nam Seo, Won-Duk Yoon, Young-Sang Suh, (2012), "Estimating the economic damage caused by jellyfish to fisheries in Korea", Fish Sci (2012) 78:1147–1152

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Interviews undertaken
Dr. Tom Doyle – Coastal and Marine Resources Centre, Ireland

Potential interviews to organise
The Scottish Salmon Producers Organization / The Norwegian Ministry of Fisheries and Coastal Affairs

Case 2: Offshore aquaculture: new sea-cage design

1. Case presentation: problem definition & opportunities

Overall context

Fish farms are traditionally settled in sheltered near-shore sites, with steel-framed rectangular support structures for the net cages, with walkways around them as work platforms. In recent years, however, there has been a move in aquaculture production for more offshore sites, requiring a different design for cages.

The salmon farming industry, for instance, is moving towards offshore, with the use of circular cages with plastic support structures and incorporating no walkway. Instead the cages are dependent on boats for maintenance. The feeding of the fish, instead of being carried out by hand or by cannon/blower, is by automatic cage-mounted machines with a capacity of up to 100 mt of feed. Visits by farm staff can thus be reduced, lowering costs. As salmon prices have slipped lower, these technology shifts, and a move towards amalgamation of companies, are allowing the industry to cut operating costs and retain profitability.

Situation in Europe

Offshore aquaculture is still relatively new in Europe, with a few countries leading the way, like Ireland and Spain: near-shore waters in Ireland are too shallow for finfish farming.

Two examples to illustrate the advantages and drawbacks of moving production offshore.

Irish experience in moving mussel production offshore.

The move happened for because many of the established bays are now overcrowded and growth rates have declined. But results in 2007 were disappointing for one main reason[11]: the failure of the equipment to withstand the harsh environment.

South of Spain

An offshore aquaculture project was put in place in Spain between 2000 and 2007. The three stages of projects were as follow:

- The first stage involved testing technologies i.e. cage trials in exposed sites.
- The second and third stages involved the culture viability of new species and transfer of technology to the aquaculture sector, respectively.

2. The need for marine knowledge in Europe

Current knowledge

Near shore waters
Though the traditional solution for sea farming, there are many disadvantages to near-shore sites :

- Maritime spatial planning: with the newly protected areas, the development of coastal tourism, of navigation and of other offshore installation, there is not

[11] International Offshore Aquaculture Workshop, 2007, Summary report

enough space to develop intensively near shore production sites
- Environmental impact: of fixed farm fishes is important because of waste disposal and because of potential change in the benthic population due to eutrophication.
- And the future is potentially difficult because of climate change:
  - The quality of the water column is to be affected but is it difficult to predict how much.
  - Sea-level rise in the coming decades will increase salinity intrusion further upstream, affecting brackish water and freshwater culture practices.
  - Aquaculture in temperate zones will be more affected by water warming to levels that will exceed the limit for many farmed species and will require changes in farmed species.
  - The increase in extreme weather events may affect aquaculture in several ways: physical destruction of aquaculture facilities, loss of stock and spread of disease. The risks will be larger in more open exposed sites.

Offshore waters

The advantages of going offshore:

- No visual impact
- Less environmental impact
- Submerged structures decrease maintenance
- Greater currents allow increased cultivation loads and decreased growth time for molluscs
- Stable environment for cultivation.

Existing initiatives

New cages designs

There is research to determine to most efficient offshore cage that would reduce the cost of shallow water breeding and be resistant enough.

So far, there is two different kinds of cages being developed:

- Surface cages
- Submersible cages

Ireland is a leader in Offshore farming because Irish waters are too shallow for finfish cage farming, but there are other countries joining the experience, through research projects like the **Offshore Aquaculture Technology Platform (OATP)**.

New practices in aquaculture management
- There is also the development of "Integrated Multitrophic Aquaculture", which consists of incorporating species from different nutritional (trophic) levels in the same system
- Multi-functional Co-management" (MFCM) is another example, with the integration of power generating wind farms and fish producing farms in open sea

Type of data need

Through the OATP evaluation, many points of concern were raised:
- Safety issues and weather conditions (exposure)
- Environmental challenges as well as the technology challenges and exposed nature of the sites.
- Research & development requirements and technological demands as the greatest concerns in the development of offshore aquaculture.

Hydrographical and topographic data to know where to install the cages:

- Structure and quality of the seabed
- Protected zones
- Navigation zones

To breed the fish more efficiently:

- Temperature
- Salinity
- Acidification
- Current flows
- Meteorology
- Topography
- Bathymetry

To make efficient cages, meteorological data to predict waves, currents, extreme weather events, etc is needed.

Marine knowledge 2020

"Uncertainty is a principal enemy of those responsible for designing offshore structures that can withstand the vagaries of the sea, for managing fish stocks or for designing protected marine areas"

3. Innovative services and benefits

Current/ future services to be developed

Objective of the products / services

Near-shore waters are often in protected areas, or touristic areas, which difficult the installation of near shore cages

Types of products / services

- New kinds of cages that would require less maintenance, limit the escape of fish, and ensure the environmental impact of fish farming is minimal.
- Mobile cages: automated cages that would have a predictable trajectory or a controllable trajectory, that could be filled with fingerlings in one point and then let loose for nine months until they reached their intended market with a harvestable crop.

Existing/ ongoing initiatives:

Cages developed specifically for offshore culture, rectangular and double cone, have been put into commercial use in recent years. In times of severe storms, the structures can be submerged below the high-energy surface waves.

Economic benefit

The economic benefit of this innovation is difficult to quantify as new cage design impacts aquaculture producers in:

- Lowering their production costs because they require fewer visits
- Lowering their production costs thanks to reduced uncertainty in the salinity and temperature of the water

A study of the Economic Feasibilty and Impact of Offshore Aquaculture in the Gulf of Mexico concluded that a single farm operation directly employing only seven individuals for offshore production will provide an additional annual regional economic output of at least US$9 million and provide additional employment for at least 262 persons, related to

processing, feed production, distribution, etc. Ireland, which is regarded as a strong potential hub for offshore aquaculture, identified 46 potential sites[12]. Taking this information, if we were to conservatively assume that there are 10 potential offshore aquaculture sites in 10 coastal EU countries, then the EU offshore market has the potential to create annual economic output of €900 million and 26,200 jobs.

The Irish Sea Fisheries Board 'Farming the Deep Blue' reports evaluates that Ireland could potentially increase its current output by 150 000 tonnes, and the quality of the end product could be maintained, as the advantages of offshore salmon farming are:

- Healthier and faster growing fish
- Lower mortality rates, firmer flesh and lower fat levels

But the only way to achieve sustainable economies of scale and unit cost in the offshore environment is to go offshore **at a large production volume**.

Other examples of services and benefits linked to the same type of data (other sectors, other services….)

Environmental benefits:

- Benthic impacts are reduced
- Visual impact reduced
- Negative interaction with migratory fish stocks are also minimised

At offshore sites, removal/dilution of wastes is facilitated by greater water exchange and volumes. In addition offshore sites offer greater salinity stability.

4. Data sources

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http://www.oceanstewards.org/pdf/Cage-aquaculture-1.pdf

Potential interviews to organise

Mairéad Mallon, Irish Sea Fisheries Board, in charge of "Deep Sea Fish Farming project"

[12] "Offshore Aquaculture Development in Ireland : Next Steps", Marine Insitute Ireland

Case 3: Acidification and shellfish aquaculture

1. Case presentation: problem definition & opportunities

Overall context

Ocean acidification is occurring because some of the increased carbon dioxide humans are adding to the atmosphere dissolves in the ocean and reacts with water to produce an acid.

The results suggest that increased acidity is affecting the size and weight of shells and skeletons, and the trend is widespread across marine species. These animals are an important food source for marine predators such as tropical seabirds and seals as well as being a valuable ingredient in human food production. Consequently, these changes are likely to affect humans and the ocean's large animals.

The effort required by clams, sea snails and other shellfish to extract calcium carbonate from seawater to build their shells and skeletons varies from place to place in the world's oceans. A number of factors, including temperature and pressure, affect the availability of calcium carbonate for species that produce carbonate skeletons

This means that shellfish larvae have a much lower survival rate, because it takes the larvae much more time to build a shell.

Situation in Europe

In 2009, mollusc and crustacean production in Europe accounted for 50% of the total aquaculture production in volume. But since bi-alves shellfish also act as natural water filter in their maturation phase, they also have a strong environmental value.

2. The need for marine knowledge in Europe

Current knowledge

Possible impact of ocean acidification on the structure of marine communities

Studies have analysed the behaviour of shellfish in more acid waters, as estimated to occur later in the century: clam and scallop larvae showed a more than 50% decline in survival. The larvae were also smaller and took longer to develop into the juvenile stage. Shellfish larvae are free swimming. The more time they spend in the water column, the greater their risk of being eaten by a predator. A small change in the timing of the larval development could have a large effect on the number of larvae that survive to the juvenile stage and could dramatically alter the composition of the entire population. Oysters also grew more slowly at this level of carbon dioxide, but their survival was only diminished at carbon dioxide levels expected next century.

With or without genetic change in relation to increased CO2 at the species level, there is clearly also the possibility of changes in the relative abundance of species as CO2 increases in the oceans. This is not an easy topic to address on the basis of available data from the oceans, because the effects are nonlinear and complex Because ocean acidification has only recently been recognised as a problem caused by climate change, impact studies are still rare and estimates of the economic impact are absent.

Impact of shellfish production on water quality

Bi-alves shellfish act as filter feeders: they feed on the rejects of other fish and the excess nutrient in the water, thus cleaning the surrounding waters and reducing the eutrophication of coastal waters.

Challenge of linking research with industry

Whilst there is a strong link between research and industry in the USA when it comes to the acidification of oceans, this is not yet the case across Europe. In the USA, there are examples where oyster farms have been relocated to Hawaii following acidification of waters off Washington State and Oregon.

Existing initiatives

Centre for observation

A new international centre, based at the International Atomic Energy Agency Environment Laboratories in Monaco, will help coordinate international research and link science and policy.

Challenge for research

To spur technological innovation in ocean health, the X-Prize foundation announced the Wendy Schmidt Ocean Health X-Prize, challenging entrepreneurs across the globe to 'replace today's expensive, cumbersome and slow pH monitoring systems' with new systems, portable and easily deployable in any conditions

All studies regarding ocean acidification point to the same limitations:

- Lack of comparability among experiments:
  - Insufficient description of the carbonate system parameters or other environmental conditions.
  - Different pH scales
- Inadequate information about animal condition: problems when experiments are carried out with stressed animals.
- Discrepancies between the use of wild and cultured specimens, and in practices of pre-acclimation, where an organism is slowly acclimated to the stressor rather than responding to sudden exposure.
- For paleo-studies, a significant limitation is the mismatch between paleo and modern ecosystems.

Type of data need

There is a strong need to understand ocean acidification, and the impact it has on shellfish in order to predict and prevent further negative impact.

The data needed is on :

- the quality of the water column,
- the behaviour of the fauna and flora to the changes in acidity,
- past events and impacts (comparable paleo-data).

Although existing quality datasets present strong evidence for the change in pH associated with the decrease in CO2, they are **few and represent limited geographic types**.
Large-scale programmes, such as the Geochemical Ocean Section Study (GEOSECS), the World Ocean Circulation Experiment (WOCE), and the US Joint Global Ocean Flux Study (JGOFS), have given precise and accurate descriptions of the global carbonate system, but only in series of snapshots, and these cannot be easily used to deduce the long-term trend from short-term variation.

There is a need, therefore, for **more long-term series of these key parameters** in other areas.

As mentioned earlier, there is also a need for a better link between industry and research, to have an environment where results of research are freely available to aquaculture producers who wish to access it. Better coordination between industry and researchers could assist in research taking place at the production site, rather than under controlled

conditions in a laboratory.

Marine knowledge 2020

"Ocean acidification or changes in ocean salinity and dissolved oxygen will certainly have an impact on marine ecosystems and our ability to harvest from them. Earlier information will give industries such as that for shellfish aquaculture time to adapt."

"To support the development and dissemination of the knowledge base on adaptation, the Commission launched the European Climate Adaptation Platform, CLIMATEADAPT in March 2012, a publicly accessible internet site to support policy-makers in the development of climate change adaptation measures and policies at EU, national, regional and local levels. CLIMATE-ADAPT features a section on EU marine and fisheries policies, indicators of climate change and a database of adaptation case studies, in particular those from OURCOAST. The Commission is developing a proposal for an EU Adaptation Strategy, to be adopted in 2013.

A more structured approach to marine observations can deliver more accurate indicators of local changes in climatic parameters such as sea-level rise and ocean acidification to the CLIMATE-ADAPT platform and therefore help the adaptation process."

3. Innovative services and benefits

Current/ future services to be developed

Objective of the products / services

The objective of quality data could be twofold

- For shellfish producers to adapt to the changing conditions: with the data on ideal carbon dioxide conditions for growth for the larvae, the survival rate of the shellfish would increase.
- Since bi-alves shellfish act as filter feeding mechanisms, maybe they could help restore local water quality

Types of products / services

- A global observing network on ocean acidification, providing real time monitoring data on the state of the ocean and enables aquaculture producers to anticipate extreme events and take necessary measures to mitigate risk to production.
- An information platform for shellfish producers

Existing/ ongoing initiatives:

- Many different **research** projects :
  - The UK Ocean Acidification Research Programme (UKOA)
  - Biological Impacts of Ocean Acidification (BIOACID),
  - European Project on Ocean Acidification (EPOCA),
  - Mediterranean Sea Acidification in a changing climate (MedSeA)
  - U.S. Ocean Carbon and Biogeochemistry Programme (OCB).
- A **communication** project: The International Ocean Carbon Coordination Project is a communication and coordination service for the ocean carbon community, sponsored by UNESCO.
- A **restoration** project: the Szczecin lagoon has a heavily eutrophicated and degraded coastal ecosystem. An experiment was simulated focused on zebra mussels farming because they are efficient in removing nutrients and improving water transparency in the Oder Lagoon. Additional potential sources of income

such as water-quality tax or emission certificates were included. The simulations show that mussel farming in the lagoon is a suitable supportive measure and, at a load-reduction target of 50% or more, it is a cost-efficient measure for removing nutrients and for implementing the Baltic Sea Action Plan.

Economic benefit

Ocean acidification has been occurring for a very long time and is unlikely to recess very soon. Real time monitoring data available through an observation network would enable risks to be anticipated and mitigated. The economic benefit in finding how lower the risks for shellfish producers would be important, as the total European shellfish production averaged EUR 1 billion in 2010.[13]

Narita et al have estimated the economic costs of reduced mollusc production due to ocean acidification in the EU 15 and Eastern Europe at 543 million USD (total net loss assuming no income rise).

Other examples of services and benefits linked to the same type of data (other sectors, other services….)

To be completed

4. Data sources

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http://www.ocean-acidification.net/Symposium2008/ResearchPrioritiesReport_OceanHighCO2WorldII.pdf

Zebra Mussel Farming in the Szczecin (Oder) Lagoon: Water-Quality Objectives and Cost-Effectiveness, Gerald Schernewski, Nardine Stybel and Thomas Neumann

Interviews undertaken

JP Gattuso, Laboratoire d'Océanographie de Villefrance-sur-mer, Observatoire Océanologique

[13] Source : Eurostat

6.1.2 Better assessment of risk by insurance companies

Case 1: Insurance products from better marine security information

1. Case presentation: problem definition & opportunities
Overall context
Commercial shipping relies on current nautical charts for one key reason – time is money. Reliable charts provide the most direct routes between ports, reduce the number of pilots required, decrease the number of groundings, and reduce insurance rates. Maritime safety and insurance costs are inextricably linked. The structure of the global marketplace requires that goods and materials be delivered not only to the geographical location where they are required but also within a very precise timeframe. This can only happen if the mariners are using up to date charts. The risks from poorly produced charts are enormous. Accidents are not only undesirable outcomes in themselves; they also lead to the loss of lives. Lloyd's Register of Shipping estimates that between 1983 and 1992, 10,013 lives were lost either from collision or wreck resulted accidents.[14] A very good example of the attribution of poor charts to maritime accidents is the case of the Sea Diamond that sunk off the Aegean island of Santorini in April 2007.[15]

2. The need for marine knowledge in Europe
Current knowledge
The reduction of accidents through the use of good charts and provision of maritime safety information could contribute to the lowering of insurance costs, which is a major operating cost factor for shipping companies. Anecdotal evidence suggests ships using waters with little hydrographic survey information have a high insurance premium related to the risk. When transportation is subject to risk factors the cost of transportation and product is increased (Bryant pers com, 2009). It has been argued that "with the exception of Algeria, Namibia, South Africa, and parts of Egypt, Morocco, Mozambique and Tunisia, most ports, port approaches and critical areas in Africa need hydrographic surveys to be undertaken and upgrading of the aids to navigation. Some projects have been started but generally the confidence of the international shipping in the information available is low. It has been reliably established that insurance charges on cargoes and vessels trading with Madagascar is 20% higher than the norm."[16]
Existing initiatives
To be completed
Type of data need

[14] Alderton, P, (2004), Reeds Sea Transport: Operation And Economics, Fifth Edition, London

[15] Lloyd's list, http://www.lloydslist.com/ll/sector/cruise-and-ferry/article48685.ece

[16] Guy, N. (2006) "Capacity Building for Countries in Transition", Proceedings of the 25th Southern African Transport Conference (SATC)

Reliable nautical charts - to be completed
Marine knowledge 2020
N/A

3. Innovative services and benefits

Current/ future services to be developed
Through more reliable data in terms of nautical charts and maritime safety information, Insurance providers may be willing to offer products with reduced premium's resulting in lower insurance costs, which is a major operating cost factor for shipping companies.
Economic benefit
The following example shows the economic benefits in terms of reduced insurance costs resulting from the use of better data: USA company MICAD Marine LLC manufactures computer hardware and software, with its flagship product being the MICAD Marine System, a real-time marine data collection and management system which, in addition to information and diagnostics, includes satellite communication, vessel and fuel management, and permanent archival of vessel data on each individual vessel or an entire fleet of vessels. In 2005, MICAD Marine and the PIMSIC Group, an international established insurance firm, announced a new agreement to provide deeply discounted insurance products to MICAD Marine customers worldwide. Recognising the greatly increased safety, security and accountability of vessels equipped with the MICAD Marine System, PIMSIC Group made a decision to offer MICAD customers up to 20% off their current insurance costs, including protection and indemnity, protection of marine hull, machinery and cargo, and crew liability and personal accident.[17]
Other examples of services and benefits linked to the same type of data (other sectors, other services….)
To be completed

4. Main data sources

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MJ Information, (2005), "Be Safe, Save Money at Seawork", http://www.maritimejournal.com/comment-and analysis101/be_safe,_save_money_at_seawork
Interviews undertaken To be completed
Potential interviews to organise To be completed

6.1.3 Coastal tourism season

Case 1: Ecotourism

1. Case presentation: problem definition & opportunities
Overall context
There is a strong mutual dependency between coastal tourism and the environment. Hotspots of biodiversity are often tourism destinations and tourists require a healthy environment (e.g. clean water, clean air, unspoiled landscapes). Aspects like quality and health are very much linked to biodiversity and represent ways to explain the benefits of biodiversity. Though tourism industry actors aim for a longer season to increase their revenues, the negative impact of increased tourism on the environment must be mitigated. Biodiversity has been increasingly negatively affected by human activity. In Europe, like elsewhere in the world, biodiversity is deteriorating. 25% of marine mammals, 15% of terrestrial mammals and 12% of birds are threatened with extinction (EEA, 2010). Moreover, 62% of European habitats and 52% of European protected species included in the "Habitat" Directive have an unfavourable conservation status (EEA-ETC/BD, 2009). There is a strong need of cooperation of all players in coastal areas in order to develop a more sustainable tourism, which takes into account fauna, flora and tourists demands. This started a strong trend in the beginning of the 2000s towards the promotion of eco-tourism as a sustainable solution for tourism. Although the concept of eco-tourism is difficult to define, it does, however, have some consistent features: - The destination itself is usually an unpolluted natural area. - Its attractions are the flora and fauna, and its entire bio-diversity. - Eco-tourism should support the local economy and its indigenous atmosphere. - It should contribute to the preservation of the environment, and promote the importance of conserving nature. - 'Eco-trips' often include a learning experience.
Situation in Europe
The European directive on Habitats and Birds has created a network of Natura 2000 protected areas, both on-land and offshore. A wide range of data is collected by Member States to implement EU Directives such as the Water Framework Directive, the Bathing

Waters Directive, the Habitats Directive, and, most recently, the Marine Strategy Framework Directive.

This situation is good for more eco-tourism initiatives all across Europe, in order to highlight representative littoral ecosystems across the member states.

The annexes to the Habitats and Birds Directives list nine habitat types, 29 seabirds and 16 other marine animals in need of protection in view of their precarious conservation state. These include such well known species as the Mediterranean monk seal, the loggerhead sea turtle, and the bottlenose dolphin, as well as rare habitats such as cold water reefs and underwater prairies.

2. The need for marine knowledge in Europe

Current knowledge

Ecotourism is still considered as an alternative form of tourism, and has not been strongly advocated for as a solution for longer seasons of coastal seasons. Ecotourism destinations can be characterised with typically standalone tourism suppliers. Although competition can be useful, but often cooperation among such small operators yields significantly better overall results. Harmonising nature conservation and tourism is also an important condition of sustainability.

The habitat types and on-land animal species are known and identified, but the marine animals habitats are less known. In order to use the fauna and flora as main attraction for tourists, there is a need for more accurate instant and predictive data on each ecosystem.

Existing initiatives

There are many initiatives to develop ecotourism on the littoral of Europe, and to encourage the sharing of best practices in terms of research and management, whether on the Mediterranean coast or on the North Atlantic Coast.

<u>The Adriatic Coast</u>

Countries alongside the Adriatic Coast are trying to increase ecotourism on the coast. Italy has 21 National Parks, 99 Regional Parks, 332 Regional Reserves, 145 State Reserves, 47 Marsh reserves and 17 Marine Reserves, which are protected zones managed either by the State in some form - Regional Councils, Provincial Councils and Municipalities - or by the environmental and protection associations such as Italia Nostra, WWF, Lega Ambiente, Greenpeace, LIPU, Touring Club, etc. Slovenia hosts a natural reserve with a rich fund of marl and sandstone and the eighty-meter Strunjan cliff, a sanctuary for more than 150 bird species. In Croatia, 8 national parks and 11 natural parks protect the marine landscape and species.

<u>Archipelago Islands marine wilderness</u>

The park in Finland is an ensemble of 2000 rugged, rocky islands and forms the core of the great Archipelago Sea Biosphere Reserve, one of the largest archipelagos in the world. In it live colonies of grey and ringed seals, moose and small rodents, as well as white tailed eagles, the pride and emblem of the archipelago.

It is the first unique example of a marine wilderness. This is the only continuous marine zone in the Baltic Sea free of fishing. Strict rules of wilderness protection exclude visitors from this part but other areas of Archipelago NP - accessible if respecting certain rules - provide similar experiences.

Type of data need

For activities such as wildlife watching, in order to mitigate the negative impact of

increased tourism flow, a more precise knowledge of meteorology, water quality, coastal erosion is necessary.

- On the species and their habitats: for example, for underwater observation, the increased knowledge to predict where the fish, dolphins and sea mammals are more likely to be and less likely to be disturbed by tourists

- On the impact of tourism on the preserved habitat : with shared past observations on specific sites in Europe, the possibility to predict the future will be enhanced.

Marine knowledge 2020

"The reporting requirements of the Marine Strategy Framework Directive are the basis of the marine component of the Water Information System for Europe, WISE-Marine. Under Article 19 of the Marine Strategy Framework Directive, there is a requirement for Member States to provide access to data resulting from the assessments and monitoring."

3. Innovative services and benefits

Current/ future services to be developed

Objective of the services

Increase the quality of the "ecotourism experience" therefore allowing for a better economic development of the region

Protect the biodiversity on the coasts of Europe to insure a more sustainable tourism

Decrease the negative impact of tourism flows on the environment, both terrestrial and underwater

An important potential market: the example of Bird watching

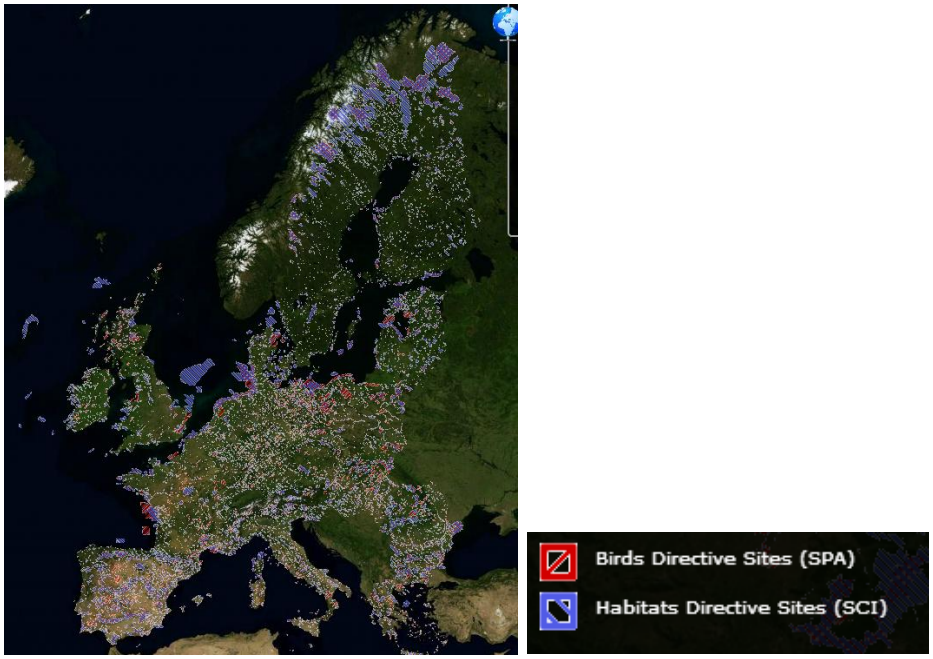
Different studies on bird watching prove that it is an important market: 51.3 million Americans claim to be birdwatchers. In the USA, in 2009, birdwatchers are estimated to spend over $2.5 billion each year. In the UK, expenditure is estimated at $500 million each year. Considering the diversity of birds on the European coast, there could be an important potential.

Types of services

Many different services could be developed:

- An information platform with data on the localisation of species, their natural habitats in order for constructors to be able to preserve the environment
- A European label for eco-tourism to be able to identify and reward sustainable travel agencies and tourism industry actor for their responsible approach toward tourism.
- Consolidated databases for tourists, to know the quality of water on the internet, similar to what is already being done in different places (e.g. http://www.izor.hr/bathing/bathing.html)

Existing/ ongoing initiatives



source : http://natura2000.eea.europa.eu

This map identifies all Natura 2000 sites across Europe. A great number of them are located on the coast, North Atlantic and Mediterranean basin alike, which increases the possibilities for coastal eco-tourism in Europe.

In Portugal

Since the 1990s, Azores has registered an increase in the number of tourists that come in search of a natural experience. A set of nine "Islands' Parks" has been created throughout the Azorean archipelago. These regions aim to protect Europe's remaining natural areas, in remote and isolated islands like the Azores. At the same time they are devoted to the practice of nature based tourist activities, and nature based tourism is in Portugal.

In order to evaluate, prevent and minimize the impacts resulting from the tourist activity in the Azores, a research project has been launched in the beginning of 2010 named, "Application of a model of sustainable tourism to areas of Natura 2000 in the Azores". So far the preliminary surveys conducted on the environmental perception of both tourists and nature based tourism enterprises, show that **some work has to be done on both sides in terms of environmental education, to prevent future environmental degradation that may compromise the fate of this kind of economic income.**

The Balearic Islands

The tourism sector on the Balearic Islands is sophisticated, and they are also a leader in the development of other tourist destinations worldwide. There are, however, negative aspects to all this development. The massive destruction of the coastline has yielded the term "Balearization". Domestic refuse production is twice Spain's average. The mean level of water tables has fallen 90 m in 15 years, and aquifers are at a mere 7% of capacity. Air pollution in Palma is twice that of Madrid. Altogether, the "ecological footprint" is equivalent to that of a much larger population on an enormously wider territory. And these problems are appreciated by tourists: 34% of all their queries relate to environmental questions. Those queries are indeed taken seriously, because current wealth is based mostly on tourism: 84% of Balearic GNP.

Economic benefit
Tourism is the third largest socioeconomic activity in the EU after the trade and distribution and construction sectors. There are some 1.8 million businesses, primarily SMEs, employing approximately 5.2% of the total workforce. Maritime tourism accounts for 3 million jobs. In 2004, ecotourism/nature tourism was growing globally three times faster than the tourism industry as a whole.[18] Taking the example of birdwatching tourism introduced earlier, Kerlinger and Brett[19] reviewed 5 studies of birding locations in North America and concluded that each would attract between 6,000 and 100,000 annual visitors, creating between USD 2.4 million and USD 40 million in economic impact. Furthermore, recent estimate by the Caribbean Whale Conservation Forum put potential income earned by a regional whale watching industry at about US$24 million a year.[20] These example show the strong economic potential for ecotourism in Europe.
Other examples of services and benefits linked to the same type of data (other sectors, other services….)
With more information on natural habitats, living conditions and localisation of species, there is a strong benefit for policy makers who will be able to do Maritime spatial planning with more information and less disruption towards sometimes endangered species.

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http://archive.defra.gov.uk/wildlife-pets/wildlife/protect/whales/documents/whale-watching.pdf

Potential interviews to organise

UN World Tourism Organization, Consulting unit on Tourism and Biodiversity

[18] World Tourism Organization, press release, June 2004

[19] Kerlinger, P. & Brett, J.J. (1995), Hawk Mountain Sanctuary: A case study of birder visitation and birding economics.

[20] http://archive.defra.gov.uk/wildlife-pets/wildlife/protect/whales/documents/whale-watching.pdf

Cathal O'Mahony, in charge of CMRC's Governance Group, Coasta Marine and Research Centre, Ireland,

http://reverse.aquitaine.eu/IMG/pdf/tourism_charter_web.pdf

Case 2: Artificial reefs – for surfing and environmental protection

1. Case presentation: problem definition & opportunities

Overall context

There is a strong mutual dependency between coastal tourism and the environment. Hotspots of biodiversity are often tourism destinations and tourists require a healthy environment (e.g. clean water, clean air, unspoiled landscapes). Aspects like quality and health are very much linked to biodiversity and represent ways to explain the benefits of biodiversity. Though tourism industry actors aim for a longer season to increase their revenues, the negative impact of increased tourism on the environment must be mitigated.

There is a strong need of cooperation of all players in coastal areas in order to develop a more sustainable tourism, which takes into account fauna, flora and tourists demands.

Artificial reefs can be seen as an innovative solution to increase sustainable coastal tourism through surf and diving revenues, as they can protect marine species and therefore also create potential dive and game fishing sites.

Situation in Europe

The situation is different according to each sea basin.

In the Mediterranean, though the underwater fauna and flora in Europe is highly diverse and a point of interest for both the environment and the tourism industry, the 1970s saw the beginning of a decline, which prompted many projects to save it.

Along the Atlantic littoral, the situation is different due to slightly colder water. Surf is more developed than diving, especially in Ireland, France and Galicia.

Two main artificial reefs in Europe illustrate this point

1) In Gibraltar, an artificial reef project was launched by divers who noticed a decrease in the diversity of the fauna and flora. The reef was built from 1975 to its latest addition in 2008. The project was adapted throughout the years to both environmental conditions (storms destroyed the reef in the first years) and European policies.

2) An artificial reef in Boscombe, Bournemouth, UK, opened in November 2009. The multi-purpose reef was expected to create waves up to 30% larger and double the number of surfing days annually. Construction on this reef began in June 2008, and was completed in August 2009.

2. The need for marine knowledge in Europe

Current knowledge

Artificial reefs have been created for surfing, coastal protection, habitat enhancement and coastal research.

Artificial reefs tend to develop in more or less predictable stages:

- First, where an ocean current encounters a vertical structure, it can create a plankton-rich upwelling that provides a reliable feeding spot for small fish, which draw in pelagic predators.
- Next come creatures seeking protection from the ocean—hole and crevice dwellers.
- Opportunistic predators also appear, waiting for their prey to venture out. Over months and years the reef structure becomes encrusted with algae, tunicates, hard and soft corals, and sponges

At Gibraltar, the artificial reef was built as an underwater scrapyard: initially experiments were tried with tyres chained together but sand movement and currents proved to be too strong and washed the articles away or buried them. Concrete polypods were tried but they also suffered from tidal force as did the tyres and proved too expensive. This was followed by sinking of cars and monitoring the effects of sealife upon them. Finally boats and barges were to be donated by the Gibraltar Port Authority and local marinas. These boats were thoroughly cleaned and emptied of all pollutants prior to sinking and every location mapped.

At Boscombe, the reef was built from large sand-filled textile containers, totalling 13,000 cubic meters. It was designed purely as a surfing break.

Existing initiatives

The reef in Gibraltar is monitored quite closely as it is the longest standing project of marine conservation in the Bay of Gibraltar, and a important point of passage for navigation purposes.

There are no initiatives for knowledge on artificial reefs

Type of data need

There is a need for more information on:

- Bathymetry and topography: how and where to place the wrecks
- Marine currents and meteorology: the strength that the reef will have to resist and the impact on current flows
- The quality of water, salinity: to know what kind of material to use in order to limit the impact on the quality of water and the fauna.

There is also the need to study the impact on coastal erosion: as artificial surfing reefs usually resemble a "submerged breakwater", proponents suggest benefits beyond surfing conditions. Many coastlines are subject to powerful waves that crash directly onshore. An artificial reef 150-300 yards offshore might create surfing opportunities and, by dissipating wave energy, make swimming safer and reduce coastal erosion.

Marine knowledge 2020

N/A

3. Innovative services and benefits

Current/ future services to be developed

Objective of the services

Create new touristic possible activities

Create new potential dive and game fishing sites

Types of services

Artificial reefs create new possibilities for diving, fishing, and as well as other nautical activities.

Existing/ ongoing initiatives:

The Gibraltar reef

The reef has proven stable and successful in attracting a diverse fauna and flora, which the tourist come to enjoy, though it is hard to quantify how many come specifically for diving purposes.

The Boscombe reef

The reef was successful in producing a new wave at Boscombe which was rideable for experienced surfers and boogie-boarders. But the new wave on the reef was significantly different to the waves that are available on the natural beach around the Boscombe Pier. It was less consistent than the neighbouring beach, when it had been hoped that the reef would increase the consistency of the surfing waves in the area. And the wave is more challenging than was first anticipated, breaking powerfully and quickly on take-off, making it difficult for even early intermediate surfers to enjoy the wave.

Economic benefit

Since surf is not yet considered as an important touristic activity, the impact of artificial reefs in Europe is hard to quantify.

In Boscombe, prior to the reef, it was estimated that there were 77 good surfing days, although surfing took place on 153 days, with a total of 5,000 surf visits to Boscombe per year. The intention was that the reef would double the number of good surfing days and it was hoped this would generate 10,000 visits. The original estimate for designing and building the reef was £1.4 million. The eventual cost was £3 million for the reef and a total of £11 million for the redevelopment of the seafront area and the refurbishment of the pier.

Outside Europe:

In 2002, an economist at Duke University tried to quantify the worth a popular surfing spot on Puerto Rico's northwest coast, to prove that the waves breaking on the beach constituted a multimillion-dollar asset and persuade the local town to take pains to preserve it. The economics of surfing is an offshoot of natural resource economics that seeks to quantify the worth of waves, both in terms of their value to surfers and businesses and their non-market value.

Other examples of services and benefits linked to the same type of data (other sectors, other services….)

- Environmental benefits of protecting new species.

4. Data sources

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http://www.dolphin-research.com/projectdetail.php?id=14

Potential interviews to organise

Dr Eric Shaw, Chairman & Head of Operations of "the helping hand", at the origin of the Gibraltar reef

The Helping Hand Trust/ 10, Queensway Quay/Gibraltar, Phone: +351-20073719 / Fax: +350-20073719

Case 3: Protection against coastal erosion

1. Case presentation: problem definition & opportunities

Overall context

With the development of coastal tourism, and the migration of human population towards the coast, coastal erosion has turned into a problem of growing intensity.

Among the problems most commonly encountered in Europe are:

- the abrasion of the dune system as a result of a single storm event, which in may result in flooding of the hinterland. This is best illustrated by the cases of Holland Coast, Wadden Sea, Rosslare, Hel peninsula, Sylt, Camargue, Vagueira, and Castellon.
- the collapse of properties located on the top of cliffs and dunes as documented in the cases of South Down, Luccombe, Normandy, Hyllingebjerg – Liseleje, Castellon, Vale do Lobo, and Estela
- the undermining of sea flooding defences as a result of foreshore lowering such as in Knokke-Zoute, Humber Estuary, Ystad, Chatelaillon, Sable d'Olonne, Donegal, or coastal marsh squeeze such in Elbe and Essex
- the loss of lands with economical value such as the beaches of De Haan, Sylt, Mamaia, Vecchia Pineta, Giardini Naxos, Sable d'Olonnes, and Ghajn Tuffieha, the farming lands of Essex or with ecological value such as the Scharhoern Island along the Elbe estuary.

Situation in Europe

All coasts in Europe are subject to coastal erosion.

3 case-studies illustrate the importance of coastal erosion in the last 20 years in Europe.

1) De Haan : North sea

De Haan is an important seaside resort in Belgium. The beach is therefore of great importance for the function tourism in this area. Erosion of the beach can threaten the tourist and recreational function. Furthermore, the function of urbanisation (safety of people and investments) was at risk because of the erosion. The beaches, partly built to

stabilise the dune belt, and the sloped seawall are a part of the coastal protection system and were threatened by the occurring erosion.

Surveys of the coastal zone in De Haan indicated a severe regression of the overall beach/dune profile from 1980 to the 2000s and particularly after the February 1990 storm a severe regression of the coast was observed. The beach had almost disappeared in the vicinity of De Haan and threats of flood became very real; even the sloped seawall foundation was eroded.

Erosion at De Haan occurs mainly after repeated storm surges and is enhanced by high water levels.

2) Isle of Wight : Channel

On the Isle of Wight, coastal erosion has led to coastal landslide problems, especially at Ventnor. The whole town has been built on an ancient landslide complex, and though present day coastal retreat is minimal, long-term erosion has helped shape a belt of unstable land which extends almost 1km inland, and 12km in length.

Contemporary movements within the town have been slight, but because of the high density of population (over 6,000 permanent residents), the cumulative damage to roads, buildings and services, and also to public and insurers confidence has been substantial.

3) Regione Marche in Italy

The Marche region in Italy is densely populated (565,200 people in a 959km2 area). Almost the entire coastal line of sand or gravel beaches is an important tourist destination, concentrated in the period of May to September.

Coastal erosion represents one of the most important factors of concern with regards to the stability of the economic system connected to the tourism industry.

Figure 1 : Length of coastline in the Aquitaine region concerned by assets exposed to risk due to an increase in coastal hazard

	Significant risk increase (km of coastline)	Drastic risk increase (km of coast line)	Significant risk increase (% of total coastline)	Drastic risk increase (% of total coastline)	Total risk increase per asset (% of coastline)
Agricultural	1 to 3	0 to 1	0.3 to 1%	0 to 0.3%	0.3 to 1.3%
Industrial	1 to 3	0 to 0.5	0.4 to 1%	0 to 0.1%	0.4 to 1.1%
Tourist	2 to 9	0.5 to 3	0.7 to 3%	0.3 to 1%	1 to 4%
Urban	10 to 38	3 to 7	3 to 13%	1 to 2 %	4 to 15%

Source: 'The economic impacts of natural hazards in coastal zones, taking account of the consequences of climate change', LIFE 03 ENV/UK/000611

2. The need for marine knowledge in Europe

Current knowledge

Coastal erosion is induced by both natural factors and man-made actions. Among the natural factors directly linked to coastal erosion:

- Waves: the breaking wave is the mechanical cause of coastal erosion in most of cases reviewed and in particular on open straight coasts such as those of Sussex,

Ventnor, Aquitaine, Chatelaillon, Holland, Vagueira, Copa do Vapor, Estella, Valle do Lobo, Petite Camargue, Marina di Massa, Giardini Naxos, Ystad, or Rostock.

- Winds participate in the landwards move of dunes (Aeolian erosion). This is particularly visible along some sandy coasts of those Aquitaine, Chatelaillon, Rosslare, and Holland.
- Tides: coasts along which the tidal range exceeds 4 meters, all along the Atlantic sea (e.g. Vale do Lobo in Portugal), are more sensitive to tide-induced water elevation than micro-tidal coasts (i.e. tidal range below 1 meter).
- Near-shore currents:
    - As an example, long-shore drift is responsible of removing outstanding volumes of sand in Vale do Lobo, Estela beach, Aquitaine, De Haan, Zeebrugge, Sylt or Jutland. Erosion induced by cross-shore sediment transport is best illustrated with the cases of Sable d'Olonne or Donegal.
    - As for tidal currents, their impact on sediment transport is maximal at the inlets of tidal basins or within estuaries such as in the cases of the Wadden Sea, the Arcachon basin, the Western Scheldt and the Essex estuaries. In some places, near-shore currents, and associated sediment cells, follow complex pathways as epitomised by the cases of Estela or Rosslare, or Falsterbo.
- Storms cause raised water levels and highly energetic waves. They can damage coastal infrastructure, and can cause beaches and dunes to retreat of tenths of meters in a few hours, or may considerably undermine cliff stability. A significant number of cases have reported extreme storm events that severely damaged the coast: De Haan and Holland (storm of 1976), Chatelaillon (1962, 1972, 1999), Cova do Vapo and Estela (2000), Normandy (1978, 1984, 1988, 1990), and Donegal (1999).
- Sea level rise also has a strong impact: though more severe in sheltered muddy areas (e.g. Essex estuaries), this phenomenon is known as a significant factor of coastal erosion in all regional seas: Atlantic Sea (e.g. Donegal, Rosslare), Mediterranean Sea (e.g. Petite Camargue, Messolongi, Lakkopetra), North Sea (e.g. Holland coast), Baltic Sea (e.g. Gulf of Riga), and Black Sea.
- Slope processes: a wide range of land-sea interactions which eventually result in the collapse, slippage, or topple of coastal cliff blocks. The cases of Luccombe, Birling Gap, Criel-sur-Mer (Normandy), Sylt, Cova do Vapor, Vale do Lobo are particularly relevant in that respect.

Existing initiatives

According to studies[21], coastal sediment processes is not often enough analysed by promoters of projects impacting coastal processes. There are few Environmental Impact Assessment (EIA) reports that address coastal sediment processes as a serious environmental impact.

The study mentions that EIA reports are still very difficult to obtain even after the administrative authorities in charge of project consent have approved them..

Type of data need

In order to prevent, and prepare an appropriate response to coastal erosion, there is a strong need to share all available information:

- On past observations,

[21] Living with coastal erosion in Europe: Sediment and Space for Sustainability, PART IV – A guide to coastal erosion management practices in Europe: Lessons Learned, Eurosion, 2004

- On current flows,
- On wind flows,
- On temperature of water,
- On topography,
- On bathymetry

Marine knowledge 2020

"Coastal authorities need knowledge of erosion rates, sediment transport and topography to determine whether protection, accommodation or retreat is the most appropriate strategy for managing shorelines."

3. Innovative services and benefits

Current/ future services to be developed

Objective of the products / services

There are many different innovative coastal defence systems that have been tested around the world

Types of products / services

- New products to protect the coast like Elastocoast. The revetment is plastic, and meant to resist environmental events. It is a joint research project between BASF Polyurethanes GmbH and the TU Hamburg-Harburg (TUHH): the suitability of the use of Elastocoast in coastal protection systems has been proven and the long-lasting stability under environmental influence has been demonstrated. In a further research cooperation with TU Delft and the engineering office ARCADIS (NL), additional tests and dimensioning procedures (GOLFKLAP) for the use of Elastocoast in accordance with international standards has been provided.
- Subsurface Dune Restoration System: a construction under the sand that protects the shape of the dune and protects the coast against erosion.
- Water/ sand inflatable emergency response devices : easy to inflate structures to reshape the coast in case of strong wind of waves.

Existing/ ongoing initiatives:

- Research: the European co-financed Theseus project's general aim is the development of innovative methods for mitigation of flooding and coastal erosion hazard in the context of increasing storminess and sea level rise.
  - Within coastal engineering, THESEUS is proposing for the first time to adopt wave energy converters for beach defence purposes. The distance from the shore at which the converters can be placed to obtain incident wave attenuation and at the same time maximize secondary benefits will be investigated.
  - THESEUS also aims to address the issue of coastline stabilization and of the volumes of sand needed for beach maintenance. Plans of dredging and nourishment operations, management of borrow areas, reactivation of the littoral drift, estimation of plume dispersion will be analysed.
- New technologies by BASF tested in both Hamburg and Ile de Ré among other places

http://www.polyurethanes.basf.de/pu/Coastal-Defense/Referenzprojekte/Hamburg

http://www.polyurethanes.basf.de/pu/Coastal-Defense/Referenzprojekte/Ile_de_Re

Economic benefit

Coastal protection is essential to preserve both the beach (tourism) and coastal infrastructure (roads, hotels, houses, etc.)

Isle of Wight

Over the last 100 years about 50 houses and hotels have had to be demolished because of ground movement. The total cost of landsliding in this area has averaged GBP 1.4 million from 1980 to 2000 in terms of structural damage, insurance costs, engineering measures and monitoring[22] .

Landslide management involves reconciling a number of conflicting demands, including reducing risk to vulnerable properties, important economic resources and facilities, and protecting areas of scenic, geological or ecological importance. It is important, therefore, that management decisions are based on the best possible understanding of landslide systems and the wider environment, and how to manage and protect it. Landslide management will generally involve a partnership between a wide range of interests, including planners, developers, insurers, environmental managers and the public, together with engineers and geoscientists.

Marche region, Italy

Coastal protection works defend approximately 100 km (58%) of the coastline from coastal erosion; excluding steep cliffs areas (the two natural parks) and harbours structures. Almost 70% (90 km) of the beach shoreline has been protected.

Many different types of coastal defences have been tested and built; principally rock armourstone located directly on the shoreline where built structures are at risk of flooding, but also offshore rock barriers with crests slightly above average sea level (preventing erosion) or slightly below the surface of the sea (to promote environmental maintenance) – in some locations the techniques have been combined, due to the changing design priorities through time.

The gross economic income, directly due to coastal tourism industries (hotel accommodation and beach services), has been carefully estimated at EUR 1,070.00 Million (12.3 Million people x EUR 87/each per day).

The Polish coast

Three sea level rise scenarios have been analysed in Poland: a rise of 30 cm, 60 cm and 100 cm between the years 2000 and 2100. The most likely scenario is thought to be a rise of 60cm. Based on this scenario for the whole Polish coastline (including both lagoons) the anticipated costs are as follows:

- If no measures were taken, the total area in risk of periodic inundation is nearly 2,200 km2, and potentially 120 km2 could be lost due to marine erosion.
- The estimated value of lost assets would amount to approximately EUR 90 billion, and approximately 178 thousand people would have to be relocated.
- Secondary costs related to relocation would be significant and would include for example, the generation of new work places (costing an estimated EUR 50 billion).
- Additionally, the value of assets at risk of periodic problems would amount to approximately 65 billion Euros and would affect approximately 108 thousand people.
- The effects of sea level rise would indirectly influence a further 1.5 million

[22] McInnes, R., Tomalin, D. & Jakeways, J. (2000b) LIFE-Environment Project: LIFE – 97 ENV/UK/000510 1997-2000 Coastal change, climate and instability: Final Technical Report. Isle of Wight Council, Isle of Wight, UK

inhabitants of coastal areas that border the primary areas of risk.
- Ecologically, there are 436 km2 of areas of outstanding natural value (European or nationally designated), within the area of risk, which would be destroyed or extensively damaged.

In an attempt to mitigate the above impacts of climate change, a long-term (50 year) coast protection strategy has been developed, which incorporates not only technical, but also land management, legal and organisational factors. The strategy indicates that the most appropriate measure to mitigate the predicted impacts of climate change is selective retreat. Selective retreat means that an appropriate level of safety is ensured for all valuable areas. However, even with the implementation of this strategy, approximately two thousand people may have to be relocated. The annual cost of implementing this strategy is estimated to be EUR 20 million during the first 10 years, EUR25 million during the next 15 years and EUR28-30 million during the last 25 years. These costs include all coastal defence measures, monitoring and research, but do not include the cost of relocation and of possible measures necessary in the hinterland area.

Other examples of services and benefits linked to the same type of data (other sectors, other services….)

Insurance

With more information on past and present coastal erosion , insurance companies will be able to:

- tailor the risk premium,
- create new insurance products,
- improve site selection location
- and improve infrastructure resilience

4. Data sources

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http://www.polyurethanes.basf.de/pu/Coastal-Defense

Potential interviews to organise

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6.1.4 Bio-economy discoveries

Case 1: Development of seaweed based products

1. Case presentation: problem definition & opportunities
Overall context
Many products can be seaweed based. Algae are proven to be a source of: nutrition, lucrative colloids, renewable energy, therapeutic health booster, food supplement for farm animals, organic manure, etc. All these and many other uses of seaweeds will demand continuous supply of good quality seaweeds raw material. The global industry turnover increased from US $6.2 billion in 1994 to US $7.2 billion in 2006[23]. Values have not been inflation-adjusted, but the trend is of increased volume and static turnover. It reflects the significant cost-reduction brought about by cultivation practices. There is a much larger amount of seaweed available and mechanized operations have improved productivity allowing lower market prices Marine biomass is attracting a great deal of commercial and political interest in particular as a feedstock for biofuel production. Researchers have discovered that algae have the capacity, through photosynthesis to convert CO2 into molecules that form the chemical basis of diesel duel. Biofuels based on marine algae have undergone large scale tests, but marine algae applications are still under development and their energy contribution over the next decade is likely to be modest. The data on the production (strain development, cultivation) of quality seaweed, and the use of algae as sources of energy or raw materials is still insufficient.
Situation in Europe
Seaweed exploitation in Europe is currently restricted to manual and mechanised harvesting of natural stocks, whereas the majority of Asian seaweed resources are cultivated. European seaweed production, at around 1,3% of world supply, is focused around Norway and France, with a significant contribution from Ireland.

2. The need for marine knowledge in Europe
Current knowledge
<u>On production and cultivation</u> Existing industries having large scale cultivation plants are located in Asian countries (China, Philippines, Korea, Indonesia, and Japan) and in Chile. The most common system in Europe to obtain seaweed biomass is by harvesting natural stocks in coastal areas with rocky shores and a tidal system. The natural population of seaweed is a significant resource. Another primarily natural source are drift seaweeds. The location and seasonal availability of these resources are unpredictable. It has traditionally

[23] Sustainable Energy Ireland: A Review of the Potential of Marine Algae as a Source of Biofuel in Ireland. 2009

been collected by coastal communities on a small scale to use as fertiliser or soil-conditioner.

The second possibility for seaweed biomass generation is through cultivation. Only a few genera have been commonly cultivated for many years. The seaweed harvested from natural stocks has decreased significantly, while cultivated seaweed has sharply increased.

Existing initiatives

In Europe, knowledge of seaweed cultivation is scattered across several R&D groups and a few industrial groups. The amount of cultivated seaweed is very low, mainly very small companies with local facilities for cultivating high value species.

Nonetheless, some projects exist:

For biofuel,

Shamash

The goal of the Shamash project is to produce biofuel from autotrophic microalgae. These organisms can accumulate fatty acids up to 50% dry weight. Their productivity is then 30 times higher than oil crops. The project involved 7 public research teams and a private company. A wide range of specialists were associated in the project: algae culture, physiology and metabolism, process design and optimisation, biofuels and lipids extraction and purification, engine testings.

Maersk and Navy Test Algae Fuel on Container Ship

Maersk Kalmar container vessel sailed in December 2011 from Bremerhaven, Germany to Pipavav, India, burning 30 tons of fuel derived from algae. A team of engineers from Maersk Line, Limited, Maersk Maritime Technology and Maersk Line ran the project from onboard. They tested blends of the fuel in one of the ship's auxiliary engines.

While the Maersk Kalmar does not sail under algae power yet - the energy produced only powered the ship's electronics-, the objective is for the main engine to also eventually run on algae fuel..

GreenStars
GreenStars is a collaborative project involving many actors in the micro algae industry in France. It aims at developing efficient biofuel based on microalgae and human activity outputs by 2020.

For biomaterials
The substances extracted from algae have been use in medicine:

- The collagen of the algae has been tested to improve medical adhesives
- The microalgaes have been useds as micro-factories to produce and assemble molecular components for scaffold manufacturing

Type of data need

- Data on cultivation of algae :
    - how to grow algae without consuming too much fossil energy in the process,
    - how to grow quality algae
    - how to create microalgae more suited to the needs
- Data on the location and availability of natural stocks

Marine knowledge 2020

The Energy Strategy 2020 states that the European Commission will promote energy research infrastructures including marine renewable energy, which is considered to have a great potential. The Energy Roadmap 2050 builds on the single energy market, the implementation of the energy infrastructure package and climate objectives as outlined in the 2050 low carbon economy roadmap.

3. Innovative services and benefits

Current/ future services to be developed

Objective of the services

Create new sources of renewable energy that is less polluting that fossil energy

Find new uses for algae other than biofuels

Types of services

- Create new algae that can be used as biofuel
- Cultivate algae efficiently
- Better knowledge of natural stocks seasonality and availability

Existing/ ongoing initiatives:

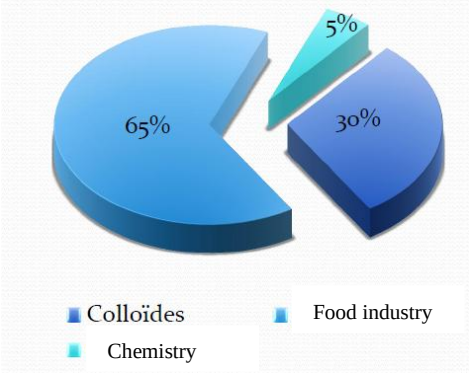
The SYMBIOSE project aims at developing a procedure to methanise microalgae that would allow the fixation of CO2 and the production of methane. The project brings together teams specialized in bacteria algae, ecophysiology of microalgae, bacterial fermentation as well as process modeling.

The Breizh'Alg project was set in place to develop a strong sustainable high quality algae production industry in Brittany, to develop the synergies with the shellfish production industry already in place.

Economic benefit

As seaweed is a commodity traded in the international market, **prices are subject to volatility**. This was particularly evident during the "seaweed price bubble" of 2008, when farm prices reached exorbitant levels and then collapsed in the course of a few months.

Figure 2 : Markets in 2008 (% volume)



Source: Algoculture 2011, Centre d'Etudes et de Valorisation des Algues

The potential of having a more stable cultivation process and a bigger outlet in the utilisation of the seaweed increases the economic benefits of more seaweed based products.

But given the two main potential markets that are **bioenergy and biomaterials**, the economic benefits of products based on seaweed are potentially very high.

Other examples of services and benefits linked to the same type of data (other sectors, other services….)

Developing aquaculture facilities in conjunction with off shore wind farms:

Anchorage of long-lines, ropes and rafts has been a major problem for pilot seaweed cultivation projects with numerous reports of structures being swept away by tides and currents. Sharing infrastructure with a wind farm or other offshore enterprise would seem to make economic sense from planning, design and operation points of view. The right conditions for cultivation of seaweed would need to be present.
➔A Dutch research centre carried out a 2 year analysis on the feasibility of offshore cultivation of seaweed species in the North Sea, using 1,000 km2 of offshore wind farm infrastructure envisioned by 2020. This considered chemical, biological and thermal processes for conversion of seaweed into energy products and platform chemicals..

Environmental impact:

- As seaweed act as integral biofilters, cultivated seaweed can improve the quality of water.
- The impact of seaweed farming goes beyond its economic benefits to communities as it reduces the incentives for overfishing

4. Data sources

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http://wwz.ifremer.fr/pba/Projets/Symbiose

Potential interviews to organise

Jean-Philippe Steyer - 04 68 42 51 51 ou Jean-Philippe.Steyer @ supagro.inra.fr, Scientific head of the GreenStars project in Montpellier

Jean Paul Cadoret, director, Laboratoire de Physiologie et Biotechnologie des algues, Ifremer

Case 2: Aquatic pharmacy

1. Case presentation: problem definition & opportunities

Overall context

Because of the physical and chemical conditions in the marine environment, almost every class of marine organism possesses the capacity to produce a variety of molecules with unique structural features. These molecules offer an unmatched chemical diversity and structural complexity, together with a biological potency and selectivity.

In recent years, the chemistry of natural products derived from marine organisms has become the focus of a much greater research effort. This is due in large part to the increased recognition of marine organisms as a source for bioactive compounds with pharmaceutical applications (antitumor, antiinflammatory, analgesia, immunomodulation, allergy, and anti-viral assays).

The fact that marine resources are still largely unexplored has inspired many scientists to intensify their efforts by using novel technologies to overcome the inherent problems in discovering compounds which may have potential for further development as pharmaceuticals or as functional products such as cosmetics, nutritional supplements and functional foods.

Situation in Europe

Much of this diversity is found in the macroscopic plants and animals that are adapted to all regions of the world's oceans (polar, temperate and tropical). Species diversity reaches very high densities on coral reefs, occasionally reaching densities of approximately 1000 species per square metre, particularly in the Indo-Pacific Ocean where tropical marine biodiversity reaches its peak.

Secondly, deep see organisms have unique adaptations that enable them to survive in cold, dark and highly pressurised environments. As a result of these unique environments, deep-sea species often produce chemical compounds that gained considerable attention due to their pharmaceutical and biotechnology potential.

2. The need for marine knowledge in Europe

Current knowledge

A number of clinically useful drugs, investigational drug candidates, and pharmacological tools have already resulted from marine product discovery programmes (see existing initiatives). However, despite noteworthy successes and the inherent promise of the ocean's vast biological and chemical diversity, marine biomedical potential has not yet matured into an economically significant field.

The clinical and commercial development of many marine natural products languishes because only a small percentage of marine biodiversity is known (e.g. it is estimated that less than 10% of reef biodiversity is known), and only small fractions of the known species have been explored as sources of biomedical compounds.

Marine ecosystems research has benefited greatly from the use of **genomic** (sequencing of axenic cultures) and **metagenomic** (sequencing of community DNA[24]) approaches. Genomics is the sequencing, annotating and interpreting information contained within the genome of an organism. DNA-based sequencing, originally developed in the biomedical field, has been quickly incorporated in the marine sciences. Current genomic methods enable researchers greater speed, sensitivity and resolution over the commonly used **molecular methods**.

The introduction of automated sequencing technologies has already led to a **massive increase of sequence data**. It should be noted that the amount of sequence data in the public data repositories has doubled every 18 months, and it is expected that this will significantly increase with the routine application of the next generation of sequencing technologies. Thoses **next generation sequencing technologies** (NGS) promise to overcome this gap in knowledge by providing information on the genetic diversity and potential function of the organisms on an unprecedented scale

Sequencing a genome or metagenomes has become a simple and relatively cheap component of any study. New third generation ultra-high-throughput **sequencing** technologies currently entering the market, promise even cheaper per base prices enticing researchers further to scale up their **sequencing** efforts.

Although the costs of sequencing has decreased, **the processing and analysis of the data mostly outcompetes the bioinformatic capacities of many researcher groups and institutes** in the marine field. In fact the new sequencing machines are described to bring what has been termed disruptive technology for scientists all over Europe (meaning that the rate at which it improves exceeds the rate users can adapt to the new performance). One of the reasons is that only in the US cyber-infrastructures have been developed to be

[24] With the diversity and sheer numbers of organisms collected, separating and individually sequencing one of each kind is impossible. To get around this, a metagenomic approach is used where all the DNA from all the organisms collected on one filter are sequenced together in a pool. Afterwards, the genomes for each organism are sorted out and assembled computationally. Of course, this means it is not always possible to identify which genome comes from which organism. However, just the analysis of different gene variations in different organisms is incredibly revealing.

able to cope with large-scale data analysis. The CAMERA system, in particular, was designed to meet the challenge of studying marine life and ecosystems for examining the genomic complexities of natural communities of microorganisms as they have evolved in their local environments. Further multi-purpose analysis pipelines in the US are IMG/M and MG-RAST. Although very useful also for European researchers, they do not provide the capacities, flexibility and a higher level of data integration framework that is needed to complement the ecosystems expertise of marine ecologists with appropriate bioinformatic approaches, finally widening the gap between technology providers and field researchers.

Secondly, it is still important **not to waste efforts on redundant genomic projects**. To reduce the duplication of effort, the sequence data and the databases and tools that allow the scientists to analyse and utilise the data must be maintained and made accessible.

Genomic studies are not always hypothesis driven; their fields are exploratory. The technology enables scientists to generate data from which hypotheses can be formulated and tested. This exploration activity should be considered an asset because of its potential to increase our knowledge base, and it should not be considered a liability, particularly in the review of proposals incorporating genomics technologies. It is important to make certain, however, that **genomic data are publicly available, and in a useful form so that the data can be used for hypothesis-driven research.** Therefore, it is important that genomic databases be developed, maintained, and made available as research tools.

Existing initiatives

Currently there are around 15 marine natural products in various phases of clinical development, mainly in the oncology area, with more on the way. It is now almost five decades since spongothymidine and spongouridine were isolated from the marine sponge Tethya crypta which eventually led to the development of Ara-C used against leukemia and Ara-A for treating viral infections (FDA approval 1969/1976).

However, it was not until 2004 that the next marine natural product ziconotide (PrialtR) was approved followed by trabectedin (YondelisR) in 2007, both of which were commercialised by European companies (Prialt by Elan, Ireland and Yondelis by Pharmamar, Spain).

Type of data need

Throughout Europe, researchers in the field of biodiscovery utilise a vast array of methods and protocols to obtain, extract and fractionate bioresources and interact in a variety of ways with screening facilities. If this resource could be harnessed and utilised efficiently through the use of common protocols and procedures, it would be a powerful adjunct to Europe's pharmaceutical and functional product industry.

Type of data that would be useful:

Biobanks : type, organism focus, taxonomy of organisms, amount available, format (preserved, freeze dried, chemical extract, DNA, strain) and any residual ownership/IP rights associated.

Extract libraries: origin of extracts, preparation format, complexity, known activities and any residual ownership/IP rights associated.

Compound libraries: origin of compound, structure, format, known activities and any residual ownership/ IP rights associated.

Screening facilities: targets and validation, types of screen, format, presentation of extract/compound libraries required, volume of testing possible at facility, how results

should be interpreted and facility for validation and follow-up testing of actives.

Greater simplification could be attained if these facilities could agree on a common set of standards for the preparation of extracts and libraries that can be used in the majority of screening formats, as well as a common format for data exchange.

This could include: the use of common extraction procedures giving drug-like purified extracts; accepted concentrations of pure compounds and assay-plate format; common presentation of data for the screening facility; common reporting format of screening data; and procedures for prioritising hits.

Capability to carry out validation of hits and conduct follow-up studies to translate a hit into a lead or products is also a necessity.

Marine knowledge 2020

To be completed

3. Innovative services and benefits

Current/ future products to be developed

Objectives:

Develop marine bases pharmaceuticals.

Types of product :

- Anti-cancer drugs
- Treatments of Alzheimer's disease
- Prevention of cancer
- Tissue rebuilding

Existing/ ongoing initiatives:

While at least one-half of all therapeutic drugs on the current market are now derived from terrestrial organisms, we can expect many new drugs to be developed from marine organisms in the coming years. These drugs will be used as pharmaceuticals, nutritional supplements, biocides, cosmetics and other life-saving and life-enhancing products (Bruckner, 2002).

Two compounds isolated from deep-sea sponges are in human clinical trials, and several other promising compounds and applications, resulting from research on deep-sea sponges and corals, are in early stages of development.

Coral reef species (e.g., algae, sponges, soft corals, sea slugs) have already been used in the development of anti-cancer and anti-tumor drugs, painkillers, and anti-inflammatory agents.

- German and American researchers have successfully sequenced the genome of **Lyngbya majuscula** (L. majuscula), a tropical marine organism able to generate substances that can be used in the treatment of human disorders including neurodegenerative diseases and cancer.
- **Discodermolide.** Scientists from Harbor Branch Oceanographic Institution isolated discodermolide from the sponge *Discodermia dissolute* found off the coast of the Bahamas in water over 460 feet (140 m) deep. Discodermolide recently completed the early stages of clinical trials and is one of the most exciting compounds to date because it may treat cancers which were resistant to other drugs (Ter Haar et al., 1996).

- **E7389.** This compound comes from the sponge *Lissodendoryx* sp., which lives in New Zealand waters at depths of 330 feet (100 m). E7389 is being tested for the treatment of lung cancer and other cancers and is currently undergoing the early stages of clinical trials (Newman and Cragg, 2004).
- **Dictyostatin-1.** Harbor Branch scientists collected a sponge from the order Lithistida (family Corallistadae) at 1,450 feet (442 m) off the northern coast of Jamaica. Dictyostatin-1 was isolated from this sponge and may be more effective than the very successful anti-cancer drug Taxol (Isbrucher et al., 2003). Harbor Branch researchers are continuing work on this promising substance.
- **Topsentin.** This is one of the only deep-sea compounds that researchers are currently investigating for noncancer related treatments. Isolated from the sponge *Spongosporites ruetzleri*, which lives at depths of 990- 1,980 feet (300-600 m), this compound shows promise as an anti-inflammatory agent to treat arthritis and skin irritations, as well as for the treatment of Alzheimer's disease and to prevent colon cancer (National Research Council, 2002).

Economic benefit

- Societal benefits of effective drug therapy to treat human diseases.
- Improving and making treatments more accessible to population.
-

To be completed

Other examples of services and benefits linked to the same type of data (other sectors, other services….)

To be completed

4. Data sources

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Interviews made

To be completed

Interviews to organise

To be completed

6.1.5 Other sectors

Case 1: Seabed mapping and mineral resources

1. Case presentation: problem definition & opportunities

Overall context

The international seabed area covers more than 50 per cent of the world's surface. It includes all the seabed areas beyond the 200-mile-limit exclusive economic zones of every country around the world. The ocean floor is so far a largely unexploited resource, due to technical, environmental and political constraints.

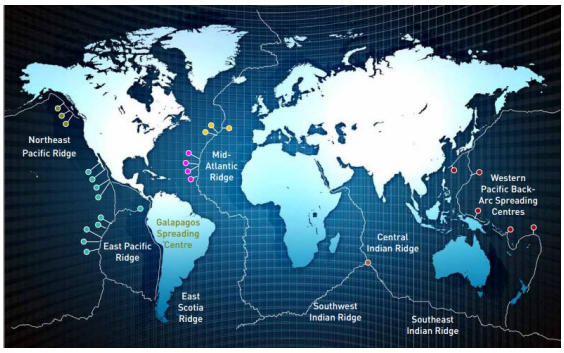
Mineral-related activities are highly diverse. Prospecting may target polymetallic nodule deposits and sulphides on the ocean floor or minerals embedded in cobalt-rich crusts. Mining may take place in depths of up to 6,000 metres and along biologically rich ocean floor areas, such as seamounts and hydrothermal vents.

The first commercial deep sea mining operation was agreed on by the government of Papua New Guinea in 2008, though the actual mining has yet to start. Canadian mining company Nautilus Minerals Inc. (Nautilus) with the mining project, known as the Solwara 1 project, will extract gold and copper from the floor of the Bismarck Sea in Papua New Guinea.

There is a high level of uncertainty about the risks posed by deep sea mining to marine environments and to communities. What is certain is that impacts will be associated with each step of the mining process.

Situation in Europe

Figure 3: Location of hydrothermal systems and polymetallic sulphide deposits. Credit Natalie Lowrey



Source : OUT OF OUR DEPTH, Mining the Ocean Floor in Papua New Guinea, Helen Rosenbaum, 2011

The location of hydrothermal systems and polymetallic sulphide deposits is mostly situated at the junction of the 9 tectonic plaques around the world, which means most are in international waters. That is the main reason for the International Seabed Authority to be leading most discussions and research on the topic.

2. The need for marine knowledge in Europe

Current knowledge

Deep-sea hydrothermal vent systems attract considerable interest from commercial mining companies: vent systems precipitate seafloor massive sulfide (SMS) deposits that are rich in copper, gold, silver, and zinc. Although commercial firms are targeting inactive SMS deposits, these deposits are so little studied that it is unknown whether they harbour unique species or ecosystems.

The new frontier of deep-sea exploration and mining raises a number of questions about the sustainable use of these resources and potential environmental impacts.

Technologies to effectively map the seabed are just emerging, are expensive, and are changing and improving rapidly

Existing initiatives

There are 3 projects led by the International Seabed Authority.

Kaplan Project: Analyzing Biodiversity, Species Ranges and Gene Flow in Nodule Areas of the Seabed

This project was a successful attempt to analyze species composition and rates of gene flow of living organisms across the abyssal plains of the Clarion-Clipperton Zone in the Central Pacific Ocean. The Kaplan Project is also an excellent example of how collaborative marine scientific research is being used by the International Seabed Authority to minimize the risks of mining activities to deep-sea biodiversity in this Zone. Scientists set out to evaluate the biodiversity of three key faunal groups by determining levels of species overlap in sample areas and estimating numbers of species at 'stations' spaced out over areas across the CCZ. The sample groups represented a broad range of ecological and life-history faunal types and, combined, they constituted a high percentage of species abundance and richness in abyssal sediments.

Before the project, there was very limited knowledge of the **number of species** residing within the nodule-rich areas and the typical geographic ranges of these species. This made it extremely difficult to predict the threat of nodule mining to biodiversity and, in particular, the likelihood of species extinctions within areas that would potentially be perturbed by single mining operations

CenSeam Project: Assessing Biodiversity Patterns on Seamounts to Identify Knowledge Gaps

The International Seabed Authority partnered with CenSeam (Census of Marine Life on Seamounts, which is part of the Census of Marine Life programme) to assess the patterns of biodiversity on seamounts and the factors that determine these patterns, in order to identify the gaps in current knowledge and encourage collaborative research initiatives that will address them.

Seamounts are undersea mountains, often of volcanic origin, that feature prominently in the world's underwater topography. Seamounts may be hotspots of biodiversity and play an important role in patterns of marine biogeography. Often highly productive ecosystems for fish, marine mammals and seabirds, seamounts are also of potential interest for deep-seabed mining. The long-term effects of prospecting and potential impacts of mining, however, are vastly understudied. The number of seamounts over 1 kilometre high has been estimated at more than 100,000 and there are many more with smaller elevation. Relatively few seamounts have been studied; about 350 have been sampled, and less than 200 of these have been sampled in any detail. As a result, the biodiversity of most seamounts on a global scale is poorly known

Geological Model Project: Metals of Commercial Interest in Polymetallic Nodule Deposits of the Clarion-Clipperton Zone

The Geological Model is a comprehensive representation of the quantity, distribution and metal content of polymetallic nodule deposits in the Clarion-Clipperton Zone. It provides exploration entities under contract with the International Seabed Authority and future mining prospectors with a detailed mineral resource assessment in the Zone. It also contributes to scientific knowledge of how these deposits form and the marine variables that may contribute to nodule formation and abundance.

While nodules have been found in all the world's oceans, and even in some lakes, their abundance and distribution in certain areas of the ocean are more economically interesting to mining prospectors. The Clarion-Clipperton Zone in the Pacific Ocean, for example, has the largest known deposits of deep-seabed polymetallic nodules.

In March 2001 a geological model of the polymetallic nodule deposits in the Zone was developed. This collaborative project was led by a group of technical experts, in partnership with the Secretariat of the International Seabed Authority, and scientists. The resulting model predicts the geographical distributions of nodule metal content (manganese, cobalt, nickel and copper) as well as abundance (kilograms of nodules per square metre of the seafloor), using data of other known variables on the seabed and in the water column of the CCZ.

Type of data need

- Data on **seabed substrata** are needed to plan the extraction of aggregates or hydrocarbons,
- Data on the sealife (fauna and flora) that lives in the deep and how they behave to assess the impact
- Data on the current flows, the water column, etc. to design the less possible invasive instruments for the actual mining

Marine knowledge 2020

The Marine knowledge 2020 initiative includes a flagship project to prepare a seamless multi-resolution digital seabed map of European waters by 2020:

"It should be of the highest resolution possible, covering topography, geology, habitats and ecosystems. It should be accompanied by access to timely observations and information on the present and past physical, chemical and biological state of the overlying water column, by associated data on human activities, by their impact on the sea and by oceanographic forecasts. All this should be easily accessible, interoperable and free of restrictions on use. It should be nourished by a sustainable process that progressively improves its fitness for purpose and helps Member States maximise the potential of their marine observation, sampling and surveying programmes."

3. Innovative services and benefits

Current/ future services to be developed

Objective of the services

Develop commercial deep sea mining

Develop our understanding of the seafloor ecosystem

Types of services

To be developed

Existing/ ongoing initiatives:

Japan's Natural Resources and Energy Agency will commission Japan Oil, Gas and Metals National Corp (JOGMEC) to develop robotic deep-sea mining technology to evacuate minerals, which will then be piped to a support ship on the surface.

Economic benefit

The economic benefit is difficult to evaluate:

- Though there is a glut of copper, the metal that probably has to cover the cost of any massive-sulphide mine, leaving gold or some other more valuable metal to provide the profit. In 2008, the industry produced 360,000 tonnes of copper that turned out to be unwanted.
- Plenty of land-based deposits still remain to be exploited. Anglo American alone produces on land as much copper as the likely output of 100 massive-sulphide mines. As for gold, a tonne of old mobile phones contains about three times as much of it as a tonne of typical ore, even though recovery may be problematic.
- The risks of working in a place where volcanic activity seems to have stopped but may suddenly resume are uncertain. So indeed are the possible obligations to repair the underwater environment: no legal codes are yet in place for deep-sea mining. That helps to explain why the only places in which companies have dipped more than a toe in the water are in exclusive economic zones, which are not just shallower than many parts of the distant ocean but also within the legal ambit of a national authority.

Other examples of services and benefits linked to the same type of data (other sectors, other services….)

Data on the seabed should help :

- ensure secure foundations for wind turbine platforms,
- assess the impact of fishing,
- reduce uncertainties for maritime navigation

The same data on marine habitats can be used to assess the impact of a new facility or to report on the state of the environment

4. Data sources

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Potential interviews to organise

Yves Guillam, SHOM

7 Benefits resulting from a reduction in uncertainty

Another objective of the study is to identify how reduced uncertainty due to improved knowledge can have positive economic benefits on marine industries and for the public authorities. It relates to question 16 of the Terms of Reference which asks for the contractor to:

> *"provide three more examples of the economic benefits of reduced uncertainty in the behaviour of the sea or the state of the seabed and marine life".*

This section presents a number of case studies developed to provide specific examples of economic benefits that could be realised through a reduction in uncertainty regarding the oceans and seas.

The structure of these case studies has been organised as follows:

- Case presentation: problem definition and opportunities : explanation of context and situation in Europe and internationally
- The need for marine knowledge in Europe: explanation of the current state of knowledge in the area, any existing knowledge/research initiatives, the types of data that may be needed to realise the benefits, and the connection to Marine Knowledge 2020
- Data sources, bibliography, and list of potential interviews to undertake

The case studies have been produced following a thorough documentary review of existing and past initiatives, projects and research papers; and where possible, the opinion of an identified expert in the field to validate the analysis and provide feedback.

The table below summarises the case studies. It provides an indication of the level of completion for each example, as well as the next steps required to achieve finalisation. Some examples are yet to be identified, and these are mentioned later in this section.

Table 7-1 Case studies on examples of benefits resulting from a reduction in uncertainty

Title	Status	Next steps
Optimisation of turbine foundation design for offshore wind	Case study fully developed, expert identified and contacted	Obtain written/telephone feedback from expert and make final changes
Protection of cables for offshore wind	Case study fully developed, expert identified and contacted	Obtain written/telephone feedback from expert and make final changes
Site accessibility to optimise operations and maintenance for offshore wind	Case study fully developed, expert identified and contacted	Obtain written/telephone feedback from expert and make final changes
Better assessment of energy yield	Case study fully developed, expert identified and contacted	Obtain written/telephone feedback from expert and make final changes
Hydrographic data to assist optimising ship navigation routes	Case study fully developed, expert identified and contacted	Organise telephone call with expert to obtain feedback and make final changes

Summary of findings

Detailed case studies for the examples identified are provided in the subsequent sections. The table below summarises the findings of these case studies, in terms of the importance of marine knowledge/data and a demonstration or estimation of the economic benefits. Improved marine knowledge, whether it be through better sharing of datasets on past and present events, improved coordination of research efforts, or other types of specific phenomena, can bring potentially significant economic, social and environmental benefits. These benefits can be realised through the mitigation of risks and negative impacts, or through a reduction in uncertainty regarding the state of the oceans and seas.

Table 7-2 Case studies on examples of benefits resulting from a reduction in uncertainty

Title	Importance of marine knowledge	Economic benefits
Optimisation of turbine foundation design for offshore wind	Need for available measured data from experimental offshore installations to validate existing models. Data is needed on different support structures and turbine technologies. Need for quality time series data on sea-state parameters, currents, sea surface elevation, also soil characteristics.	Cost effective design optimisation of turbine foundation installed more economically. An example in the UK showed minor design changes could lead to significant savings in construction schedule and costs.
Protection of cables for offshore wind	Uncertainties would be reduced through better sea-bed data: seabed mapping systems that accurately chart depth, topography, slope angles and seabed type.	Optimisation of cable protection will reduce risk of damage in long term, reduce costs in installation phase, as well as costs for ongoing maintenance. In 2012 a technical fault in cabling in a UK wind farm

		resulted in a total cost of €5.6 million. The benefits of protective systems are obvious given that while cables make up 8% of investment, 80% of insurance enquiries refer to these systems.
Site accessibility to optimise operations and maintenance for offshore wind	Actual weather conditions, forecasts of wind and sea state to optimise operations and maintenance.	Better accessibility results in reduced downtime losses, avoidance of energy production losses and thus revenue losses, and potentially prevention of costly future repairs.
Better assessment of energy yield	Information required includes wind data, air intensity, turbulence intensity, topography, in order to provide accurate wind energy estimations.	A better assessment of energy yield will have a positive impact on the investment case, resulting in more confidence in project financing, reduction in cost through optimisation of site selection, and crease in potential production.
Hydrographic data to assist optimising ship navigation routes	High resolution access to seafloor morphology and texture, covering topography, bathymetry, geology, etc	ROI of a national hydrographic program in Canada was estimated as 1:10. Improved charts enable cost reductions through faster transit for ships, more direct routes, reduced insurance costs, avoidance of maritime accidents.

7.1 Case studies on the benefit of reducing uncertainty

7.1.1 Case 1: Hydrographic data to assist in optimising navigation routes of ships

1. Case presentation: problem definition & opportunities
Overall context
Hydrography deals with the measurement and description of the physical features of oceans, seas, coastal areas, lakes and rivers, as well as with the prediction of their change over time, for the primary purpose of safety of navigation and in support of all other marine activities, including economic development, security and defence, scientific research, and environmental protection. The International Hydrographic Organization (IHO) is an inter-governmental consultative and technical organization, governed by an international Convention. Established in 1921, the IHO is a competent international organization, as referred to in the United Nations Convention on the Law of the Sea. It primarily supports the safety of navigation and the protection of the marine environment, and coordinates on a worldwide basis the setting of

standards for the production of hydrographic data and the provision of hydrographic services in accordance with the SOLAS Convention.

Over 90% of international trade is transported by sea. A fundamental requirement for the safe transportation of goods is adequate nautical charting. Yet despite this massive reliance upon sea transportation many areas and regions do not have adequate cartographic coverage.

The IHO maintains a publication, C-55, on the IHO website that aims to detail and describe the current status of Hydrographic surveys for each maritime state. Many IHO member states are tasked with collecting nautical information and surveying international waters that would otherwise remain uncharted. However, it is often the case that hydrographic officers only learn by accident of surveys that have been performed by private companies.

Improved knowledge of hydrography through better access to data and information will positively benefit safety of navigation and protection of the marine environment, among many other benefits, such as National infrastructure development, Coastal zone management, marine exploration, resource exploitation and disaster prevention and response.

Navigational routes are determined based mainly on the bathymetric characteristics of the area. Routes must provide ships a safe clearance and sufficient manoeuvring area for the operations, especially in restricted waters, due to the narrow of the passages, the existing depths and currents. Nautical charts, representing all the required hydrographic information for this purpose, is considered to be main aid to navigation.

Most marine accidents, (groundings in particular) are the result of operator error. Approximately 25% of all serious ship accidents occur in coastal waters or during harbour approach. Of these, greater than 75% result from insufficient information, mistaken interpretation or assessment, and lack of timely preventative action.[25]

In addition, 70% of all marine insurance claims are related to navigational incidents, which again add to indirect costs in the form of additional premiums, call money etc. Enhanced safety thus also means lower costs.[26]

Situation in Europe and internationally

The EMODnet-Hydrography portal provides hydrographic data collated for a number of sea regions in Europe:

- the Greater North Sea, including the Kattegat and stretches of water such as Fair Isle, Cromarty, Forth, Forties,Dover, Wight, and Portland
- the English Channel and Celtic Seas
- Western Mediterranean, the Ionian Sea and the Central Mediterranean Sea
- Iberian Coast and Bay of Biscay (Atlantic Ocean)
- Adriatic Sea (Mediterranean)
- Aegean - Levantine Sea (Mediterranean).

The portal development started in June 2009 and the provision of bathymetric data products has been available to users since June 2010. The second year's activity consists of gathering more data sets and metadata and producing enhanced data products. The second release of the portal will also be provided with additional functions (user defined

[25] Hecht, H., Berking, B., Buttgenbacj, G.,Jonas, M., Alexander, L (2002), The Electronic Chart, Functions, Potential and Limitations of a New Marine Navigation System, GITC

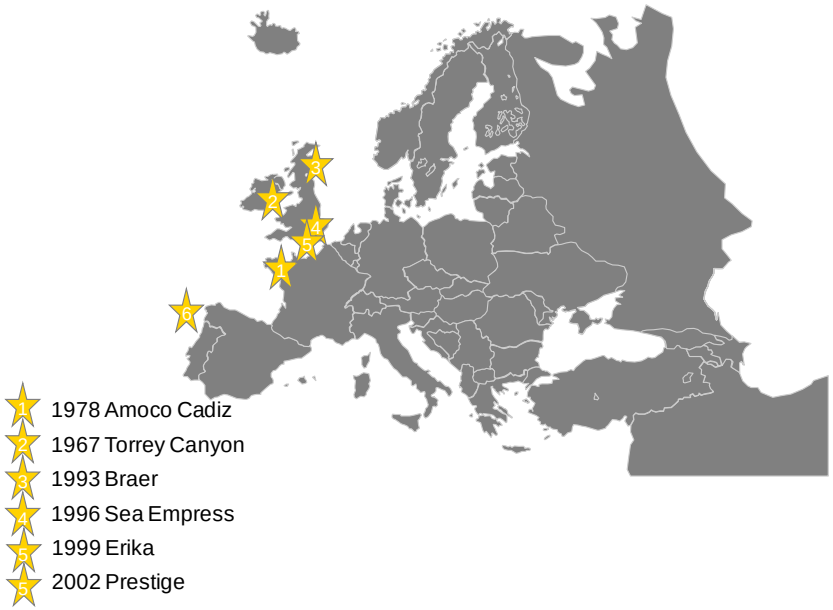
[26] Hydro International, (2011), "Paperless Navigation – Better Now Than Later", January-February 2011, Volume 15, Number 1, http://www.hydro-international.com/issues/articles/id1237-Paperless_Navigation__Better_Now_Than_Later.html

transects, metadata per grid cell). The third (and last) year of the project will be the maintenance phase of the project.

However, according to IHO's latest version of the C-55, there are still large gaps in major international shipping routes in the Indian Ocean, South China Sea, Western Pacific and adjacent waters. In the Caribbean, some coastal waters of Africa, Australasia, Oceania and the Antarctic, modern surveys, metrication and datum shift to WGS 84 are all urgent requirements in locations which are now frequented by cruise liners.

Where charting is inadequate, shipping companies will deploy a fleet that is older, less efficient and capable, and more likely to be involved in a maritime accident due to the age of the equipment and competence of the crew.[27]

Figure 4 : Major tanker spills in Europe



Source: http://news.bbc.co.uk/2/hi/europe/2491317.stm

In the last 50 years, there have been significant oil tankers accidents in Europe and around the world (1979, Atlantic Empress, Tobago; 1989 Exxon Valdez, Alaska) which argue the need for a better cartography of the seabed for a safer navigation.

2. The need for marine knowledge in Europe

Current knowledge

The IHO's mission is to facilitate the provision of adequate and timely hydrographic information for world-wide marine navigation and other purposes through the co-ordination of the work of national hydrographic offices.

Through Regional Hydrographic Commissions, there is regional coordination of nautical information, hydrographic surveys, production of nautical charts and publications,

[27] Brinkman, G. L., and S. L. Caverley. (1992) "Benefit-Cost Assessment of the Canadian Hydrographic
Service"; Report prepared by Intercambio Limited for Canadian Hydrographic Survey, Ottawa

training, technical cooperation, and hydrographic capacity building projects.

A key work goal is to achieve global coverage and availability of high quality official hydrographic data, information, products and services necessary for safety of navigation at sea and for non-navigational uses, e.g. by means of the developing spatial data infrastructure.

The third edition of IHO Publication No. 55 (C-55), last updated in September 2011 presents a clear picture of the worldwide coverage of surveys and nautical charts and of the extent of effective organisations for the timely promulgation of navigational safety information. The data base covers the waters of 90% of the coastal states of the world.

Significant progress has been made in some areas of great importance to international shipping and to the protection of coastal environments. This has mainly resulted from the firm requirements laid down by the IMO before ships routeing systems can be approved. There is also encouraging evidence of regional co-operation to provide modern coverage of maritime shipping routes.

However regional studies indicate that there is a lack of up to date charting and hydrographic survey data in many developing maritime areas. It is most likely that some hydrographic surveys undertaken do not meet the required international specifications, or the data is restricted or lost.

The UK Hydrographic Office's mariner's handbook suggests that "before using a chart to plan or navigate a passage, mariners should make themselves aware of the quality of the survey data that has been used to place the soundings and contours on the chart, since not all sea areas have been surveyed to modern standards or even systematically surveyed at all. Indeed large areas of sea, especially in offshore areas, have never been systematically surveyed to any standard".

Data needed

To obtain a high resolution access to the seafloor morphology and texture, data should cover:

- topography,
- geology,
- hydrography,
- bathymetry,
- habitats,
- ecosystems,
- the physical, chemical and biological state of the water column,
- the impact of human activities on water and on the environment

In order for the data to have an impact, it should be easily accessible, interoperable and free of restrictions on use. It should be nourished by a sustainable process that progressively improves its fitness for purpose and helps Member States maximise the potential of their marine observation, sampling and surveying programmes.

Marine Knowledge 2020

The Green Paper on Marine Knowledge notes the vision for a seamless multi-resolution digital seabed map of European waters by 2020.

- highest resolution possible in areas that have been surveyed;

- free of restrictions on use;
- topography, geology, habitats and ecosystems;
- accompanied by timely information on
  - physical, chemical and biological state of the overlying water column
  - oceanographic forecasts;
- together with a process that helps Member States maximise the potential of their marine observation programmes

The European Commission launched the European Marine Observation and Data Network (EMODnet) in 2007 for the Marine Strategy Framework Directive. The overall objective is to create pilots to migrate fragmented and inaccessible marine data into interoperable, continuous and publicly available data streams for complete maritime basins. The results will help to define processes, best technology and approximate costs of a final operational European Marine Observation and Data Network.

3. Benefits

Economic benefit

The economic impacts of hydrography and bathymetry on safety of navigation have been studied for a number of years. A Canadian Study in 1992 has estimated the return on investment from having a national hydrographic program in the order of 1:10.[28] Given this cost/benefit ratio, countries should have an incentive to properly chart their waters.

Improved charts may allow for faster transits of ships with deeper draughts, resulting in a greater amount of goods moving through navigational choke points and ports. Hydrography and bathymetry are equally needed to support the development of strategies to sustain and protect ocean resources.

The economic profitability of commercial shipping relies particularly on current nautical charts. Reliable charts provide the most direct routes between ports, reduce the number of pilots required, decrease the number of groundings (and reduce insurance rates), and allow deeper draft vessels (i.e. more cargo) to be used. The National Oceanographic and Atmospheric Administration (NOAA) reported that one additional foot of draft may account for between $36,000 and $288,000 of increased profit per transit into Tampa, Florida, USA.[29]

The economic benefits and savings associated with preventing marine accidents through more adequate survey are significant. The cost of an oil spill can be measured by the revenue lost through the loss of cargo, the vessel and days at sail, as well as the cost of cleanup. For example, the Exxon Valdez oil spill of 1989 cost Exxon USD 2.1 billion for

[28] Johnston, G., (2011), "The Economic Benefits of Hydrography and Ocean Mapping", featured in International Federation of Surveyors, (2011), "Report on the Economic Benefits of Hydrography", FIG Publication no. 57

[29] National Oceanic and Atmospheric Administration (NOAA), (2000), Technical Report NOS COOPS 031, National Physical Oceanographic Real-Time Systems (PORTS) Management Report. Silver Spring, Md.

clean up, USD1.1 billion for settlements and in 1994, a US jury found Exxon negligent and fined them USD 5 billion for the incident.[30] The destruction of wildlife, habitat and future resources are more difficult to assign an economic value to however the estimated price that the residents affected were willing to give their pristine environment for one degraded by the spill was approximately USD 7.9 billion. [31]

The impact of the oil spills has been economically and environmentally important in Europe. For instance, one of the most recent accidents, the sinking of the Erika, cost a total of EUR 350 million : EUR 180 million spent by central government, EUR 140 million spent by Total to clean up difficult access sites, etc. and EUR 30 million spent by local government in cleaning and repairing the coast.[32]

The introduction and implementation of Electronic Chart Display and Information Systems (ECDIS) and Electronic Navigation Charts (ENC) into the maritime industry has the potential to significantly reduce the margin for human error during navigation scenarios.

Other benefits of hydrographic data:

- Management of marine resources, both living and mineral
- Coastal zone management: Disaster modeling is made possible by high resolution bathymetry data, and with high resolution coastal data, an accurate set-back zone can be determined
- Offshore aquaculture production and fisheries: as fish tend to congregate in shallow waters, with precise bathymetry information, it is easier to determine where the fish are.
- Climate Change, natural disasters, pollution, and hazard mitigation: bathymetry is a baseline element in terms of storm surge modelling, and wave hind casting.
- Tourism: data can offer new and unspoilt locations, and assist in maintaining coastal waters, bays, beaches and islands.
- Ports and harbours: investment decisions for port expansion need up to date data, in particular to provide safe berthing and passage for an increasing number and size of vessels.

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Interviews undertaken

To be completed

Interviews to organise

SHOM, Yves Guillam

7.1.2 Case 2: Offshore wind energy – optimisation of turbine foundation design

1. Case presentation: problem definition & opportunities

Overall context

One of the major drawbacks in using offshore wind turbine farms to date has been the very high foundation costs. Studies have found that turbine foundation costs amount to approximately 20-25% of total installation costs. Others have claimed that the cost of the support structure for offshore wind installations is close to 40% of the total cost of the installation. Therefore the development of highly cost effective concepts is required, as the optimisation of the foundation is essential for economic feasibility of offshore wind farms.

Furthermore, for environmental and energy gain reasons require, wind farms are being located farther from shore in deeper waters. This trend of increasingly large turbines in deeper and rougher waters has seen a proportional increase in the design and construction challenges and complexity.

Deciding on the type of foundation and turbine model for an offshore turbine is the crucial step in constructing an offshore wind farm. These two decisions are inextricably linked as the size or, more precisely, weight of the turbine is a factor in settling on a foundation

type. However, choice of foundation is also determined by water-depth and type of seabed.

Innovative designs for foundations are constantly being considered and assessed by the industry, and research is underway to develop new types of jacket foundation, such as twisted jackets which are strengthened by specially calculated tensions, and to reduce the use of steel in their manufacture so as to reduce the costs.

Situation in Europe

Europe leads the way in offshore wind energy. The power generated by offshore wind farms in Europe increased by 51% in 2010, with current installed capacity of 3,295 megawatts (EWEA). Offshore wind energy however is still a fledgling industry in comparison with onshore wind power, and much of the technology in use today is borrowed from land based wind farms. The challenges and demands of the installation process are, however, markedly different to onshore installations due to the difficulties of operating at sea. The logistical complexity of these installations and the costs involved in terms of construction place heavy constraints on the industry; the design challenge is to make offshore wind farms an economical and viable source of power.

Construction, transportation and installation of foundations can cost up to three times as much as the installation of the turbines, so it forms a critical part of cost analysis. There are several design concepts in research and development and at testing stage that may answer the economic questions through engineering.

In Europe, given the potential of the offshore wind sector and to address the prevailing high costs, there are many initiatives designed to reduce costs and maximise production. One of these is Offshore Wind Accelerator (OWA), Carbon Trust's flagship collaborative RD&D programme. Set up in 2008, the OWA is a joint industry project, involving eight offshore wind developers with 60% (30GW) of the UK's licensed capacity, that aims to reduce the cost of offshore wind by 10% by 2015.

2. The need for marine knowledge in Europe

Current knowledge

Sub-structures represent a significant proportion of offshore development costs. It is necessary to extend the lifetime of structures, reduce costs, and develop risk-based life cycle approaches for future designs.

There are existing research projects aiming at reducing the cost of turbine foundations. One such project, “OPTI PILE”, has been financed under the Fifth Framework Programme. This project, looking at the optimisation of monopile foundations for offshore wind turbines in deep water and North Sea conditions, commenced in 2003 and will end in 2063. It is led by E-Connection Project B.V., and also involves Germanischer Lloyd Windenergie GMBH and Vestas Wind Systems A/S. The project funding received amounts to €1,238,896 out of a total project cost of €2,753,103.

For the time-being few data are available to the research community from existing experimental offshore test sites, mainly due to the confidentiality of the data, usually property of the manufacturers involved in the projects. There is a need to perform different experiments for different technologies, and therefore better sharing of knowledge would assist in reducing duplicate research and assist in cost reduction efforts.

Type of data need

At the moment, the impact of uncertainty is that installations are oversized in order to be

conservative. There is therefore a need for available measured data from experimental offshore installations to validate the existing developed models, supporting research into improved design tools and techniques, and better design standards. Data is needed for different support structures (monopile, jackets, tripods, TLP, etc) and different wind turbine technologies. Better access to the available data of scale models tested could be very useful for ongoing research projects.

To improve and optimise design of the foundation, there is a need for quality time-series data relating to sea-state parameters, currents, sea surface elevation. Furthermore, detailed knowledge on soil characteristics and scour behaviour is needed before detailed design optimisation can be carried out. It is necessary to have information on the soil conditions to model the dynamic behaviour of the wind turbines. In reference to the procedures for characterization of the soil, it was stated that for deep waters the cost could be very high.

Detailed assessments of the seabed are a vital element of the preparatory work undertaken by or on behalf of developers. Geophysical surveys form a part of this. They utilise an advanced, high-tech form of sonar helping operators build up a three-dimensional picture of the seabed, and can tell what materials, such as sand, gravel or chalk, the turbine foundations will be dug into. Geotechnical surveys are carried out to get a better picture of what the seabed is made of up to 80 metres below the bottom of the sea. Such information is crucial when deciding whether an area is suitable for wind turbine construction and how deep the foundations need to be driven.

Marine knowledge 2020

N/A

3. Benefits

Economic benefit

The overall economic benefit is a cost effective design optimisation of the turbine foundation. With better knowledge of the seabed as well as currents and sea surface elevation, foundations can be tailored to the conditions and constructed and installed more economically.

As an example, the wind farm at Scroby Sands in Norfolk, United Kingdom showed how minor design changes could lead significant savings in construction schedule and costs. The designers decided to make minor modifications to the monopile by welding a flange to which the wind tower could be bolted thereby getting rid of the transition piece and the expensive grouting used to connect it to the monopile altogether.[33]

Another benefit is the mitigation of geotechnical risk, which refers to the circumstances in which the location proves to be inadequate to support the foundations of an offshore device.

4. Main data sources

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Input received by: To be completed
Interviews: To be completed

7.1.3 Case 3: Offshore wind energy – protection of export and array cables

1. Case presentation: problem definition & opportunities
Overall context
Offshore wind farms generally use two cable types. The inter-array cable, usually rated from 10 to 32 kilovolts (kV), connects individual turbines to an offshore substation. The export cable, rated at 132kV takes the electricity from the offshore substation to the connection point onshore. Cables are exposed to the following hazards: • Interaction with recreational vessels • Interaction with fishing gear • Interaction with dropped or dragged ship anchors • Exposure of the cable due to seabed conditions e.g. sand waves, scour • Exposure of the cable when exposed from unsupported lengths or jagged rocks • Dredging Activities When a break occurs in a cable within the inter array on a wind farm, that particular turbine or connected series of turbines trips off. Turbines are links in series to a central power station, from which a much larger export cable sends the farm's total power to land. Only with a break in the export cable is the whole farm affected.[34] The consequential damage to an unprotected export cable can amount to many months of downtime. Proper care in laying cables is essential to keeping long term repair costs down. The Managing Director of Offshore Marine Management has stated that "the biggest problem for a wind farm once it is operational is the sub-sea cabling. You can

[34] Phil Walker and Cliff McDougall, Pharos Offshore Group Ltd. "Burial Protection Index for Offshore Wind Farm Power Cable"

have a thousand wind turbines offshore but if you break the export cables no electricity will get into the grid."[35]

Burying the cables is an essential measure to protect them from being dragged by currents or from more immediate damage by getting caught up in fishing gear or by anchors. For both export and in-field cabling the trenches that are cut fall back in after the machinery has passed, making it a self-burying system. Techniques of protecting the in-field cables and export cables may differ on any particular project.

The optimal protection is to bury the cable just below the depth the threat will reach. For the most common hazards, only a small depth (often less than 1 metre) is required. However no truly effective measure can be taken against anchors dropped from large ships, as modern anchors can dig deep into the seabed although they cannot usually be dragged a great distance. The depth of a trench to completely avoid all potential incidents would be economically unviable.[36]

Hitting a cable has no severe environmental effects and only a limited safety impact. If a cable is torn, the resulting electrical short may lead to an equipment overload and the shut-down of converter or transformer stations. The offending ship will suffer no electrical shock due to the high electrical conductivity of seawater, resulting in a complete earthing of the damaged cable.[37] The economic damage, however, may be significant as the repair of broken cables is very expensive.

2. The need for marine knowledge in Europe

Current knowledge

Uncertainties during installation phases mean that solutions are not cost effective. Additional data particularly on soil density and hardness is required in order to improve knowledge regarding options to protect cables. With all other factors being equal, "harder" sea floor conditions, measured by geotechnical characteristics, provides buried cable with more protection than "softer" sea floor conditions. Protection must be consideration in relation to soil density and hardness. This means that cables do not always need to be buried to the deepest possible level to achieve adequate protection.

Furthermore, in terms of recovery and repair, locating cable installed deeper than 1 metre requires a 'tone' listening rather than a 'metal detector' technology. Excessive burial could prevent cable from being located, detrenched or recovered. If an entirely new length of cable needs to be re-installed and buried, this would exponentially add to cost of repairs.
One of the leading providers of cable protection systems is Tekmar Energy Ltd, which has already installed 1,000 protection systems at 18 offshore wind farms. The protection

[35] Offshore Wind Energy: A UK Success Story - UK Trade & Investment, www.ukti.gov.uk/uktihome/aboutukti/item/310240.html

[36] http://bsee.gov/uploadedFiles/BSEE/Research_and_Training/Technology_Assessment_and_Research/671AA-Final%20Report%20Offshore%20Electrical%20Cable%20Burial%20for%20Wind%20Farms.pdf

[37] http://www.greenpeace.org/international/Global/international/planet-2/report/2006/3/offshore-wind-implementing-a.pdf

systems basically consist of a casing which is pulled over the cable, preventing damage to the section of cable between the sea floor and the turbine's foundation.[38]

CPNL Engineering GmbH has very recently supplied a complete cable protection system for the NSO offshore wind project of RWE, a leading utilities company in Germany. The cable protection system of CPNL is the first system that can be adapted to any kind of cable project.[39]

Circor Energy has also developed a cable protection system called PEFLEX, which is used to protect freespan array and export cables on offshore wind farms. Circor is partnering with Dong Energy, E.ON and Masdar to supply Cable Protection Systems for the first phase of the London Array Offshore Wind Farm. The London Array cables require protecting during deployment and during service life from movement due to wave action and other turbulence across the exposed monopile scour zone. The system provides abrasion protection, impact protection, fatigue protection and cable over bending protection, while allowing for quicker deployment and reduced installation costs.[40]

Blue Ocean Projects (BOP) has also developed a range of Cable Protection Products designed to provide protection for subsea cables at offshore wind or tidal energy foundations, in shallow water and at landfalls, boulder fields or areas of rocky seabed where cable burial is impractical.[41]

Type of data need

Uncertainties would be reduced through better sea-bed data: seabed mapping systems that accurately chart depth, topography, slope angles and seabed type. This would improve knowledge regarding options to bury (or not) the cable in order to make decisions regarding how to armor the cable and what armoring is required from risks due to "navigation" e.g. ships and trawlers, rocks, unsupported lengths and from other environmental hazards such as creatures burrowing into the cable.

The best sea burials require knowing the soil. Getting a clear picture of the seabed soil type will determine the best route and equipment to use for burying cable.[42] For example, generally the deeper you bury a cable, the more expensive it is. However if the soil is particularly hard, it will not have to be buried as deep as if the soil were soft, thus saving on important costs. Deeper burial requires more specialised equipment, more specific operator experience, more time to cover a given distance and larger ships contracted at higher daily rates. [43]

[38] Windforce 2012 Conference in Bremen, http://www.windforce2012.com/wp-content/uploads/2012/10/Nachbericht_EN_final.pdf
[39] http://www.offshorewind.biz/2012/11/14/cpnl-provides-cable-protection-for-german-offshore-wind-farm/
[40] http://www.circor.com/solutions/partner-peflex
[41] http://www.blueoceanprojects.com/cable_protection_products.html
[42] Phil Walker and Cliff McDougall, Pharos Offshore Group Ltd. "Burial Protection Index for Offshore Wind Farm Power Cable"
[43] Phil Walker and Cliff McDougall, Pharos Offshore Group Ltd. "Burial Protection Index for Offshore Wind Farm Power Cable"

Furthermore, rather than applying a constant burial depth across a wind farm site, a site-specific cable protection strategy should be developed. This will require a cable threat and risk assessment based of seabed geotechnical and geophysical data along the cable paths.[44]

Marine knowledge 2020

N/A

3. Benefits

Economic benefit

The benefits of optimisation of cable protection are to reduce risk of damage in long term, reduce costs during the installation phase, as well as costs for ongoing maintenance. Economic damage may be significant as the repair of broken cables is very expensive.

In 2012, a technical fault with the cabling serving the 300MW Thanet wind farm, off England's south east coast, was reported. The total cost to Vattenfall for the fault was approximately SEK50m (€ 5.6 million).[45]

In April 2012, the NorNed 700MW direct-current cable connecting the Netherlands and Norwegian electricity systems failed. NorNed predicted at the time that repairs would take approximately ten weeks. It has been argued that if Tenne T's nine offshore wind cable projects connecting 900MW of offshore wind capacity with the mainland went down for 10 weeks, whilst operating at 4,400 full load hours per year (as achieved by Germany's first offshore station Alpha Ventus in 2011) lost earnings could reach around €145 million.[46]

Over the last eight years, many insurance claims have been needed by offshore developers to cover the costs of damage to cables during the installation and burial processes currently used.[47]

James Ritchie from Tekmar Energy recognizes the benefits of protective systems are obvious, stating that "the cables make up only eight percent of the total investment, but 80 percent of all insurance enquiries refer to these systems". [48]

4. Main data sources

[44] Phil Walker and Cliff McDougall, Pharos Offshore Group Ltd. "Burial Protection Index for Offshore Wind Farm Power Cable"

[45] http://www.windpoweroffshore.com/2012/07/31/thanet_cable_failure_cost_vattenfall_more_than_5m/

[46] http://www.windpowermonthly.com/news/rss/1137126/Germany-proposes-shared-liability-offshore-cable-failures/

[47] http://www.pharosoffshoregroup.com/NewsPages/Subsea_cable_burial.htm

[48] Windforce 2012 Conference in Bremen, http://www.windforce2012.com/wp-content/uploads/2012/10/Nachbericht_EN_final.pdf

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7.1.4 Case 4: Offshore wind energy – optimisation of operations and maintenance

1. Case presentation: problem definition & opportunities

Overall context

Wind turbines – like any other industrial equipment – require service and maintenance (known as operation and maintenance, (O&M), which constitute a sizeable share of the total annual costs of a wind turbine. Strategies that maximise energy production while minimising O&M costs are essential. Effective access systems are essential for the operation of the offshore facilities and the safety of personnel involved.

Maintainability of the turbines: If offshore turbines fail, maintenance technicians need to access the turbines and carry out maintenance. Especially in the case of failures of large components, offshore turbines are being modified to facilitate these large scale replacements. The maintainability of present day onshore wind turbines is such that similar failures offshore will require more repair time and more expensive repair equipment than onshore.

Weather conditions: Offshore weather conditions, especially wind speeds and wave heights, have a strong influence on O&M procedures of offshore wind farms. Maintenance activities and replacement of large components can only be carried out if the wind speed and wave heights are favourable. Preventive maintenance actions therefore tend to be planned in the summer period. During harsh weather conditions turbines cannot be accessed by personnel and crane ships cannot be used for e.g. installation and repair actions. If failures occur in the winter season, it is possible that turbines cannot be

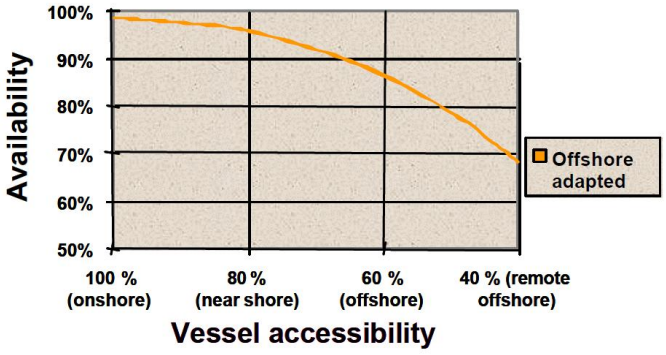
accessed for repairs, and this may result in long downtimes and significant revenue losses.

Transportation and access vessels: for current day offshore wind farms, small boats are being used to transfer personnel from the harbour to the turbines. If the weather is not favourable, helicopters can be used. For intermediate sized components like a yaw drive, main bearing, or pitch motor it is often necessary to use a larger vessel for transportation. However some boats may not be able to access during periods of high waves.

Situation in Europe

A study has found that wind turbines at the North Sea can be accessed between only 60 to 70% of the time. Therefore improved access systems are required for large scale offshore wind.

The diagram below represents availability as function of vessel accessibility of a 100 unit offshore wind farm, undertaken as part of a research project into the "Development of an Expert System for the determination of Availability and O&M Costs for Offshore Wind Farms".



Danish inshore sites, such as Vindeby and Tuno, have an average accessibility by vessel of approximately 85%. In harsher conditions, such as in the North Sea, the accessibility with a standard vessel can drop as low as 60%.[49] Thus there is a strong call for improved access methods in order to improve the availability of a wind farm and hence its economic viability.

2. The need for marine knowledge in Europe

Current knowledge

To maximise energy production it is essential that wind turbine failures be addressed quickly. In order to keep the number of expensive offshore repair operations to a minimum, it is necessary to carry out preventive maintenance. However regular preventative maintenance requires regular and easy access to installations. The impact of uncertainty in weather conditions is that it is difficult to be sure whether/when site can be accessed by boat for Operations and Maintenance or even during construction.

Some maintenance strategies remain very similar to the strategy for land. Two times a year a service and preventive maintenance visit is made to each wind turbine, preferably

[49] http://www.offshorewindenergy.org/ca-owee/indexpages/downloads/Brussels01_O&M.pdf

when the wind and sea conditions are favourable. Repair actions are carried out when maintenance crew and equipment are available and weather permits.[50] With better data on wind and sea state forecasts, this process could be improved.

New expert systems and planning models are being developed to take into account weather conditions, failure characteristics of wind turbine components, and the access and docking characteristics of maintenance vessels. sVarious systems have been developed to transfer personnel, tools and spare parts from a moving ship to a wind turbine safely.[51]

Three Dutch access systems have been developed and applied successfully: [52]

1. Offshore Access System OAS developed by Fabricom Oil & Gas BV
2. The Ampelmann developed by Ampelmann Company: stabilises an access platform in waves of up to 2.5 m significant wave height. This means an increase up to 93% in accessing time of a wind turbine in the North Sea.
3. WindCat, a catamaran vessel designed and exploited made by Windcat Workboats.

Type of data need

The ability to maintain offshore wind turbines is very much dependent upon the access system used. The actual weather conditions at the site, and its forecast are important for planning transport of maintenance crews and landing using vessels.[53] Therefore better wind and sea state forecasts are essential in optimising operations and maintenance and setting the O&M strategy.

As an example, within the scope of the DOWEC (Dutch Offshore Wind Energy Converter) project, the required weather windows are determined on basis of the NEXT/NESS (North European Storm Study) database. An estimate of the availability of an offshore wind farm can be realised in an advanced way using a Monte Carlo simulation model of the O&M operations within the wind farm.[54]

Marine knowledge 2020

N/A

3. Benefits

Economic benefit

The benefit to be gained is the optimization of Operations and Maintenance through better accessibility to sites. This will result in reduced downtime losses, avoidance of energy production losses and thus revenue losses, and potentially prevention of costly reactive

[50] http://www.offshorewindenergy.org/ca-owee/indexpages/downloads/Brussels01_O&M.pdf
[51] http://www.we-at-sea.org/leden/docs/reports/We@Sea%20RL5%20report.pdf
[52] http://www.we-at-sea.org/leden/docs/reports/We@Sea%20RL5%20report.pdf
[53] http://www.ecn.nl/fileadmin/ecn/units/wind/docs/dowec/2003-OWEMES-Accessibility.pdf
[54] http://www.ecn.nl/fileadmin/ecn/units/wind/docs/dowec/2003-OWEMES-Accessibility.pdf

repairs in the future.

In time of harsh weather conditions (wind, waves and visibility), a wind farm may be inaccessible by boat or helicopter for a period of one or two months.[55]

4. Main data sources

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Input received by:

To be completed

Interviews:

To be completed

[55] http://www.ecn.nl/fileadmin/ecn/units/wind/docs/dowec/2003-OWEMES-Accessibility.pdf

7.1.5 Case 5: Offshore wind energy – better assessment of energy yield

1. Case presentation: problem definition & opportunities

Overall context

Offshore wind can play an important role in the transition to more sustainable energy systems, and it is critical to be able to predict the interaction between wind farms in order to optimise production. Levels of production of wind energy can be difficult to predict as they rely on potentially unstable weather conditions present at the wind farm.

Interaction between wind farms[56]: the wind flow pattern downwind of a wind farm will influence neighbouring farms, therefore the size and location of offshore wind farms are of great importance. On a smaller scale, individual turbines will also influence neighbouring turbines. Consequently, predicting the interaction between wind farms and turbines is important for optimizing wind energy production for large installations offshore.

Predicting wind energy generation[57]: new prediction tools are needed to make wind energy more competitive, harness the potential of offshore resources and facilitate grid integration. This project addresses this issue through the development of new, advanced modelling tools that can be used both in localising new wind farms and for optimising the operation of existing and future offshore wind farms. The current proposal aims at developing such tools using meteorological data.

Prediction tools are important when deciding where to locate farms with respect to each other and for more precise forecasting of power generation for a certain wind farm and for a certain area. In order to predict the energy production of the wind farm it is necessary to undertake the following tasks:

- Predict the variation in the long-term wind speed over the site at the hub height of the machines, based on the long-term wind speeds at the mast locations;
- Predict the wake losses that arise as a result of one turbine operating behind another – in other words in its wake; and
- Calculate or estimate the other losses.

Situation in Europe and internationally

EWEA has a target of 40 GW of offshore wind in the EU by 2020, implying an average annual market growth of 28% over the coming 12 years. For 2010, EWEA expects the completion of 1,000 MW more of offshore wind capacity, equivalent to a market growth of 71% compared to 2009.

However a number of barriers face the offshore wind industry including an urgent need to develop the European energy infrastructure (offshore grid and onshore networks), high technological and operational costs, and political support and targets.

Given the vast offshore resources in Europe, there are many R&D programmes looking

[56] Norden, Nordic Energy Research, http://www.nordicenergy.org/project/prediction-tools-for-offshore-wind-energy-generation/
[57] Norden, Nordic Energy Research, http://www.nordicenergy.org/project/prediction-tools-for-offshore-wind-energy-generation/

into optimising production and predicting output in order to bring costs down and improve the future attractiveness of this industry. A few of these examples are elaborated upon below.

2. The need for marine knowledge in Europe

Current knowledge

The impact of current uncertainty is an underestimation of energy yield. As accurate meteorological measurements and wind energy maps become more commonly available, wind project developers are able to more reliably assess the long-term economic performance of wind farms. However, current techniques must be improved so that, given the geographic coordinates of any wind farm (flat terrain, complex terrain or offshore; in a region covered by extensive data sets or largely unknown), predictions with an uncertainty of less than 3% can be made.

The European Energy Research Alliance project "Design tools for offshore wind farm clusters" (EERA-DTOC)[58], part of the 7th Framework Programme, seeks to combine expertise in a common integrated software tool for the optimized design of offshore wind farms and wind farm clusters acting as wind power plants. To decrease uncertainties around wind farm wake predictions a small measurement campaign together with new data available from the industry partners will enable better tuning and ultimately better modelling of the far-reaching field of wind farm wakes.

Another example of an FP7 project is led by 3E[59], and focuses on developing a "Toolbox for Offshore Wind Farm Cluster Design". The project is running from 2011 to 2016, and will combine different design optimisation tools such as advanced wake models, turbine load models, grid interconnection models and by incorporating the operation of the offshore clusters as a virtual offshore power plant.

TPWind is working on some specific R&D priorities in order to implement its 2030 vision for the wind energy sector. Specific objectives are to increase the availability of data sets from large wind farms, improve models to predict the observed power losses from wakes, and evaluate the downwind impacts of large wind farms, especially offshore. There is also work on offshore meteorology in order to improve the knowledge and understanding of processes in offshore conditions.

There are also research projects that specifically look into developing prediction tools for offshore wind energy generation. One of these projects is undertaken by IRIS, the International Research Institute of Stavanger involving Statoil (Norway), Mälardalen university (Sweden), Aalborg university (Denmark), StormGeo AS (Norway), WindSim AS (Norway). The project aims to develop prediction tools for offshore wind energy production in order to make wind power production more reliable and efficient in the future. The tools developed will be used for individual farms, but given an extensive development of offshore sites the wind pattern from one farm can severely influence the potential to capture the wind energy at neighbouring wind farms within the same wind farm cluster. Using the best available computational resources, the prediction tools will address this issue.

[58] http://www.ewea.org/annual2012/conference/project-workshops/eera-design-tools-for-offshore-wind-farm-clusters/

[59] http://cordis.europa.eu/search/index.cfm?fuseaction=proj.document&PJ_RCN=12443338

Type of data need
Information required for prediction of energy yield include wind data, air density and turbulence intensity, the topography and surface group of the site and surrounding area, and weather conditions. Accurate wind energy estimations depend on these inputs. Wind data/measurements / wind speed distribution: the variability of wind speed has a strong influence on the assessment of long term wind resource at a site. There is a strong need for past information on wind currents in potential offshore sites. This type of knowledge is being used to develop new models and to revise and expand upon existing ones. This is necessary in order to develop methods for determining the external design conditions, resource assessment, and short-term forecasting. The speed of the wind is crucial to the success of wind farms, and it may vary drastically over time. For example, the wind atlas of UK's waters provides basic generalised information on speeds, but layouts are determined by higher-resolution data collected by offshore met masts or laser anemometers. Other weather conditions such as temperature, air pressure and humidity can also assist in better predicting energy output, and are important imputs into some predictive models. A pre-construction energy yield assessment is typically calculated based on the best information available, but will often rely on assumptions and hence contain significant uncertainties. This may lead to un-favourable financing conditions, and possible error in the prediction.
Marine knowledge 2020
N/A

3. Benefits

Economic benefit
Overall benefit: a better assessment of the energy yield through improved knowledge and predictive tools will have a positive impact on the investment case resulting in more confidence in project financing, reduction in costs through optimisation of site selection, and increase in potential production. The benefits of a more accurate energy yield assessment are better cash flow planning and better re-financing conditions for offshore wind farm operators.[60]

4. Main data sources

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[60] http://www.ecofys.com/files/files/ecofys-glossy-lowres.pdf

http://www.ecofys.com/files/files/ecofys-glossy-lowres.pdf
Input received by: To be completed
Interviews: To be completed

8 Options for governance of European marine observation and data networks

8.1 Marine Knowledge – the governance context

The Integrated Maritime Policy (2007) seeks to provide a more coherent approach to maritime issues, with increased coordination between different policy areas. Specifically it covers these cross-cutting policies:

a) Blue growth
b) Marine data and knowledge
c) Maritime spatial planning
d) Integrated maritime surveillance
e) Sea basin strategies

In September 2010, the EC adopted an agenda "Marine Knowledge 2020" that provides common objectives for all EU marine data initiatives and identifies a number of actions that would achieve these objectives.

The creation of marine knowledge begins with →observation of the sea and oceans. → Data from this observation are assembled, → then analysed to → create information and knowledge. →Subsequently the knowledge can be applied to deliver smart sustainable growth, to assess the health of the marine ecosystem or to protect coastal communities.

The European Marine Observation and Data Network (EMODNet) is concerned by the first two stages of the process chain – i.e. data collection and assembly. Data collection is mostly the responsibility of Member States. The EU has the potential to add value in the assembly phase by ensuring coherence across borders and between different user communities. It is not the first or only initiative that aims to provide better dissemination of marine data. Indeed "Marine Knowledge 2020" emphasises that it is only one of a number of complementary EU efforts.

To test how this could be done a number of preparatory actions were started in the period 2008-2010. Several consortia comprising marine data organisations were selected through calls for tender. Prototype websites (portals) were established

through procurement contracts providing access to marine data, metadata and data products for six themes (see table below) and for whole sea-basins.

The portals facilitate overview and access to the available data are available for a given sea basin. Engineers and scientists can see and download both original observations and derived data products such as digital terrain models, sediment distributions and marine habitats.
The portals should provide access to:
(1**) Data** – raw observations or measurements.
(2) **Metadata** – information about the data such as location and time of measurement, units, precision.
(3) **Data products** – products derived from the data; normally by interpolation in space and time. Data products include digital terrain models on regular grids or geological maps. The predicted habitat maps are also a product, developed through integration of other data sets. Thus users can obtain estimates of parameter values between measurement points.

The consortia are the principal nodes of EMODNET. Each consortium is a group of experts in particular field. Their tasks are the following:

- Ensure that participating institutions and national data centres use the same standards and metadata.
- Facilitate access to all data and metadata through a single common web page or "portal"
- Develop data products for whole sea-basins and provide access to them through the same portal.

Thematic group	Type of data	Main contractor	Start	Coverage
hydrography	water depth, coastlines, underwater features	MARIS b.v, Netherlands	29/05/2009	North Sea, Celtic Seas, the Western Mediterranean, the Ionian Sea and the Central Mediterranean;
hydrography	water depth, coastlines, underwater features	MARIS bv, Netherlands	08/06/2010	Eastern Mediterranean, Black Sea, Iberian Atlantic and Biscay
geology	sediments, strata, coastal erosion, geological hazards	NERC BGS, UK	16/07/2009	North Sea, Baltic and Celtic Seas
physics	temperature, waves, currents, sea-level, light penetration	ETT, Italy	17/12/2010	All European seas
chemistry	concentration of chemicals in water, sediments and biota	OGS, Italy	04/06/2009	North Sea, Black Sea and selected parts of Mediterranean
biology	abundance of living species	VLIZ, Belgium	15/05/2009	North Sea, Bay of Biscay and the Iberian Coast

physical habitats	habitat classification based on physical parameters: water depth, light penetration, sediments	JNCC, UK	18/02/2009	North Sea, Celtic Seas, Baltic and Western Mediterranean
Human activity	*Gravel extraction, aquaculture, shipping*	-	*To be created*	

The above Table provides an overview of the current 7 consortia comprising 53 different organisations. The participating organisations are largely public bodies responsible for managing marine data at national level as well as some smaller private companies with specific data management expertise.

The aim of EMODNet is not to construct a database. The data may remain in separate archives but they should be accessible through a single entry point or so-called "portal". Six different portals have been set up to facilitate the different types of data requirement and approaches.

The funded preparatory action was not sufficient to cover data from all European seas so each one covers a subset of the sea-basins. Each portal includes the North Sea and at least two other sea basins. All European seas subject to the Marine Strategy Framework Directive, except Macaronesia, are included in at least one portal.

The next phase of EMODNet is being funded through Regulation 1255/2011 which is intended to support the maritime policy until the proposed European Maritime and Fisheries Fund is in place for the period 2014-2020[61].

The next phase will focus on:

- Providing access to *more* data, metadata and data products by completing the work started in the first phase in order to deliver complete coverage of European waters by the end of 2014.
- Creating an extra thematic group to assemble data on human activity (gravel extraction, aquaculture, and shipping). This is of particular interest for marine spatial planning.
- Starting a process to identify the fitness for purpose of the present EMODNet and develop evidence based priorities for further work in collecting, assembling and processing marine data.
- Evaluate sustainable and cost-effective mechanisms for the EMODNet infrastructure.

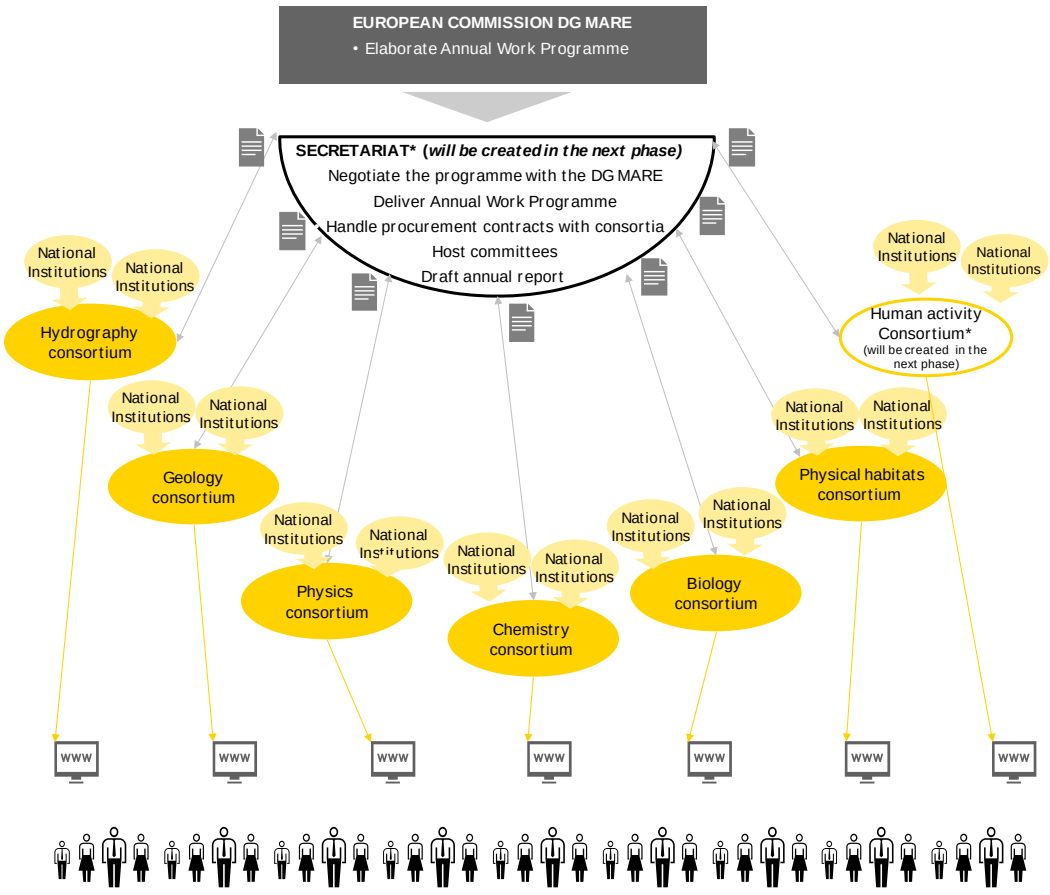
[61] This is subnject to approval of the next financial perspective 2014-2020 and of the budgets and programmes as proposed by the Commission.

8.1.1 The secretariat

The figure below presents the EMODNet organisation and the role of the secretariat in providing funding to a group of organisations based on an annual work programme in 6-7 fields.

In the 2012 road map it is mentioned that the Commission proposes an annual budget of EUR 30 Million. The annual budget includes the secretariat and the fund to be disbursed. The funding will be disbursed in line with the financial regulation e.g. call for tender, call for proposal or in a different way.

The following sections will look at the different organisation options for the secretariat as well as fund disbursement options.



Currently the secretariat is being managed directly by DG MARE using an external contractor to monitor the EMODNet projects, disseminate the EMODNet results and to collect feedback and statistics on EMODNet use by users.

DG MARE is carrying out the tasks related to the programming of EMODNet and contracting of the portals.

8.2 Description of options

In order to assess the governance of the secretariat for the European Marine Observation and Data Network this section looks at the different options to organise the secretariat and the options provided for under the financial regulation to disburse the fund (this section and observation are based on preliminary findings).

8.2.1 Regulatory agencies

A number of specialised and decentralised EU agencies have been established to support the EU Member States and their citizens. These agencies are an answer to a desire for geographical devolution and the need to cope with new tasks of a legal, technical and/or scientific nature. Regulatory agencies have a variety of specific roles, set out in their own legal basis, case-by-case.

The regulatory agencies can be categorised roughly on the basis of their functions:

- adoption of individual decisions;
- technical or scientific advice to the Commission and the Member States;
- responsibility for operational activities;
- information and networking services;
- services to other agencies and institutions.

The specific roles of each agency are set out in its own founding legal act. These agencies are independent bodies, usually governed by a Management Board. The Management Board has responsibility for overseeing the performance of the agency and for nominating the Director, who in turn is in charge of the agency's operational aspects. Most of the agencies are funded by the EU budget, and hence the European Parliament has responsibility for their budgetary discharge. In addition, the general Financial Regulation, along with the Framework Financial Regulation, provides common rules for the agencies' financial governance.

8.2.2 Executive Agencies

Executive agencies under the European Commission are a new structure within the European Community and are governed by Framework Regulation (EC) No. 58/2003 laying down the statute of Agencies. The role of an Agency is to handle Community programmes fully or partly. The Agencies are established by the Commission and can only operate within the area entrusted to them. The Agencies may not have any political or programming tasks as these tasks lie with the Commission. The main objective of out-sourcing certain management tasks to Executive Agencies is to achieve the goals of Community programmes more cost effectively.

At present, these agencies are:

- European Research Council Executive Agency (ERC Executive Agency)
- Research Executive Agency (REA)
- Executive Agency for Competitiveness and Innovation (EACI)
- Trans-European Transport Network Executive Agency (TEN-T EA)
- Executive Agency for Health and Consumers (EAHC)
- Education, Audiovisual and Culture Executive Agency (EACEA)

The existing executive agencies have the following characteristics. REA and ERC executive agencies implements research programmes under the supervision of DG Research and Innovation. EACEA is to implement programme strands in the fields of education and training, active citizenship, youth, audiovisual and culture. The parent DG of EACEA is DG EAC as well as DG INFSO for the media programme. EAHC is under the supervision of EAHC dealing with programme implementation under public health, food safety and consumer affairs. The TEN-T EA is dedicated to transport infrastructure projects to ensure technical and financial implementation and management of the TEN-T projects funded by the TEN-T Programme. Finally EACI is dedicated to the management of energy, transport, environment, competitiveness and innovation and reports to DG Energy, DG Mobility and Transport, DG Enterprise and DG Environment.

8.2.3 Joint Initiatives

In addition to agencies, the responsibility of the EU to stimulate research and economic development has led it to set up special partnership bodies. It has been recognised that to achieve some goals, the public sector needs to work in partnership with the private sector, providing funding and maintaining a voice but standing aside from key strategic decisions on direction.

The result is innovative bodies such as joint undertakings like ITER for nuclear fusion and SESAR for air traffic management, the Joint Technology Initiatives under the 7th Framework Programme, and the European Institute of Innovation and Technology.

Arrangements for the financial and administrative governance of these bodies are governed by special rules under the Financial Regulation, and they are directly responsible to the discharge authority for budget implementation. Their raison d'être is explicitly to work differently to a normal "public sector" body: though supported by public funds, they should make decisions from the perspective of commercial edge or expertise. These are therefore not agencies, and are not covered by this communication.

8.2.4 Private Public Partnership (PPP)

The current secretariat set-up is being run on the principles of providing data to the public at marginal costs. This was a request made by the user community at the time of the 2010 consultation. A PPP model would as minimum mean running the secretariat at marginal costs as well as a profit margin to the operators charged to the users of EMODNet. At this stage we have not yet described the option of running the secretariat as a PPP And During the next phase this option will be looked into further.

8.2.5 Fund disbursement

This section has not yet been developed.

The financial regulation provides different options for disbursement of funds and programming through call for tenders, call for proposals and funding of specific organisations. The options will be assessed more detailed.

Also EU funds can be disbursed through different types of management depending on the nature of the funding:

- Shared management refers to the implementation of structural policies e.g. agriculture, region etc.
- Centralised Direct Management (centralised indirect management if agencies etc). This is typical for internal policies.
- Research. Research management is common for the research budget managed by DG RTD and DG INFSOC.
- External management relates to the EU budget for external actions and policies including aid and trade.

It will be assessed if the type of management is an issue for EMODNet.

8.3 Preliminary findings and assessment of options

The following section contains a number of initial findings and assessments made at this stage. It is important to notice that the findings are preliminary and during the next phase of the study the costs and benefits will be assessed in a conclusive manner also taking into account the findings in the other parts of the study.

Marginal costs

In the 2012 Roadmap for European Marine and Data Network it was stressed that the data should be available at marginal cost which means that data distributed through the internet should be free of charge.The current “pilot EMODNet” as presented above is based on this approach stating that:

"All the metadata and data products and most of the data are made available to users (public authorities, private industry, researchers, etc.) free of charge and free of restriction of use."

The continuation of this principle will limit the options of a PPP set-up to run the secretariat. In a PPP set-up a user charge would cover the marginal cost running the secretariat and a profit margin to the operator.

Size of the secretariat

It is important to consider the size of the secretariat and the resource intended to be used on the governance of the marine knowledge programme. When looking at the different organisational options the administrative and horizontal cost (also to ensure alignment with the principles of sound financial) might outweight benefits in smaller organisational set-ups.

DG MARE indicated that in the case of an executive agency option two to three persons or full time equivalent (FTE) were envisaged to be involved in with EMODNet in the agency as well as two to three persons in DG MARE.

This is a relatively small organisational set up and will not justify setting up an agency in itself. The adminisrtrative and horizontal costs would most likely outweight any benefits. However an already existing executive agency (or other existing organisational structure) could host the secretariat with a relatively modest increase in administrative and horizontal costs.

According to the Financial Regulation, the DGs must always be responsible for tasks that are concerned with : i) defining objectives, strategies and priority areas of action, ii) adopting work programmes serving as financial decisions, and specific financing decisions, iii) representing the Commission in the Programme Committee and the submission to it of measures to be taken where there is a comitology procedure, iv) undertaking inter-service consultations with the Commission, v) activities involved in launching and taking enforceable recovery decisions. Those tasks are expressly excluded from any possible externalisation discussions.

Other tasks may be externalised, but the degree to which this is permitted will depend on the **nature** of the body to which they are being confided.

The financial regulation provides an option for a limited externalisation to the private sector. However, private sector contractors cannot undertake any tasks forming part of the public service mandate, which concretely translates into the fact that they cannot make contracts or handle money on behalf of the Commission.

There are no obvious legal impediments concerning Agencies and Joint initiative solutions (Eurogoos, EEA, JRC). Executive Agencies were expressly created to be part of the Commission's public service mission.

Hypothetical tasks	Regulatory agency	Executive agency	Joint undertaking	Private contractor
Preparation and publication of calls for proposals based on the priorities set out in the working programme	all	all	?	Part only
Awarding grants	all	all	?	None
Preparation and signature of contracts and subsequent management of contractual arrangements	all	all	?	None
Monitoring of projects, including potential site visits and assessments of reports and deliverables	all	all	?	Part

Source: Cost benefits Analysis of the externalisation of the certain tasks regarding the implementation of the Competitiveness and innovation Framework programme (2007-2013) through an executive agency, Technopolis, 2006.

The selection of the best suitable existing body to include the network programme management should be based on a comparison of similarities between the programmes that are already being managed on the following aspects:

- Similarities in *contents and objectives* of the programme(s): focused on transport, infrastructure, sustainability, etc.
- Similarities in *beneficiaries* of the programme(s):
- Similarities in *type of projects*: public-private partnerships, size of the projects, lead-time
- Similarities in *project management cycle*: selection criteria, involvement of Member States, complexity of implementation process, legislative aspects
- E.g. The JRC has a mission to support EU policy with research. It does not have the mandate for a long-term operational task.
- The recent screening of resources by the Commission suggested that there are no strong candidates for a new executive agency. If new needs appear, the starting point of the Commission will be to explore the option of extending the scope of an existing executive agency to cover a new programme

Executive agency: although it is limited in the number of staff that can be seconded from the Commission, it is able to recruit contract agent staff on long term contracts and can use programme budgets for this. Experience in other executive agencies suggests that attracting adequate qualified staff is not a problem, although it has been slightly harder to fill some of the seconded posts from the DGs (study on externalisation). Potential weakness: moving staff from the DG to the Agency: uncertainty about the effect on carreer progression and prospect might deter some people.

2009 Court of Auditors' report: The report argues that while there have been net cost savings from setting up the Executive Agencies (in particular through their use of contract agents), the precise extent of these savings is difficult to quantify because this depends on the redeployment of the Commission staff who were previously doing the work taken over by the agencies, and on the suppression of the contract staff posts within the corresponding programme at the Commission. Sharing of "back-office" functions has also contributed to savings. Less positively, there are costs and a loss of efficiency involved in replacing executive agency staff who leave the organisation - the recruitment procedure, the loss of knowledge when staff leave, the costs of induction, training and familiarisation of new joiners, the loss to the programme/ project teams involved when a team member leaves (it takes about three months to replace a person), and the resultant knock-on effect on beneficiary satisfaction, all of which reduces the quality of programme delivery and drives up costs – which could have been used for other, more productive purposes. On the plus side it can be said that new staff can bring in new experiences, approaches and ideas.

Capacity / administrative experience: each of the existing bodies would be **capable** of performing the tasks: reporting (annual report to the EC), handling contracts and hosting committees (preparing meetings), etc.

In theory, the improvements in efficiency or simplification of procedures could equally be applied in the Agencies. Executive agencies are more likely in practice to be able to do so – firstly, because programme implementation is their core activity, they have more scope to identify and develop new solutions than people trying to manage programmes in the margins of policy work.

2009 Court of Auditors' report : The report argues that Executive Agencies have proved beneficial as a result of their specialisation and consequent ability to provide a better service in terms of guidance to beneficiaries, communication of projects' results, reduced time for contracting, more rapid approval procedures for technical and financial reports, lower payment delays, etc.

Executive agencies are always located close to Commission headquarters in Brussels or in Luxembourg. Regulatory agencies are based in different EU Member States.

For regulatory agency, executive agency and joint initiatives are perceived by outsiders to be a part of the Commission. Where private bodies are involved the issue is more complex with the potential of the Commission's visibility being diluted.

In all cases the risk of loss of know-how is present, however there could be an improvement in information if the Regulatory, Executive Agency or Joint Initiative is able to carry out additional tasks in the way of project monitoring and follow up that may be subordinated to other more pressing activities linked to the policy imperative (case of in-house DG).

- A high **level of turnover** in staff would risk a significant loss of know-how, not just in the practical issues but in loss of relationships with the network stakeholders. An outsourced solution to contractors and the solution of contract agents in the DG both have a high level of turnover structurally embedded, and the cost of this could be extremely high, although difficult to measure.

- When using an external provider (PPP option) there is a risk that the know-how will be held by the provider rather than the Commission making it difficult for the Commission to seek alternative solutions. Secondly there is a risk that this build up of know-how with the provider will effectively lock other competitors out of the market. Using private contractors, because of the breaks in the management process, would provide the greatest risk of information lost.

Are regulatory and executive agencies more stable than Joint Initiatives and private contractor?

- Executive agencies are set up for a limited period which can be renewed.

- Having an agency dedicated to the execution of a programme helps to ensure a continuity of high quality service to the beneficiaries which could be put at risk through changes in external contractor.

- Transition issues. It normally takes between 18 months and 2 years for an agency to become fully operational. The use of existing agency or initiative means that this potential problem is avoided, which is a major advantage.

The management chain

- Using agencies or joint initiatives provides a shorter management chain and a high standard of governance than any solution involving outsourcing to the private sector could provide.

- The responsibility of the Commission for executive agencies is clear: the Commission creates them, maintains "real control" over their activity, and appoints the key staff. Their annual activity reports are annexed to the report from their parent Directorate-General. A standard financial regulation adopted by the Commission, governing the establishment and implementation of the budget, applies to all executive agencies.

European membership?

- E.g. ICES is not a European body but is an intergovernmental body whose **members** include States from outside the European Economic Area (Canada and USA) ad excludes many MS (notably those from the Mediterranean and Black Sea).

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Appendix A Off-shore wind farm data

Site specific marine biological surveys for EIAs and monitoring parameters for offshore wind farms

Cost estimates

1 Introduction

This Appendix describes the results of detailed review of existing EIAs, monitoring reports and guidelines on offshore wind farms from different member states. The aim of the review has been to:

- Get information on marine biological data usually required for planning, building and operating offshore wind farms in Europe
- Get detailed information on types of investigations, methodology and scope of investigations for site specific marine biological data required in the different Member States (such as, number of samples of different, number of sampling sites etc.)

Based on this and knowledge of expenditure of time and typical costs of different types of investigations and knowledge on differences in salaries and costs in different countries as well as information from questionnaires (from Germany and UK).

2 EAST ANGLIA ONE, UK

2.1. Background

2.1.1. Operator

East Anglia Offshore Wind Limited has been awarded a licence to develop East Anglia One wind farm.

2.1.2. Characteristics of farm

The planned East Anglia ONE wind farm site is located approximately 43 km east of the Suffolk coast , UK and covers an area approximately 300 km^2.

2.2. Biological field surveys carried out during baseline study for the EIA

An EIA has been prepared and the following site specific biological field surveys were carried out in connection with the preparation of the baseline for the EIA:

- Benthic fauna survey

- Fish survey
- Birds and marine mammal survey

2.2.1. Benthic fauna

The following site specific field surveys were carried out:

- Quantitative sampling of benthic fauna. During the period 20th September 2010 to 7 January 2012 grab samples of benthic fauna was collected at 108 sites. Three samples were collected at each site. The samples were obtained using a 0.1 m^2 mini-Harmon grab. Samples were sorted, identified to species and counted in the laboratory. Biomass of major groups determined (Annelida, Crustacea, Mollusca, Echinodermata, miscellaneous groups). The data was analysed using multivariate statistics (cluster analysis, MDS ordination SIMPER analysis, ANOSIM). Habitat maps were prepared
- Seabed imagery at 19 camera and grab stations. Video imagery and multiple still seabed images were acquired from each of these stations together with a 0,1 m^2 mini-Hamon grab. All imagery was obtained using an underwater camera lowered from a vessel. 5-10 still images and 5-10 min video were taken during each camera deployment.
- Epibenthic sampling and analysis. 20 trawl samples were collected at 20 sites during the period 23 August -4 September 2010. Each trawl sample was obtained with a 2m scientific beam trawl. Catch photographed and fish and invertebrates caught were sorted, identified, enumerated and weighed on board the vessel

2.2.2. Fish

Site specific Fish Surveys were carried during the period 14-19. November 2010 and 16-20. February 2011. A commercial trawl was chartered for the fishery. The following trawl sampling was carried out during the two periods:

- For demersal fish:
  - Otter trawl sampling at 13 sites within the East Anglia ONE site and at 5 control locations outside the site. CPUE (individuals/hour) was estimated for each species caught.
  - Beam trawl sampling at the same 18 sites. CPUE (individuals/hour) was estimated for each species caught
- For **pelagic fish** (target species herring)
  - Pelagic trawl sampling at 9 sites in order to assess the potential presence of spawning herring in the area immediately south of the East Anglia ONE site. The sex, length and spawning condition of each individual of herring was determined (spawning condition was assessed from maturity

stages of testes and ovaries using a nine stage maturity key. By catch species were also identified and counted

2.2.3. Birds and marine mammals

The following site specific surveys of birds and marine mammals were conducted:

- Aerial bird and marine mammal surveys of the overall distribution, density and population size of birds, seals and porpoises by high resolution digital still photo aerial survey undertaken monthly over an 18 month period from April 2010 to October 2011 (18 days of flight time). The survey area for East Anglia ONE comprised the wind farm site area together with a 4 km buffer zone around it.

- Boat based bird and marine mammal surveys over an 18 month period (subject to weather conditions) from May 2010. The surveys were undertaken through a series of transects running east to west across East Anglia ONE at a distance of 2.5 km from one another. A 4 km buffer around East Anglia ONE site boundary to the north, south and west will also be included within the transects. The surveys were undertaken using a team of four experienced surveyors

- Passive acoustic monitoring (PAM) of cetaceans initiated in July 2010 to compliment the visual observations, for period of six months PAM is only able to detect vocalising cetaceans which pass within the detection range of the hydrophone and so is not as reliable as visual observations.

2.3. Biological monitoring

Monitoring activities has not been initiated yet and a monitoring programme has not been published.

2.4. Cost estimate

A cost estimate of these activities is given in the table below.

	Cost €
Benthic fauna studies	260,000
Fish studies	90,000
Bird studies	315,000
Marine mammal studies	315,000
Total	980,000

3. SEAGREEN PHASE 1, UK

3.1. Background

3.1.1. Operator

Seagreen phase 2 is planned by Seagreen Wind Energy Limited which is a joint Venture between SSE Renewable Developments UK Limited and Flour 'Limited.

3.1.2. Characteristics of farm

Seagreen is seeking to construct and operate two offshore wind farms known as Seagreen Alpha and Seagreen Bravo. Each of the two offshore wind farms will accommodate up to 75 wind turbine generators with the potential to generate up to 525 MW of power. Project Alpha will occupy and era of 197 km^2 and Project Bravo 194 km^4. The wind farms will be situated 27-38 km east of the Scottish East coast.

3.2. Biological field surveys carried out during baseline study for the EIA

An EIA has been prepared and the following site specific biological field surveys were carried out in connection with the preparation of the baseline for the EIA:

- Sediment quality survey
- Benthic fauna and demersal fish studies
- Bird and marine mammal studies.

3.2.1. Sediment quality

A total of 50 grab samples were collected and analysed for contaminants.

3.2.2. Benthic fauna and fish studies

The following benthic fauna and fish surveys were conducted during the period: 2010-2012:

- Grab sampling of benthic fauna on 150 sample stations. 100 of these samples were analysed for infaunal identification
- Benthic trawl survey using a 2m wide beam trawl at 50 sites for analysis of epibenthic species and demersal fish species
- Drop down video-survey at 50 sites in approximately the same locations as the epibenthic trawls

3.2.3. Bird and marine mammal studies.

Bird and marine mammal surveys were carried out during the period 2009-2011. The following surveys were conducted

- Bird and marine mammals counting from boat was carried out on a monthly basis during period of two years (i.e.24 surveys) months in an app 500 km^2 area
- Aerial survey of birds and marine mammals in an app500 km^2 area carried out between May 2000 and April 2010

3.3. Biological monitoring

The EIA report was finalised in September 2012. Monitoring activities have not been initiated yet and a monitoring programme has not been published.

3.4. Cost estimate

A cost estimate of these activities is given in the table below.

	Cost €
Benthic fauna studies	80,000
Fish studies	80,000
Bird studies	270,000
Marine mammal studies	270,000
Total	700,000

4. OFFSHORE WIND FARM EGMOND AAN ZEE, Netherlands

4.1. Background

4.1.1. Operator

The operator of the offshore wind farm Egmond aan Zee in the Netherlands is the Nuon-Shell consortium "NoordzeeWind".

4.1.2. Characteristics of farm

The wind farm is situated between 10 and 18 km off the Dutch coast west of Egmond aan Zee and cover an area of 40 km^2. It was built in 2006 and became fully operational at the beginning of 2007. It has a capacity of 108 MW generated by 36 turbines. There is a 500 m safety exclusion perimeter zone which will be closed to all shipping.

The wind farm is a demonstration project for gaining knowledge and experience for future large scale wind farms at sea. The environmental studies were carried out by the National Institute for coastal and Marine Management (RIKZ) which is a part of the 'Directorate General of Public works and Water Management

4.2. Biological field surveys carried out during baseline study for the EIA

Baseline field surveys was carried out in 2003-2004 and comprised:

- Benthic fauna studies
- Fish studies
- Bird studies.
- Marine mammal studies.

4.2.1. Benthic fauna studies

Benthic fauna survey was conducted between 22 and 31 May 2003. The survey included the collection of benthic fauna samples using box core and dredge sampling.

- Box core samples using a 0.068 m^2 box core sampler was collected at 126 sites (a total of 238 samples were collected).
- Dredge samples were collected at 51 dredge sites were larger (100 m^2) more deeply penetrating samples were collected.
- In the lab particle size and organic matter content of sediment were determined. The fauna was sorted, identified and enumerated. Data were analysed statistically using the following statistics: Shannon-Wiener index, Pielous evenness, ANOVA, Kruskal-Wallis, Scheffe post hoc, Dunnes procedure and Cluster analysis using PRIMER software.

4.2.2. Fish studies

Site specific fish studies were carried out in 2002 and 2003 including:

- Hydro-acoustic survey of pelagic fish and trawling for validation in June 2002 (7 work days), April 2003 (7 work days), October 2003 (4 work days). A total distance of 980 nautical miles was surveyed and a total of 81 trawl hauls were done.
- Beam trawl sampling for demersal fish was carried out during the periods 23 June - 4 July 2003 and 19-30 January 2004 (18 work days). A total of 84 transects were trawled. The haul duration at each transect was 15 minutes with an average speed of 3.5 knots. Fish were identified to species and counted . Biological data were collected from selected individuals (length, weight, sex,

maturity and otholits). Catch per unit effort for each species were determined and the following statistics were calculated: Ordination using Conoco 4.5, Redundancy analysis, power analysis.

4.2.3. Bird studies.

Bird counting from ship was carried out nine times during the period 7 April 2003 - 19 February 2004. An area of 239- 486 km^2 (mean 390 km^2) was surveyed each time. At total of 3134 km^2 during the eight surveys. Four bird counters participated during each survey. Total workdays 30

4.2.4. Marine mammal studies.

The following studies on marine mammals were conducted

- Tagging of 12 Harbour Seals with satellite transmitters for 90-227 days in order to define the use of the area by seals
- Surveys of Harbour porpoise including:
  - Acoustic monitoring of harbour porpoise at 8 fixed stations using 8 permanently deployed T-PODs equipped with a CTD, that detects and logs echolocation clicks from harbour porpoises and other cetaceans. The T-PODS were deployed 3. June 2003 and retrieved 25-25 May 2004. The T-PODS were serviced three times during this period.
  - Ship-based surveys carried out 8 times during the period 23 September 2002 -19. February 2004. The total durations of the surveys were 28 days.

4.3. Biological monitoring

In order to assess the impacts of the wind farm the following monitoring activities were carried out:

- Monitoring of benthic fauna
- Underwater acoustic measurements
- Monitoring of pelagic and demersal fish
- Monitoring of birds
- Monitoring of marine mammals

4.3.1. Benthic fauna

Benthic fauna monitoring was conducted 20-26 March 2007 a few months after the completion of the wind farm. The survey included the collection of benthic fauna samples using box core and dredge sampling i.e.:

- Box core sampling of macrobenthos at 60 sites using a 0.078 m^2 box core sampler
- Dredge sampling of macrobenthos at 18 sites

In addition the following surveys were conducted:

- Box core sampling of juvenile bivalve species in October 2006 using a 20 x 30 cm box core sampler in order to assess the impact on bivalve recruitment. Samples were collected at 70 sites. Current meter, fluorescence and turbidity sensors, and CTP were deployed.
- Videorecordings of monopiles and rocks of the scour protection layers were taken on 17-18 February 2011 and 24-25 September 2011. in order to monitor the development of flora and fauna on the hard substrates after completion of the wind farm. In additions Samples of organisms present on the monopoles and rocks were collected. Organisms were identified and counted in the laboratory. biomass was also determined
- In the lab particle size and organic matter content data were determined. Fauna sorted, identified and enumerated. Data were analysed statistically using the following statistics: Shannon-Wiener index, Pielous evenness, ANOVA, Kruskal-Wallis, Scheffe post hoc, Dunnes procedure and Cluster analysis using PRIMER software.

4.3.2. Underwater acoustic measurements

Underwater acoustic measurements using a hydrophone from a fishing vessel which was passively drifting with all equipment switched off were conducted in 2007 during three wind turbine operations.

4.3.3. Fish

Fish monitoring was carried out in 2007 and 2008 after the construction of the farm. The fish monitoring/study included:

- Hydro-acoustic survey of pelagic fish and trawling for validation during the period 4- 20 April 2007 (13 work days). A survey was planned for spring 2011, but it has not been possible to get information on this survey
- Beam trawl sampling was carried out in June 2007 (10 work days) and January 2008 (10 work days). A total of 40 transects were trawled during each survey. A survey was planned for January 2011, but it has not been possible to get information on this survey. The haul duration at each transect was 15 minutes with an average speed of 3.5 knots. Fish were identified to species and counted. Biological data were collected from selected individuals (length, weight, sex, maturity and otholits). Catch per unit effort for each species were determined and the following statistics were calculated: Ordination using Conoco 4.5, Redundancy analysis, power analysis.

› Tagging and telemetry experiments with cod and sole in order to study the potential effects of wind farms on fish behaviour

4.3.4. Birds

The following bird monitoring activities were conducted

› Ship counts of birds along 10 transects (A total length of 250 nm, area 800 km^2), during the period April 2007 - Nov 2009 to assess the distribution patterns of local seabirds. A total of 17 surveys were conducted during a total of 51 days

› Assessment of flight paths of birds flying through the wind farm by visual observation and by fully automated radar observations visual observations were carried out during the period 21 February2007- 16 December 2010. Observations were carried out for a total of 53 days and 6 nights. Radar observations were carried out during the period April 2007 - 31 May 2010.

4.3.5. Marine mammals

The following marine mammal monitoring activities were conducted:

› Tagging of 24 Harbour Seals with satellite transmitters in the spring 2007 after the construction phase and 20 in the autumn 2007 in order to assess the use of the area by seals and to assess any impacts of the wind farm on the seals

› Acoustic monitoring of harbour porpoise at 8 fixed stations using 8 permanently deployed T-PODs equipped with a CTD, that detects and logs echolocation clicks from harbour porpoises and other cetaceans. The acoustic monitoring was carried out during the period June 2007 -April 2009. To investigate the potential effect of the wind farm a statistical before -after-control (BACI) analysis was carried out

4.4. Cost estimate

A cost estimate of these activities is given in the table below.

	Cost planning phase €	**Cost construction phase €**	**Cost operation phase €**
Benthic fauna	200,000	No survey	200,000
Fish	200,000	No survey	190,000
Birds	200,000	No survey	575,000
Marine mammals	650,000	No survey	325,000
Total	1,250,000	No survey	1,290,000

5. BIOLOGICAL MONITORING, Belgium

5.1. Background

A monitoring programme for two wind farms in Belgium has been undertaken in order to assess environmental impacts: The C-Power wind farm on the Thorntonbank and the Belwindfarm.

The C-Power wind farm has 60 windmills with a capcity of 325 MW and is located at 27 kilometres off Zeebrugge. The park is situated in water of 12 to 27 metres deep and the turbines are installed in an area of 18 km² in size.

The Belwind wind farm with a capcity of 330 MW is located 42 kilometres off the coast of Zeebrugge. The parkis built in water of 20 to 35 metres depth and the turbines are installed in an area of 35 km² in size.

As stipulated in the environmental permits, MUMM (Management Unit of the North Sea Mathematical Models of the Royal Belgian Institute of Natural Sciences started a monitoring programme around to estimate the positive and negative effects of the windmills at sea. Different aspects were monitored at the two sites.

5.2. Biological monitoring carried out

In order to assess the impacts of the wind farms the following monitoring activities were carried out:

- Monitoring of benthic flora and fauna
- Monitoring of fish
- Monitoring of birds
- Monitoring of marine mammals

5.2.1. Benthic flora and fauna

The following benthic flora and fauna monitoring was carried out during the period 2005 - 2011:

- Monitoring of biofouling on foundations of C-Power wind farm and Belwin during the period September 2008-November 2011. Quantitative samples of fouling organisms were collected 13 times at C-Power and 9 times at Belwin, during 17 sampling days. Subtidal samples were collected by a SCUBA diver scraping the fouling organisms with a putty knife from a sampling surface area of 0.25 x 0.25 m. two to six replicates were collected during each sampling event. A total of 111 replicate scrape samples were sampled. Videorecordings of the fouling organisms were also taken. Organisms were identified to the lowest possible taxon and counted . Densities were expressed as the number of

individuals per m^2. Data was analysed statistically by the PRIMER-E software.

- Monitoring of soft sediment macrobenthos at C-Power. Van Veen grab samples were collected by SCUBA diver and Van Veen grab around turbine D5 in May 2005, in July and September 2010 and in May 2011. Three replicates were collected at each site (one for sediment analysis and two for biotic analysis). A total of 87 sediment samples and 103 fauna samples were collected. Sediment samples were analysed for grain size distribution, dry weight and total amount of organic material (TOM%). The benthic fauna in the samples were identified and counted. Data were analysed statistically by non-metric multidimensional scaling using the software PRIMER.

- Monitoring of soft sediment macrobenthos at C-Power and Belwin during the period spring 2005 - autumn 2008, 21-24 September 2009 Van Veen grab samples were collected four times. A total of 463 samples were collected visited. Sediment samples were analysed for grain size distribution, dry weight and total amount of organic material (TOM%). The benthic fauna in the samples were identified and counted. Data were analysed statistically by non-metric multidimensional scaling using the software PRIMER.

5.2.2. Fish

The following fish monitoring was carried out during the period 2005 - 2012:

- Monitoring of epifauna and demersal fish fauna at Belwin by trawling with shrimp trawl along twelve, 2 km long transects once in spring and autumn 2008, 2009, 2010, 2011 and 2012. Fish and epifauna were identified and counted and abundance of each species estimated estimated

- Monitoring of epifauna and demersal fish fauna at C-Power by trawling with shrimp trawl along ten 2 km long transects once in spring and autumn 2005, 2008, 2009. Fish and epifauna were identified and counted and abundance of each species estimated

- Monitoring the migration of acoustically tagged cod. 19 specimens were tracked during the period 6 August and 1 October 2010

- Monitoring of changes of fish diet at C-Power in spring 2009 and autumn 2010. Samples for stomach analyses of fish were collected at 4 sites using shrimp trawl. Line and gill net fishing for codfish for analysis of stomach content was also carried out in 2009

- Underwater census by SCUBA divers on scour protection at C-Power between July and October 2009 (9 surveys were carried out)

- Line fishing for cod fish at 7 C-power piles during the period 7 January 2009 - 6 November 2009 (9 fishing rounds were carried out). CPUE was calculated for each species

5.2.3. Birds

The following bird monitoring was carried out during the period 2005 - 2011:

- Monthly ship based counts of birds at C-Power wind farm and Belwin wind farm in 2005 - 2011. A total of 186 surveys were carried out at the two sites
- Test of Radar system for observation of migration of birds in 2010. The system has not yet been deployed at a wind farm.

5.2.4. Marine mammals

The following marine mammals monitoring was carried out during the period 2008 - 2011:

- Aerial survey of harbours porpoise and seals before and during piling operations at C-Power wind farm with a view to assess impacts of piling. Surveys were carried out During the period April 2008 - March 2011. The total duration of surveys during this period were 15days surveys 8-9 April 2008, 5 May 2008, 7 May 2008 29 July 2008, 18-19 February 2009, 14-May 2009 and 4-5 August 2009.
- Passive acoustic monitoring of Harbour porpoise using C-PoDs before and after piling operations at three sites. The C-PoDs were deployed during the period end 19 October 2009, March - May 2011
- Acoustic underwater measurements at four sites before and during piling in order to quantify the underwater noise emitted during the construction phase. Measurements were carried out 11 times during the period 2008-2011.

5.3.Cost estimate

A cost estimate of these activities is given in the table below.

	Cost construction phase both wind farms €	**Mean cost per wind farm**
Benthic fauna	680,000	340,000
Fish	500,000	250,000
Birds	1,500,000	750,000
Marine mammals	550,000	275,000
Total	3,230,00	1,615,000

6. HORNS REV I, Denmark

6.1. Background

6.1.1. Operator

Elsam A/S and Eltra A.m.b.A. established Horns Rev I offshore **wind farm** in 2002. In 2006 Vattenfall took over 60% of the farm making the company responsible for the operation of the **wind farm** and for the environmental monitoring programme.

6.1.2. Characteristics of farm

The Wind farm is situated 14 km west -south west of Blåvands Huk on the southern part of the West coast of Jutland Denmark. The **wind farm** is comprised of 80 2MV wind turbines. The **wind farm** covers a total area of 4 km^2 including a 200 m wide exclusion zone around the periphery of the wind farm. The water depth is 6.5-13.5 m.

6.2. Biological field surveys carried out during baseline study for the EIA

Baseline field surveys was carried out in 1999-2002 and comprised:

- Benthic flora and fauna studies
- Bird studies.
- Marine mammal studies.

6.2.1. Benthic flora and fauna studies

Benthic in fauna survey was conducted in 1999 and 2001. The following surveys were carried out:

- EIA screening spring 1999 including video survey by SCUBA diver at 80 sites. Quantitative sampling of benthic infauna at 40 stations (two replicates at each), aerial photography
- Baseline surveys of benthic infauna were conducted in June and September 2001. In June 2001, samples were collected from a total of 18 stations. In September 2001, samples were collected from 9 stations. At each station, three quantitative HAPS-samples with a surface area of 0.0123 m^2 were taken by SCUBA divers (two for fauna analysis and one for analysis of sediment characteristics). In the laboratory sediment samples were analysed for grain size distribution, dry matter content loss on ignition. Fauna samples were sieved, sorted and the animals were identified to the lowest possible taxon. The data were subject to the following statistical analysis (Multidimensional Scaling (MDS) and ANOVA

6.2.2. Bird studies.

Aerial surveys of bird numbers and distribution in the Horns Rev area 16 times during the period 1999-2001. At each survey a total of 26 north south oriented parallel transects, flown at 2 km interval were surveyed (total lengths of transects 800 km (during one work day). Four observers participated in each survey. For all relevant species, distribution maps based on pooled data from all surveys were prepared and Jacobs sensitivity index calculated

6.2.3. Marine mammal studies.

The following studies on marine mammals were conducted

- Line transect survey from ship of harbour porpoise each year during the period 1999-2001. Transect lay out consisted of 14 parallel lines oriented east-west and with a total length of 500 km. The transects could be completed in two days.3 observers participated in each survey.
- Acoustic monitoring of harbour porpoise at 6 fixed stations using 8 permanently deployed T-PODs equipped with a CTD, that detects and logs echolocation clicks from harbour porpoises and other cetaceans. The T-PODS were deployed 1 July 2001 and were in operation during the pre construction phase until 3. March 2002.

6.3. Biological monitoring

In order to assess the impacts of the **wind farm** the following monitoring activities were carried out:

- Monitoring of Benthic flora and fauna
- Underwater acoustic measurements
- Monitoring of fish
- Monitoring of birds
- Monitoring of marine mammals

6.3.1. Benthic flora and fauna

During the monitoring period, infauna surveys were conducted in 2003, 2004 and 2005 i.e.

- In September 2003 and 2004, samples were collected at 24 stations
- In March-April 2005 samples were collected from 45 stations.
- At each station, three quantitative HAPS core samples with a surface area of 0.0123 m^2 were taken by SCUBA divers (two for fauna analysis and one for analysis of sediment characteristics. In the laboratory sediment samples were analysed for grain size distribution, dry matter content loss on ignition. Fauna

samples were sieved, sorted and the animals were identified to the lowest possible taxon. The data were subject to the following statistical analysis (Multidimensional Scaling (MDS) and ANOVA.

Monitoring surveys of hard bottom flora and fauna were performed in March and September each year from 2003 to 2005 in order to monitor the colonisation of flora and fauna on monopoles and scour protection. Surveys were performed at six turbine sites. The surveys at each turbine site included

- Collection of samples on the scour protection by SCUBA divers along a transect in the direction of the main current Three stations at distances 0.5 m, 2 m and 5 m from the monopiles were selected along the transects. As a reference, one station was additionally sampled 5 metres upstream from the monopole. At each station, samples of fouling organisms were thoroughly scraped off the stone blocks within a frame of 0.04 m² using a special scraping tool and a special underwater air-lift device. A total of 72 scour protection samples were collected during each survey.

- Collection of samples by SCUBA divers on three e monopile at three locations at depth intervals of 0 m, 2 m, 4 m, 6 m and 8 m measured from the bottom of the scour protection Two 0.04 m² frame samples were taken within each depth interval on each side of the monopile. Larger algae and shellfish as well as other fouling organisms were scraped off using the same technique used on the scour protection

- Visual determination by SCUBA diver A semi quantitative assessment was carried out on the coverage of different groups of organisms on monopoles and scour protection using the Braun-Blanquet scale .Underwater video recordings were also made for documentation.

6.3.2. Underwater acoustic measurements

Measurements of underwater noise were done at one site in the **wind farm** area during the period 2-5 November 2005.

6.3.3. Fish

Fish monitoring was carried out in 2003, 2004 and 2005 after the construction of the farm. The fish monitoring/study included:

- Test fishing was performed at a turbine site in September 2003 in March 2004 and September 2004 In order to assess the fish fauna at monopoles and scour protection. Both pelagic biological survey gill nets and sinking gill nets were used during day and night.

- Hydro-acoustic survey of fish during the periods 9-10 October 2004 and 4-6 September 2005. The hydroacoustic surveys were carried out along four transects. During the 2005 survey fishing with pelagic and benthic gill nets as well as small pelagic trawl was carried out as well

› Fishing for sandeels and shellfish using a special sandeel dredge at 12 sites in February March 2002 (5 workdays) and in March 2004 (5 workdays). The sandeels caught were identified to species, counted, measured and weighed. Maturity was also determined. The different species of shellfish caught were counted and length and weight of each individual was measured. The swept area of each dredge hauls was calculated and used to estimate relative densities of sandeel. 36 grab samples for grain size distribution analysis were sampled as well at each of the two sampling rounds.

6.3.4. Birds

› Aerial surveys of bird numbers and distribution in the Horns Rev area 16 times during the period 2002-2005. At each survey a total of 26 north south oriented parallel transects, flown at 2 km interval were surveyed (total lengths of transects 800 km (during one work day). Four observers participated in each survey. For all relevant species, distribution maps based on pooled data from all surveys were prepared and Jacobs sensitivity index calculated

› Radar and visual observation of birds with a view to assess avoidance behaviour and collision risk due to the presence of the **wind farm** in spring and autumn during the period 2003-2005. Observation of migratory birds was undertaken from a transformer station 560 m north of the **wind farm**. Observations were performed during a total of 19 visits to the area. In total 243 hour of visual observation and 403 hours of radar observations were carried out. The migration routes of the birds were mapped by tracing the course of bird flocks.

› Radar, visual and acoustic observations of migrating birds were carried out from anchored vessel during spring and autumn 2005. 10 trips with 35.5 effort days were carried out. In spring 67 hour of acoustic surveys during night were carried out and 297 in autumn.

6.3.5. Marine mammals

› Harbour seals. Tagging of 21 Harbour Seals with satellite transmitters during the period 2002-2005 in order to observe the use of the area by seals and to assess any impacts of the **wind farm** on the seals

› Line transect survey from ship of harbour porpoise each year during the period 2002-2005. Transect lay out consisted of 14 parallel lines oriented east-west and with a total length of 500 km. The transects could be completed in two days.3 observers participated in each survey.

› Acoustic monitoring of harbour porpoise at 6 fixed stations using 8 permanently deployed T-PODs equipped with a CTD, that detects and logs echolocation clicks from harbour porpoises and other cetaceans. The T-PODS operated from 18 December 2002 to 31 December 2005.

6.4. Cost estimate

A cost estimate of these activities is given in the table below.

	Cost planning phase €	Cost construction phase €	Cost operation phase €
Benthic fauna	190,000	No survey	280,000
Fish	25,000	No survey	150,000
Birds	180,000	30,000	410,000
Marine mammals	150,000	110,000	265,000
Total	545,000	140,000	1,105,000

7. NYSTED OFFHORE WIND FARM, Denmark

7.1. Background

7.1.1. Operator

Nysted Offshore Wind farm was established in 2003 by ENERGI E2 as operator. Ownership is shared between ENERGI E2, DONG and Sydkraft.

7.1.2. Characteristics of farm

Nysted Offshore Wind Farm is located in the Baltic Sea south of the Danish island Lolland. The nearest distance to the shore (Nysted) is 10 km. It consists of 72 wind turbines each of 2.3 MW, corresponding to a total of 165.6 MW installed power. The farm occupies an area of

7.2. Biological field surveys carried out during baseline study for the EIA

Baseline field surveys was carried out in 1991-2001 and comprised:

- Benthic flora and fauna studies
- Fish studies
- Bird studies.
- Marine mammal studies.

7.2.1. Benthic flora and fauna studies

Benthic flora and fauna surveys were conducted in 1999 and 2001 and included:

- Mapping of distribution of marine habitats and extent of and coverage of eelgrass and macroalgae based on photo sampling on 165 sites within the future wind farms site and at reference sites during the period 10-12 May 1999. The photosampling equipment consisted of a photo camera and a video camera mounted on a steel frame that is lowered to the bottom. The video is connected to a monitor a videorecorder on board the survey vessel. Extent of seagrass, algae, musselbeds and sand bottom was mapped based on a general evaluation of the photo and videorecordings and the coverage of seagrass and macroalgae estimated.

- Mapping of distribution of marine habitats and extent of and coverage of eelgrass and macroalgae based on photo sampling on 310 sites within the future wind farm site along the cable transect and at reference sites during the period 25-27 May 2001.

- Quantitative sampling of benthic fauna, sediment, common mussels and fouling organisms during the period 2-5 August 1999 within the future wind farms site and at reference sites Benthic fauna and sediment were collected at 89 sites using a 0.1 m^2 Van Veen grab (one sample at each site). The sediment samples were analysed for dry weight and loss on ignition. 'The benthic fauna samples were sorted and the animals identified to species level and counted. A diver collected 5 quantitative samples of common mussels at each of 19 sites. Biomass and condition were measured in the laboratory. Videorecordings and quantitative samples of fouling organisms were collected from a metocean measurement mast in the area mast . Data were analysed statistically using cluster analysis, MDS, BIENV, SIMPER and ANOSIM-test.

- Quantitative sampling of eelgrass and macroalgae in August 2001 by SCUBA diver at 6 and 7 sites respectively. Six samples were collected at each site. Shoot density biomass of eelgrass were determined as well as species composition and biomass of algae

- Quantitative sampling of benthic fauna and sediment along the cable transect in August 2001. Benthic fauna and sediment were collected at 20 sites using a 0.1 m^2 Van Veen grab.

7.2.2. Fish studies

Fish surveys were carried out during the spring 1999. The following fish surveys were carried out:

- Test fishing using gill nets and fish traps at 10 sites on 27 and 28 April 1999. Catch per unit effort were estimated for each species of fish caught

- Test trawling along 8 transects during the period 26 - 27 May 1999. Catch per unit effort were estimated for each species of fish caught

- Test fishing for adult fish and fish fry at 24 sites using specially designed (scientific) gill and fyke nets. The fishing for adults were carried out during the periods 16-27 May and 16-20 June 2001. The fishing for fry was conducted in the periods 24 -27 September, 25 -28 October and 24 -26

November 2001. Catch per Unit effort for numbers and total weight of each species were estimated

7.2.3. Bird and marine mammal studies.

The following bird and marine mammals studies were conducted:

- Observations of migrating birds in the Rødsand area during 22 September-12 November 1999 (28 days) and during 20 March - 19 April 2000 (13 days). Observations were conducted from an observation tower placed 5 km northeast of the wind park area
- Observation of foraging movements of Cormorants from observation tower on 29 September 1999
- Aerial surveys of bird, seal and porpoise numbers and distribution in the Rødsand area 7 times during the period 9 February 1999 -4 April 2000. During each survey a 26 north south oriented parallel transects were flown (total lengths of transects 597-1176 km (during one work day). Four observers participated in each survey. For all relevant species, distribution maps were prepared
- Bird, seal and porpoise surveys from ship were carried out nine times during the periods 30 January- 12 February, 21-22 March and 17-18 August 1999. The survey included a total 25 north-south orientated parallel transects

7.3. Biological monitoring

In order to assess the impacts of the wind farm the following monitoring activities were carried out:

- Monitoring of benthic flora and fauna
- Monitoring of fish
- Monitoring of birds
- Monitoring of marine mammals

7.3.1. Benthic flora and fauna

During the monitoring period, benthic fauna surveys were conducted in, 2004, 2005 and 2006 i.e.

- Monitoring of the composition of the benthic fauna by photosampling and videorecording at 200 sites in May 2005, Qauntitative sampling by Van Veen grab (0.1 m^2) on 88 sites in August and Quantitative sampling of common mussels in 'August 2005

- Monitoring the colonisation by fouling organisms on concrete foundations, stone filling on foundations and scour protection stones by video recording, underwater photography and quantitative sampling of sessile organisms in September-October 2003 and in September 2005.

7.3.2. Fish

Fish monitoring was carried out in 2004 and 2005. The fish monitoring/ included:

- A static hydroacoustic survey of fish at a turbine foundation to investigate effects from foundations and turbine activity on fish behaviour during the period 11 November - 11 December 2004. The surveillance system consisted of two submerged surveillance units, a hydroacoustic surveillance unit and a shared control/data acquisition unit. The acoustic survey was supplemented with videorecordings and test fishing using "biological" gill nets

- A dynamic hydroacoustic survey of fish from a dinghy sailing along a 28 km long track on 31 October and 1 November 2004

- A Hydro-acoustic survey of fish from a large vessel during the periods 1½6-17 September and 21-23 September 2005. The hydroacoustic surveys were carried out along 6 transects with a total length of 28 km.. Supplementary fishing with pelagic and benthic gill nets as well as small pelagic trawl was carried out as well

- Test fishing with fyke nets deployed on both sides of the cable from the wind farm in order to assess any impacts on fish migration from electromagnetic fields around the cable. . Fishing was carried out from a rubber dinghy during the periods 23 September to late November, 10 August - 25 September 2002, 9 September -17 November 2003. During the fishing periods the nets were emptied every second day.

7.3.3. Birds

The following bird monitoring activities were conducted:

- Aerial surveys of birds numbers and distribution in the Rødsand area 25 times during the period May 2000 - November 2005. During each survey a 26 north south oriented parallel transects were flown (total lengths of transects 597- (during one work day). Four observers participated in each survey. For all relevant species, distribution maps were prepared

- Radar and visual studies of bird migration with a view to assess avoidance behaviour and collision risk due to the presence of the wind farm in spring and autumn during the period 2000-2005. Each year observations were carried during 14 March -19 April and 30 August -12 November

7.3.4. Marine mammals

The following marine mammal monitoring activities were conducted:

- Tagging and satellite monitoring of 4Harbour Seals and 6 Grey Seals with satellite transmitters during the period 21 April 2001 -29 April 2002 in order to observe the use of the area by seals and to assess any impacts of the wind farm on the seals

- Monthly aerial surveys of seals at hauls out sites during the period March 2002 -October 2005. A total of 48 surveys each lasting 2 hours were conducted. Two observers were employed at each survey

- Remote video monitoring of seals at a seal sanctuary (haul out site) close to the wind farm to monitor impacts of construction of wind farm. Two web based video cameras were installed in April 2002 and operated to the end of 2004. A total of 656 days of recording took place resulting in 5 million pictures which were stored and analysed

- Acoustic monitoring of Harbour Porpoise at 6 fixed stations using deployed T-PODs equipped with a CTD, that detects and logs echolocation clicks from harbour porpoises and other cetaceans From 14 November 2001 to 19 December 2005 a total of 12 different T-PODs were deployed resulting in a total of 7018 deployment days. The stations were visited around 40 times for service and deployment .

7.4. Cost estimate

A cost estimate of these activities is given in the table below.

	Cost planning phase €	**Cost construction phase €**	**Cost operation phase €**
Benthic fauna	190,000	No survey	230,000
Fish	145,000	No survey	75,000
Birds	250,000	125,000	460,000
Marine mammals	No survey	160,000	280,000
Total	585,000	285,000	1,045,000

8. KRIEGERS FLAK II, SWEDEN

8.1. Background

8.1.1. Operator

Construction of Kriegers Flak II is planned to start 2012/2013. The developer is Wattenfall in cooperation with WPD Offshore. An EIA has been prepared and permission to construct the wind farm has been issued .

8.1.2. Characteristics of farm

The planned construction site is situated on the north Eastern section of Kriegers Flak inside Sweden Economic Zone about 30 km south of Trelleborg Sweden. The water depth is 16-42 meters. The wind farm is planned to consist of a maximum of 128 wind turbines with a capacity of 5 MW each and covering an area of 75 km^2.

8.2. Biological Field surveys carried out during baseline study for the EIA

Baseline field surveys was carried out in 2000-2004 and comprised:

- Benthic vegetation and fauna studies
- Fish studies
- Bird studies.
- Marine mammal studies.

8.2.1. Benthic vegetation and fauna studies

Benthic vegetation and fauna surveys were conducted in 2002 and 2003. The surveys included:

- Videosurveys along five transects with a total length of 20 km in September 2003
- Quantitative sampling of benthic infauna at 20 sampling sites using 0.1 m^2Van Veen grab. Three samples were collected at each site. Samples were twice in 2002 and twice in 2003. Data were subject to cluster analysis and multidimensional scaling analysis

8.2.2. Fish studies

Trawling for fish was carried out in April, May and June 2004 during a total of 28 days.

8.2.3. Bird studies.

The following bird surveys were conducted:

- Aerial surveys of birds in an 840 km^2 area 16 times during the period April 2000 - March 2004.
- Ship surveys of birds in a 500 km^2 area 35 times during the period April 2000 - March 2004.

› Radar and visual studies of bird migration . Observations were carried out 65 days during the period April 2002-March 2003 and 58 days during the period April 2003-March 2004

8.2.4. Marine mammal studies.

The following surveys of seals and porpoises were conducted:

› Aerial surveys in a 560 km^2 area 21 times during the period April 2002 and - March 2004. (conducted together with the bird surveys)

› Ship surveys in a 500 km^2 area 35 times during the period April 2000 - March 2004 (conducted together with the bird survey

› Acoustic monitoring of harbour porpoise from an anchored ship using T-PODs 2-3 days 15 times resulting in 36 days of observations .

8.3. Biological monitoring

The EIA report was finalised in 2004. The construction of the farm is planned to start 2012/2013, monitoring has therefore not been initiated

8.4. Cost estimate

A cost estimate of these activities is given in the table below.

	Cost €
Benthic fauna studies	180,000
Fish studies	180,000
Bird studies	660,000
Marine mammal studies	530,000
Total	1,550,000

9. GERMANY GENERAL GUIDELINES

9.1. Background

Bundesamt für Seeschiffahrt und Hydrographie in Germany has prepared general guidelines for investigations that are mandatory for baseline surveys and monitoring of impacts of offshore windmills in German waters. This section outlines the mandatory biological investigations.

9.2. Baseline Survey

In Germany the following baseline investigations for the Environmental Impact Assessment of Offshore wind farms are mandatory:

- Benthic fauna and benthic vegetation investigations
- Fish investigations
- Bird investigations and
- Marine mammal investigations

The investigations must cover two successive complete seasonal cycles

9.2.1. Benthic fauna and vegetation

The benthos, sediment and water quality investigations must comprise:

- Grab sampling survey of infauna during at least two consecutive complete seasonal cycles (spring and autumn) prior to the start of construction, i.e. at least four survey rounds. At least 20 stations in small areas (< 20 square nautical miles). At least two samples must be collected per stations. The samples shall be collected by 0.1 m^2 Van Veen grab
- Beam trawl/dredge survey of epifauna during at least two consecutive complete seasonal cycles (spring and autumn) prior to the start of construction, i.e. at least four survey rounds. The number of sampling sites depends on the number of infauna stations. Half of the infauna stations have to be surveyed by means of beam trawls or dredge hauls. In smaller areas (< 20 square nautical miles), ay least 10 beam trawl surveys or dredge hauls should be conducted
- Videosurvey of epifauna, near stations for beam trawl, dredge and grab sampling stations videosurvey of about 15-30 min duration and or photo with 10 to 20 photos per station
- Investigation of benthic vegetation (macroalgae/seagrasses) if present in the area, by videosurvey along transects. At least 3 transects in each habitat type must be carried out. once a year during two years prior to the start of construction

9.2.2. Fish.

Fish survey by beam trawl or otter trawl must be carroed out twice a year (spring and autumn) at least two consecutive years before the start of construction. In project and reference areas > 100 km^2., the minimum number of hauls should be 30 each. 20 hauls will be sufficient if a beam trawl Is used. In project and reference areas < 100 km^2 the minimum number of hauls should be 20 each. 15 if beam trawl is used.

9.2.3. Birds

The bird investigations shall include:

› Monthly ship based transect counts of birds at least two consecutive complete annual cycles before the start of construction.

› Monthly aerial counts at least two consecutive complete annual cycles before the start of construction.

› Radar surveys of bird migration during main migration period (i.e. March to May and mid-July to mid November (end of November in the Baltic) at least two consecutive complete annual cycled before the start of construction. Survey frequency in the main migration periods must be 7 days/month.

9.2.4. Marine mammals:

The marine mammal investigations shall include:

› Aerial counts of marine mammals. The assessment area including the reference area must cover at least 2000 $km^2$and should have a rectangular shape

› Ship based counts of marine mammals. The assessment area of a project area must cover at least 200 km^2 in principle. The size of the reference area correspond to the size of the assessment area for the project

› Acoustic monitoring of harbour porpoise using 3 click detectors T-PODs at least two consecutive complete seasonal cycles prior to the start of construction

9.3. Biological monitoring

9.3.1. Benthic fauna and vegetation

Monitoring of impacts on benthic fauna and vegetation shall include:

› Monitoring of infauna by grab sampling during construction and operation phase. At least 20 stations must be sampled in small areas (< 20 square nautical miles). At least two samples must be collected per stations. The samples shall be collected by 0.1 m^2 Van Veen grab. In addition installation based effect monitoring has to be started upon completion of two installations during construction phase (with six sampling sites per installation). During the operation phase installation based effects monitoring must be carried out additionally at two wind turbines as a minimum (with six sampling sites per installation)

› Beam trawl/dredge s monitoring of epifauna throughout the construction phase and at least three years up to five years during the operation phase. Each year one survey shall be conducted during spring and one during autumn. The number of sampling sites depends on the number of infauna stations. Half of the infauna stations have to be surveyed by means of beam trawls or dredge

hauls. In smaller areas (< 20 square nautical miles), ay least 10 beam trawl surveys or dredge hauls should be conducted

- Videosurvey of epifauna during construction and operation phase, near stations for beam trawl, dredge and grab sampling stations videosurvey of about 15-30 min duration and or photo with 10 to 20 photos per station

- Investigation of fouling on underwater structures. During construction and operation phases piles, foundations and scour protections must be surveyed by SCUBA divers that takes photo and videos and collect quantitative scratch samples at three depths. The survey shall be carried out after erection of piles/foundations and at least three years up to five years in the operation phase.

- Monitoring of benthic vegetation (macroalgae/seagrasses) if present in the area, by videosurvey along transects. At least 3 transects in each habitat type. Must be carried out once a year throughout the construction phase and at least three years up to five years if required after commissioning.

9.3.2. Fish

Monitoring of impacts on fish shall include:

- Fish survey by beam trawl or otter trawl once a year, one year during the construction phase and in the first, third and fifth year of the operation phase. In project and reference areas > 100 km^2, the minimum number of hauls should be 30 each. 20 hauls will be sufficient if a beam trawl Is used. In project and reference areas < 100 km^2 the minimum number of hauls should be 20 each. 15 if beam trawl is used.

- Additional Installation based fish monitoring at two operational wind turbines or set net

9.3.3. Birds

Monitoring of impacts on birds shall include:

- Monthly ship based transect counts of birds throughout the construction phase and at least three years, up to five years if required, after commissioning.

- Monthly aerial counts throughout the construction phase and at least three years, up to five years if required, after commissioning.

- Radar surveys and visual observations/recording of flight calls of bird migration during main migration period (i.e. March to May and mid-July to mid November (end of November in the Baltic) throughout the construction phase and at least three years, up to five years if required after commissioning. Survey frequency in the main migration periods must be 7 days/month.

9.3.4. Marine mammals

Monitoring of impacts on marine mammals shall include:

- Monthly ship based transect counts of marine mammals together with the bird count throughout the construction phase and at least three years, up to five years if required, after commissioning.
- Monthly aerial counts of marine mammals together with the bird survey throughout the construction phase and at least three years, up to five years if required, after commissioning. six additional aerial surveys per year covering only marine mammals have to be made
- Acoustic monitoring of harbour porpoise using 3 click detectors T-PODs throughout the construction phase and at least three years, up to five years if required after commissioning
- Surveys of waterborne noise emissions and immissions throughout the construction phase and within 12 months after the wind farm has been put into operation.

9.4. Cost estimate

A cost estimate of these activities is given in the table below.

General cost estimates for a 200 MW wind farm was received from two German operators, cf. tables below

	Cost planning phase €	**Cost construction phase €**	**Cost operation phase €**
Benthic fauna	1,200,000	600,000	1,200,000
Fish	210,00	105,000	210,000
Birds	2,250,000	750,000	2,250,000
Marine mammals	630,00	300,000	600,000
Total	4,290,000	1,755,000	4,260,000

	Cost planning phase €	**Cost construction phase €**	**Cost operation phase €**
Benthic fauna	425,000	210,000	425,000
Fish	75,000	40,000	75,000
Birds	500,000	250,000	500,000
Marine mammals	500,000	250,00	250,000
Total	1,500,000	750,000	1,250,000