

CELTIC SEAS  
PARTNERSHIP

Marine Strategy Framework Directive

**Discovering Data And Information  
in the Celtic Seas**

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## EXECUTIVE SUMMARY

This document describes and analyses some aspects of the spatial data infrastructure currently in place around Europe that may support the implementation of the Marine Strategy Framework Directive in the Celtic Seas and makes recommendations for targeting of the Celtic Seas Partnership (CSP) data portal.

The Marine Strategy Framework Directive (MSFD), the environmental pillar of Europe's Integrated Maritime Policy, requires EU member states to achieve Good Environmental Status for each of 11 descriptors by 2020. The Directive is structured around a cycle of adaptive management, takes an ecosystem-based approach and obliges member states to harmonise their efforts across regional seas. One critical aspect of successful application of ecosystem-based management is consideration of scale; it is vital to for successful management that relevant data at appropriate spatial scales are available to guide the management process. Accessibility and reliability of data are also key issues in the provision of data relevant to the Directive and, ideally, the provision of data should be targeted at key relevant audiences.

There are a large number of relevant sources of environmental data gathered for the purposes of complying with a range of aquatic and marine environmental directives. Given the long evolution of European environmental policy over time, sourcing relevant information can be complex. Practical application of specific environmental legislation may rest in the hands of national and local governments or devolved authorities and local governments. All have different institutional structures, cultures and sometimes languages and this further complicates the task of finding relevant data for application to the MSFD.

Added to the institutional and legislative complexity, the 11 descriptors of the MSFD may be measured by different indicators, comprised of criteria and sub-criteria, and these data may be gathered by different institutions in different ways using different instruments, units and file formats.

Furthermore there are many possible users of MSFD relevant data, which form a spectrum from data-intensive users (such as environmental scientists) to less technical users (such as local decision makers) and finally the general public. Facilitating data use must therefore consider the appropriate target audience.

There are a number of large-scale initiatives at the

European level to facilitate the sharing and quality control of marine data. The INSPIRE directive places a legislative requirement on national governments to improve data availability and traceability. Some major data sharing initiatives include SeaDataNet and MyOCean/ Copernicus, both of which are targeted at technical, oceanographic and scientific communities. Other data portals such as SeaDataNet and Disconet provided more policy focussed collections of marine environmental data. In order to examine the practical aspects of data availability for implementation of the MSFD in the Celtic Seas two use case studies were selected; the first pertains to Descriptor 3 (Commercial fisheries) of the Directive and the second pertains to Descriptor 2 on non-indigenous species.

At the scale of the Celtic Seas, individual nations and devolved authorities each have various data portals that contain some data relevant to commercial fishing. The exact types of information on fishing pressures varies across portals and between countries and sometimes is not particularly well documented. Nevertheless the relatively long history of fisheries management around Europe has resulted in a well-established structure for the collection and dissemination of fisheries-related data and the International Council for the Exploration of the Seas (ICES) provides spatially explicit data targeted at specific levels of public interest within and around Europe and within the Celtic Seas. By contrast, data on the presence or absence of non-indigenous species are less readily discovered and data sources are patchier. While there are a number of databases collating information on the occurrence of non-indigenous species there is no harmonised regional database of non-indigenous species in the marine environment.

The review of web portals and data sources along with considerations of the different potential audiences for MSFD-relevant data were combined to make a number of recommendations for design of portals for dissemination of information and data across the Celtic Seas.

Major considerations in the construction of a Celtic Seas portal should include: the target audience, the message to be conveyed, the level of functionality required, the stakeholders, the legacy of the portal and the amount and type of data that should be included.



## PURPOSE

Data and information at appropriate spatial and temporal scales are key ingredients to support ecosystem-based management and to implement the Marine Strategy Framework Directive. The purpose of this document is to examine the complexity of the data landscape within European marine environmental policy, to identify the current state of the art and the challenges of delivering Marine Strategy Framework Directive data at relevant spatial and temporal scales to interested stakeholders. The report will conclude with a set of recommendations for the CSP web portal.

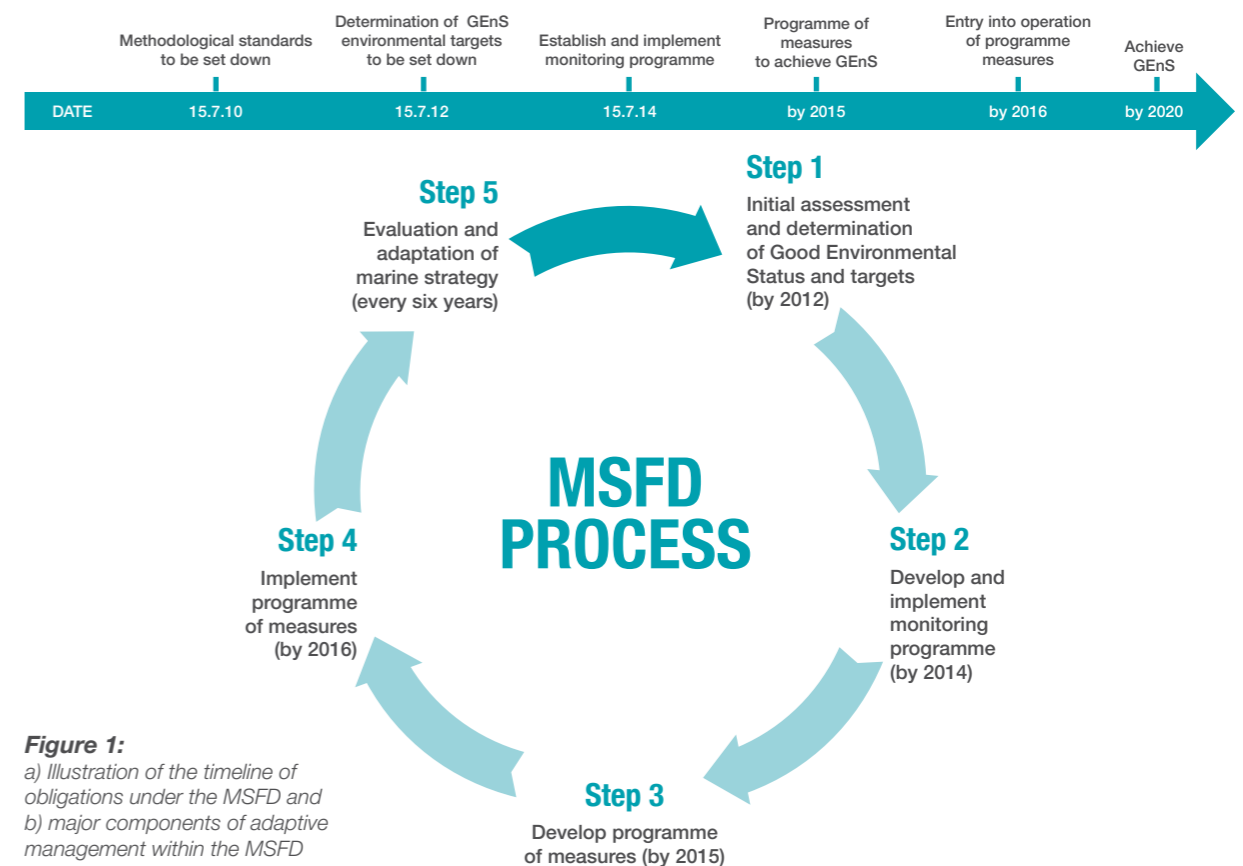
## INTRODUCTION

### MARINE STRATEGY FRAMEWORK DIRECTIVE

The Marine Strategy Framework Directive (MSFD), adopted in 2008, is a directive of the European Union with the aim of protecting Europe's marine environment. The Directive applies to the marine waters of all European member states and requires EU nations to achieve 'Good Environmental Status' (GES) for each of eleven environmental descriptors by 2020. The scope of the directive includes management of the environment as a whole system with, for example, descriptors on biodiversity and non-indigenous species as well as the management of specific human pressures such as commercial fisheries and discharges from agriculture and waste water. The Directive sets out a strict timeline for member states to achieve certain milestones on the road to achieving GES (Figure 1a) and includes an adaptive management process (Figure 1b) obliging each EU member state to assess its progress towards GES every 6 years, allowing members, based on this information, to refine their targets for GES and to set out the measures they will take to reach these targets. The Directive also

mandates that implementation be harmonised on a regional seas basis. The national statutory reports based on the timeline below containing information on initial assessment and monitoring programmes have been reported and the associated reports are publicly available for download for all EU nations, including those within the Celtic Seas, on the European Environment Agency's Reporting Obligations Database.

The adaptive management process of the Directive includes three main steps, which occur in a cycle - these are assessment of environmental status, production of a set of measures to achieve GES and monitoring of the marine environment. This process of adaptive management is one element of what is often called the ecosystem-based approach to management (shortened here to EA). The MSFD stresses the importance of EA in implementation and as such it is an important aspect of the MSFD. The concept of the EA (also sometimes called Ecosystem Based Management) is enshrined in the UN Convention on Biodiversity (CBD); as such its inclusion in the MSFD recognises the role of the directive in global conservation. The preamble of the Directive explicitly acknowledges the CBD.



**Figure 1:**  
 a) Illustration of the timeline of obligations under the MSFD and  
 b) major components of adaptive management within the MSFD

There have been many different definitions of the EA (see Farmer et al. 2012 for review), but its three main characteristics are generally considered to be

- Inclusion of all ecosystem components
- Consideration of ecosystems processes and the ecosystem services they provide
- An emphasis on the inclusion of stakeholders

At the fundamental level the ecosystem approach seeks to integrate the connections between human activities and the environment, so that humans can understand and manage the environmental consequences of their actions. The approach recognises that human societies are contained within and are entirely dependent on ecological systems (Boumans, 2006). The ecosystem approach therefore seeks to balance the goals of conservation and development.

One critical aspect of the ecosystem approach is that of scale (Cash et al., 2006; Cummings et al., 2006; O'Higgins et al., 2014), for effective environmental management scales of action must match the scales of the phenomena occurring within the ecosystems to be managed. While the large geographical scale of jurisdiction of the MSFD (covering over 11M km<sup>2</sup> throughout Europe), the capacity to manage these marine ecosystems effectively requires action, supported by information and data at the appropriate spatial scales.

Just as data to support management at the appropriately large (and small) spatial scales are required to support effective management under the MSFD, temporal scales of management are also important. The feedback loops of the adaptive management within the Directive (Figure 1) must occur sufficiently rapidly to respond to manageable problems as they arise while supporting prolonged campaigns to improve environmental status for ecosystem components and human drivers, which may respond over longer timescales (O'Higgins et al., 2014b).

Further to gathering data at appropriate spatial and temporal scales, delivering these data to the appropriate individuals is also a major challenge. In particular the assessment of environmental status and the monitoring of the marine environment generate data about the state of the marine environment that are of interest to many different audiences (e.g. users, policy-makers, special interest groups). Interested groups may include specific economic sectors concerned with their impacts (positive or negative) on the state of the environment, to individual citizens who may be concerned about the health of the oceans. Different types of individuals interested in the management of the marine environment have different data needs and requirements. The environmental scientists tasked with monitoring the state of the marine environment may want data in minute detail, measurements to several decimal places of accuracy;



they may wish to know the exact species, number and weight of worms living in a particular patch of submarine mud. At the other extreme a recreational beach user may simply want to know whether it is safe to swim in the water, while the manager might need to know if the beach should be open or closed to recreation, fisheries or other activities.

The challenges of delivering these types of data at appropriate spatial and temporal scales to appropriate audiences is the subject of this report. The remainder of this section gives an overview of the complex legal and institutional framework that currently generates MSFD data at the European scale. Section 2 gives an overview of some major Europe-wide data sharing initiatives. Section 3 provides practical examples of data discovery for MSFD descriptors in the Celtic Sea, while Section 4 derives some overall conclusions. Overall this report aims to provide an overview of the challenges of producing an integrated system for data discovery within the Celtic Seas region that may be of interest to planners and managers, while signposting individual resources that may be of interest to specific resources for stakeholders and user groups with an interest in the Celtic Seas region.

## LEGISLATIVE COMPLEXITY

The characteristics of the ecosystem-based approach enshrined within the MSFD, along with its broad suite of 11 indicators and large geographic scope, clearly mandate a broad consideration of the marine environment. With such a comprehensive scope, it is not surprising that many elements of the MSFD relate to other parts of European policy and legislation.

Though the MSFD is the most integrated and ambitious piece of marine environmental legislation put in place by the European Union, it is not the only one, and legislation relevant to the marine environment has developed over time. It should be noted that each piece of marine

environmental legislation has its own particular set of legislative actions and reporting requirements and, as such, each piece of legislation generates data and information.

European legislation with relevance to marine environmental health has been evolving since the foundation of the European project. With an initial post-war focus on food security, environmental policy (such as it was) focussed on the exploitation of the environment, at first through agriculture under the Common Agricultural Policy and subsequently through fisheries under the Common Fisheries Policy (O'Higgins, 2015). The complex evolution of agricultural and fisheries legislation over time would require many volumes

Policy/Directive/Regulation	Year	Information Platform	Organisation
Common Agricultural Policy	1962		
Bathing Water Directive	1976		JRC
Birds Directive	1979	EIONET	ETC Bio
Common Fisheries Policy	1983		
Urban Waste Water Treatment Directive	1991	Eurostat	JRC
Nitrates Directive	1991	FATE	JRC
Habitats Directive	1992	EIONET	ETC Bio
Convention on Biodiversity	1992	Cbd.int	UNEP
Water Framework Directive	2000	WISE	EEA
Recommendation on Integrated Coastal Zone Management	2002		
Floods Directive	2007	EIONET	ETC/IC
Marine Strategy Framework Directive	2008		
Waste Framework	2008	EUROSTAT	
Regulation on Alien Invasive Species	2014	EASIN	JRC
Maritime Spatial Planning Directive	2014		EUMOFA

**Table 1:** List of major EU policies and directives relating to the marine environment including year of introduction, existing public data platforms and the European level institutions responsible for maintaining the resulting data and information. JRC= EU Joint research centre. ETC= European topic centre

to explore (to examine the most recent changes in fisheries legislation visit the commission's dedicated website ([http://ec.europa.eu/fisheries/cfp/control/index\\_en.htm](http://ec.europa.eu/fisheries/cfp/control/index_en.htm)). As the awareness of adverse environmental consequences of human activities both on land and in the marine domain began to emerge, newer, more environmentally focussed legislation was developed. Table 1 lists some of the major EU and international environmental legislation relevant to the marine environment under which data and information relevant to the MSFD have been collected - note the increasing amount of environmental legislation over time and the diverse locations of data holdings.

The most important feature of this table is that it illustrates the multiple different origins and objectives for data gathering initiatives at the European scale within the marine environment. While such data are of clear relevance and importance to the MSFD and to implementation of an ecosystem approach with Europe's seas it should be clear that different groups of individuals, different economic sectors and different government departments may have responsibilities for generation and dissemination of the data, which can result in the lack of data visibility and clarity for the interested stakeholder.

## INSTITUTIONAL COMPLEXITY

While the MSFD provides a common objective in terms of marine environmental quality for all member states, the responsibility for implementing the MSFD and providing the monitoring and assessment to achieve this objective may occur at different scales. Each individual nation within the EU has its own Exclusive Economic Zone over which the directive applies. For example within the Celtic Seas area, there are four independent states Ireland, France, the United Kingdom and the Isle of Man (which is not a member of the EU). Within the United Kingdom, government is further subdivided with three devolved authorities, Scotland, Northern Ireland and Wales, with one centralised government in Westminster. Further subdivisions also occur within each nation, for example the counties of Ireland each have their own county council. At the political level further subdivisions may be relevant as individual groups may lobby local government representatives on locally important management issues. To further complicate matters within each nation, different institutional structures mean different government departments have different responsibilities and data are reported in different formats and locations all having emerged from the gradual process of policy development over several decades. For example, in the UK, The Department for the Environment Food and Rural Affairs (Defra) is responsible for delivering the MSFD, but data relevant to the assessment of environmental status come from diverse sources, including (among many others) the Centre for Environment Fisheries and Aquaculture Science (CEFAS) (for England and Wales) as well as from Marine Scotland for fisheries, the

Environment Agency (for England and Wales) and the Scottish Environmental Protection Agency (SEPA). In some of these cases the data are in turn gathered by local authorities before being centralised. The full depth of institutional complexity is beyond the scope of this report, the Celtic Seas Partnership has applied tools to investigate the complexity of governance and policy Implementation within the Celtic Seas Region (Potts et al., 2013) and Bainbridge et al (2012) give a detailed treatment for the UK and Scotland. Figure 2 illustrates some of the spatial scales of governance that may be relevant to MSFD implementation and data gathering within the Celtic Seas region.

Given the new obligations of the EU governments under the Directive and the long history and institutional complexity of data gathering initiatives under existing legislative obligations, various regulations and directives, there is a risk that the information gathered to contribute to MSFD may be inaccessible to stakeholders in the marine environment. This lack of clarity is at odds with the aspiration of the directive to implement the Ecosystem Approach with its focus on stakeholder involvement.



**Figure 2:** Illustration of the legislative complexity in the Celtic Seas, National EEZ are shown in white, International terrestrial boundaries are shown in green, nations and devolved authorities are shown by different colours, purple lines illustrate National Territorial Statistical Unit (NUTS) Aggregations. Administrative wards are shown for Wales only, to illustrate the level of complexity in local management.



At present, member states around Europe are compiling programmes of measures for implementation of the MSFD. While the Directive was drafted and adopted at a time of relative economic prosperity in Europe currently economic conditions have meant that, for some governments the first programmes of measures under the MSFD have been under severe financial constraints and the major efforts have focussed on the examination and collation of existing measures under other policy initiatives and legislation and their contributions to the goals of achieving GES. Understanding the diverse array of pre-existing legislation and diversity of institutions is therefore key to navigating data discovery for the MSFD.

## MSFD DESCRIPTORS

While the EA, as described above, is characterised by its holistic approach, including the integration of ecosystem services and the importance of stakeholder inputs to decision making, the MSFD itself sets out a more focused set of environmental objectives, based on 11 descriptors of environmental status, contained in Annex I of the Directive. Table 2 lists the 11 descriptors of GES under the MSFD and the major pieces of existing environmental regulation to which they relate. The descriptors cover a broad range of ecological problems and represent a mixture of objectives. While some

descriptors, such as biodiversity and food web structure, are clearly related and particularly focused on ecology and the state of the environment, others such as levels of contaminants, marine litter, energy and noise relate to the level of human pressures on the environment, while the descriptors on commercial species and contaminants in seafood have a distinctly human focus.

Similarly some of the descriptors are related to broad areas of existing European environmental policy. For example eutrophication is one of the primary considerations of the Water Framework Directive (WFD) (European Commission 2000) and as such has already been the subject of intense policy-related research and monitoring for more than a decade while other descriptors, for example, marine litter, energy and noise are new to legislation and such are relatively poorly understood. At the European level fisheries management, essential to achieving GES for fish stocks, is regulated under the Common Fisheries Policy, while the Common Agricultural Policy, the WFD and Urban Waste Water Treatment Directive (UWWTD) (European Commission, 1991) are all vital to preventing eutrophication, both these (fisheries and eutrophication) are areas of very complex policy and legislation where European management has evolved over decades.

Descriptor		Directives and legislation
1	Biodiversity	Birds , Habitats , CBD
2	Non-indigenous species	Regulation on Alien Invasive Species
3	Population of commercial fish species	CFP
4	Elements of food webs	Habitats , CBD
5	Eutrophication	CAP, UWWT, Nitrates, WFD
6	Sea floor integrity	Habitats
7	Permanent alteration of hydrographical conditions	Floods
8	Concentrations of contaminants	Water Framework
9	Contaminants in seafood	
10	Marine litter	Waste
11	Introduction of energy (including underwater noise)	MSP

**Table 2:**  
The 11 descriptors of the MSFD and major pieces of existing European and International environmental legislation to which they relate. CBD= Convention on Biological Diversity, CFP= Common Fisheries Policy, UWWT= Urban Waste Water Treatment Directive, Nitrates=Nitrates Directive, WFD=Water Framework Directive, Waste = Waste Framework Directive, MSP= Directive on Maritime Spatial Planning

These descriptors were further refined in 2010 by an EU policy document (EC 2010), which set out in detail further criteria and sub-criteria that might contribute to development of initial assessment of environmental status under the Directive. Following this Commission Decision on Descriptors, EU member nations were then able to develop suites of indicators best suited to the assessment of GES in their own national context. The full suite of descriptor criteria and sub-criteria set out in the commission decision are summarised in Table 3.

The list of 55 sub-criteria in Table 3 may provide a daunting prospect to the interested stakeholder; there is clearly a large amount of information required to

assess environmental status from the perspective of a non-scientist. But this list does not mark the limit of complexity in the measurement and monitoring. For each of the criteria and sub-criteria listed above there may be several different ways of measuring or monitoring the information, thus each individual member state is required to determine how these criteria might be assessed within their own regional seas. Figure 3 illustrates the link between descriptors, criteria, sub-criteria and potential indicators for Descriptor 5. While the state of the knowledge for some descriptors is good (for example Descriptor 5, Descriptor 3) other descriptors particularly those for marine litter (10) and Energy and noise(11) are relatively new and many member states have not yet established which indicators for these descriptors are most suitable for their assessments.

**Table 3:** Summary of the complete list of criteria and sub-criteria for assessment of environmental status under the MSFD.

D		Criteria		Sub-criteria
1	1.1	Species Distribution	1.1.1	Range
			1.1.2	Pattern
			1.1.3	Area
	1.2	Populations Size	1.2.1	abundance/biomass
	1.3	Population Condition	1.3.1	demographic characteristics
			1.3.2	genetic structure
	1.4	Habitat Distribution	1.4.1	range
			1.4.2	pattern
	1.5	Habitat Extent	1.5.1	area
			1.5.2	volume
	1.6	Habitat condition	1.6.1	condition
			1.6.2	abundance/biomass
			1.6.3	physical/hydrological/chemical conditions
	1.7	Ecosystem structure	1.7.1	composition and proportions of habitats and species
2	2.1	Abundance / state of non-indigenous species	2.1.1	Trend
	2.2	Impact of non-indigenous species	2.2.1	Ratio between invasive non-indigenous species and natives
2.2.2			Impact of non-indigenous species	
3	3.1	Level of pressure of fishing activity	3.1.1	Fishing mortality
			3.1.2	Ratio between catch and biomass index
	3.2	Reproductive capacity of stock	3.2.1	Spawning stock biomass
3.2.2			Biomass indices	
3.3	Population algae and size distribution	3.3.1	Proportion mature fish	
		3.3.2	Mean maximum length	
		3.3.3	95%ile of fish length distribution	
		3.3.4	Size at first maturation	
4	4.1	Productivity of key species	4.1.1	Performance of key predator
	4.2	Proportion of species at top of food web	4.2.1	Large fish by weight
			4.3.1	Abundance trends
5	5.1	Nutrient levels	5.1.1	Nutrient concentration
			5.1.2	Nutrient ratio
	5.2	Direct effect of nutrient enrichment	5.2.1	Chlorophyll concentration
			5.2.2	Water transparency
			5.2.3	Opportunistic macroalgae
	5.3	Indirect effects of nutrient enrichment	5.3.1	Abundance of perennial seaweeds and seagrasses
			5.3.2	Dissolved Oxygen
6	6.1	Physical damage	6.1.1	Type abundance biomass and extent of biogenic substrate
			6.1.2	Extent affected by human activities
	6.2	Condition of benthic community	6.2.1	Sensitive and tolerant species
			6.2.2	Multi-metric indices
			6.2.3	Proportion above a specified size
			6.2.4	Size spectrum of benthic fauna
7	7.1	Spatial characterisation of perm. alterations	7.1.1	Extent affected by permanent alteration
	7.2	Impact of hydrographical change	7.2.1	Spatial extent
7.2.2			Changes in habitats and their functions	
8	8.1	Concentrations of contaminants	8.1.1	Comparable to WFD
	8.2	Effects of contaminants	8.2.1	Effects on ecosystem components
8.2.2			Occurrence origin and extent of acute events	
9	9.1	Levels number and frequency of contam.	9.1.1	Level exceed regulatory levels
			9.1.2	Frequency of levels being exceeded
10	10.1	Characteristics of litter	10.1.1	Trends in amount washed ashore
			10.1.2	Trends in water column
			10.1.3	Trends in microparticles and microplastics
	10.2	Impacts of litter on marine life	10.2.1	Trends in litter ingested by marine animals
11.1.1			Levels likely to entail significant impact on marine animals	
11	11.1	Distrib. in time of certain sounds	11.1.1	Levels likely to entail significant impact on marine animals
	11.2	Continuous low frequency sound	11.2.1	Trends in ambient noise level

Potential indicators	Subcriteria	Criteria	Descriptors	Environmental Status
[N],[P],[Si] N:P:Si	5.1.1 Nutrient Concentrations	5.1 Nutrient Levels	D 1	
	5.1.2 Nutrient Ratios		D 2	
Chlorophyll a, mean max, percentile Kd, Secchi depth g/m2 algae, percent coverage Harmful blooms /year	5.2.1 Chlorophyll Concentration		5.2 Direct Effects of nutrient enrichment	
	5.2.2 Water Transparency	D 4		
	5.2.3 Abundance of Opportunistic Macroalgae	D 5 Eutrophication		
	5.2.4 Shift in floristic Composition			
g/m2 seaweeds, Seagrass shoots/m2 D.O. % Saturation	5.3.1 Abundance of Perennial seaweeds and seagrasses adversely impacted by decreasing water transparency	5.3 Indirect effects of nutrient enrichment	D 6	
	5.3.1 Dissolved oxygen i.e. Changes due to increased organic matter decomposition and size of the area concerned		D 7	
			D 8	
			D 9	
			D 10	
			D 11	

The DEVOTES project (an EU project sponsored under its FP7 research program) has collated a list of indicators for MSFD used around Europe and discovered 557 separate indicators in use around the continent (<http://www.devotes-project.eu/software-and-tools/>). The level of data relevant to different stakeholders represent a continuum - while the specific indicators may be of interest to the scientist, the overall environmental status is the concern of the manager while specific criteria or sub-criteria may be relevant to different interested parties.

**Figure 3:** Illustration of different levels of information contributing to description of Environmental Status (descriptors, criteria, sub-criteria and indicators) for Descriptor 5. The type of data relevant to the individual will depend on interest and expertise.

### Marine Strategy Framework Directive and the Celtic Seas Partnership

Another important aspect of the MSFD is an obligation for cooperation and harmonisation in achieving GES at the regional seas level. While the regional seas of Europe are traditionally considered to be those bounded by discrete geographical limits (for example the Baltic, Black, Mediterranean and North Seas) for the purposes of the MSFD the Celtic Seas Partnership, along with the European Commission have recognised the Celtic Seas, an area that stretches from Brittany in the northwest of France to the Shetland Islands in the north of Scotland including the whole of the Irish Sea, large parts of the Irish continental shelf as well as many coastal habitats including estuaries and Scottish fjordic loch systems,

make up a distinct entity in the wider North East Atlantic, having common Celtic cultural connections. While other regional seas within Europe have specifically dedicated management bodies, such as the OSlo PARis Convention (OSPAR), the Helsinki Commission (HELCOM), the Black Sea Commission or the United Nations Mediterranean Action Plan, the Celtic Seas have no specifically dedicated management bodies (though all nations of the region are signed up to OSPAR) helping to coordinate management efforts in the wider North East Atlantic.

Firmly grounded in the MSFD policy process, stakeholders within the PISCES project (<http://www.projectpisc.es.eu/>) and the subsequent Celtic Seas Partnership have agreed eleven principles for the management of the marine environment (based on the principles of the Convention of Biodiversity) and have particularly stressed the importance of the EA within the Marine Strategy Framework Directive and the important role of stakeholders in management of the marine environment under the MSFD and implementation of



**Figure 4:** Map of the Celtic Seas Partnership areas of interest.

the EA (PISCES 2012). The PISCES declaration, with its foundation in CBD therefore reflects the spirit of the EA and the language of the MSFD in its recognition of the importance of balancing conservation and sustainable development.

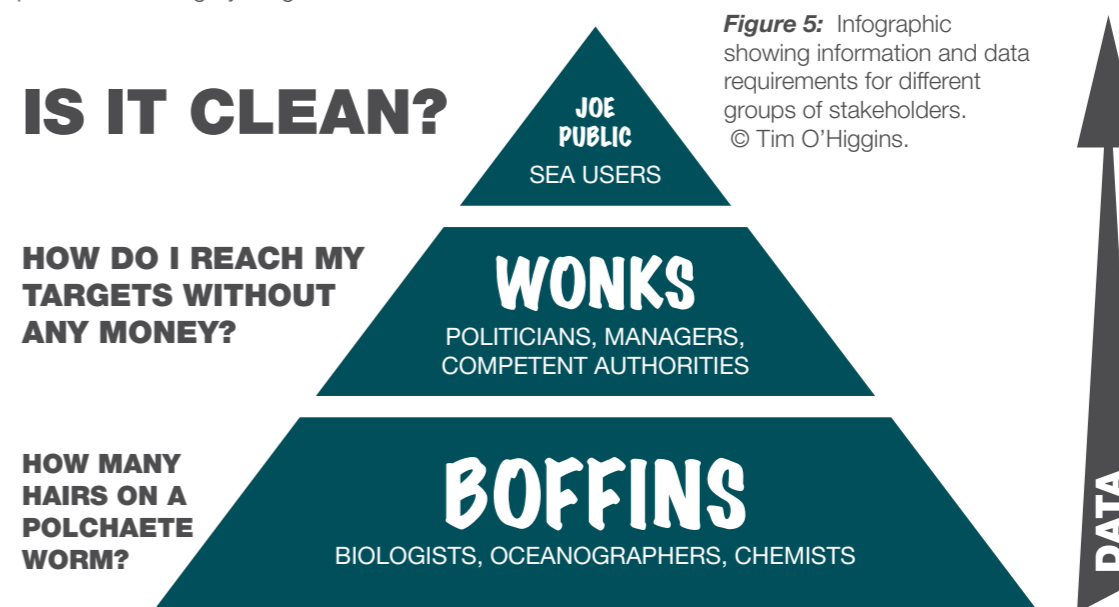
These two projects (PISCES, Celtic Seas Partnership) have provided a platform for the development of a group of interested parties, bringing together stakeholders within the Celtic Seas including industrial and sectoral interests as well as local, regional and national groups. This core group of stakeholders share a common understanding of the ecosystem approach and actively participate in overseeing and contributing to the implementation of the MSFD. The project has not only provided essential stakeholder oversight of the policy implementation but also facilitated non-statutory exercises, which can contribute to the ecosystem approach in the Celtic Seas region, to which the MSFD aspires but is not legally obliged to deliver. These include

examples of best practice for the implementation of the ecosystem approach within the Celtic Seas, which are being used to develop a series of best practice guidelines to be released by the Celtic Seas Partnership.

The overview given above illustrates several important points relevant to Marine Strategy Framework Directive data discovery in the Celtic Seas

1. In order for the MSFD to be compatible with the concept of the ecosystem approach, stakeholder involvement and information about ecosystem services must be included in the process.
2. There is a complex history of environmental legislation that contributes to the current process of MSFD implementation.
3. There is a complex network of different institutions contributing to the MSFD process within and between nations.
4. A great degree of technical expertise is required to fully understand the technical calculation of Good Environmental Status and not all data are relevant to all interested parties.

Nevertheless the Celtic Seas Partnership has demonstrated both the necessity and the desire for stakeholder involvement and understanding of the MSFD process. Thus one key challenge for data discovery and delivery in the context of the Celtic Seas is providing relevant data and information to the particular audience of diverse stakeholders, the type of data relevant depends both on the stakeholder and their level of knowledge. Figure 5 shows a schematic diagram illustrating different levels of interest and data and information requirements of different types of stakeholders.



**Figure 5:** Infographic showing information and data requirements for different groups of stakeholders. © Tim O'Higgins.

## INITIATIVES AND RELATED PROJECTS

The Celtic Seas Partnership are not alone in recognising the importance of public participation and stakeholder engagement in management of the environment and there have been substantial institutional efforts to engage and include the general public in environmental decisions for many years. In the European context perhaps the most important major international agreement in this respect was the Aarhus Convention on access to information, public participation in decision making and access to justice in environmental matters adopted in 1998 by the United Nations Economic Commission for Europe (UNECE). This convention obliges signatories to make publicly available any data gathered regarding the state of the environment. The objectives of the Aarhus Convention have been adopted by the European Union under three directives, the Directive on public access to environmental information (EC 2003), the Directive providing for public participation (EC 2003b) and the Aarhus convention itself, formally adopted by the EC by commission decision (EC 2005).

### INSPIRE - INFRASTRUCTURE FOR SPATIAL INFORMATION IN THE EUROPEAN COMMUNITY

In addition to the international initiatives under the Aarhus convention, the EC introduced the INSPIRE Directive for the establishment of Spatial Data Infrastructure to aid with European Community Environmental policy (EC, 2007). Spatial data are a prerequisite for implementation of an ecosystem approach (EC 2010). Over the past decade public awareness of the power of spatial data has developed, particularly through web applications such as Google Maps and Google Earth. In tandem with the private development of these technologies an open source alternative has also been developed and is constantly evolving, providing accepted sets of standards e.g. for interoperability of geospatial data through the Open Geospatial Consortium (<http://www.opengeospatial.org/>). The potential of web-based geographical information systems and the popular advent of GPS has brought about wider understanding of the power of spatial data, and the technologies to support spatial data visualisation, sharing and analysis of marine and environmental data are rapidly developing. While web mapping interfaces are now familiar and ubiquitous, the technical aspects of combining and visually communicating diversely held marine datasets within Europe are considerable. When it comes to supporting MSFD implementation another major challenge concerns the delivery of relevant yet digestible information to the appropriate target audience. There

are several different ways in which data may be made available. Downloadable, as spatial format or as raw data, as Web Map Service (these are links allowing users to display mapping data from other sources in one location). All these aspects are part of Spatial Data Infrastructure (SDI). The INSPIRE Directive (2008) puts in place a legislative obligation to develop efficient spatial data infrastructure within Europe, yet a fully standardised way of creating the best spatial data platforms has not yet emerged. Software continues to improve and developers as well as users are only beginning to get a sense of what SDI can achieve and what they want from it. Nevertheless the goals of the INSPIRE Directive are clear, its common principles are as follows.

- Data should be collected only once and kept where it can be maintained most effectively.
- It should be possible to combine seamless spatial information from different sources across Europe and share it with many users and applications.
- It should be possible for information collected at one level/scale to be shared with all levels/scales; detailed for thorough investigations, general for strategic purposes.
- Geographic information needed for good governance at all levels should be readily and transparently available.
- Easy to find, what geographic information is available, how it can be used to meet a particular need, and under which conditions it can be acquired and used.

These principles of INSPIRE are clearly very relevant to the MSFD where, as described above, there are a diverse range of relevant institutions and regulations contributing specific MSFD relevant data. Figure 6 shows the roadmap for Europe to full INSPIRE Compliance. Due to INSPIRE there is also a legally binding obligation with regards to metadata. Separate metadata regulations under INSPIRE (Commission Regulation (EC) No 1205/2008) placed obligations on public authorities and third parties to create full metadata for spatial data sets and data services. In a nutshell metadata must include information about the data on: quality and validity, who is responsible for creating, managing, maintaining and distributing the data or service, any restrictions on public or other use and if there are charges for access or use. As the member states make progress along this timeline more and more

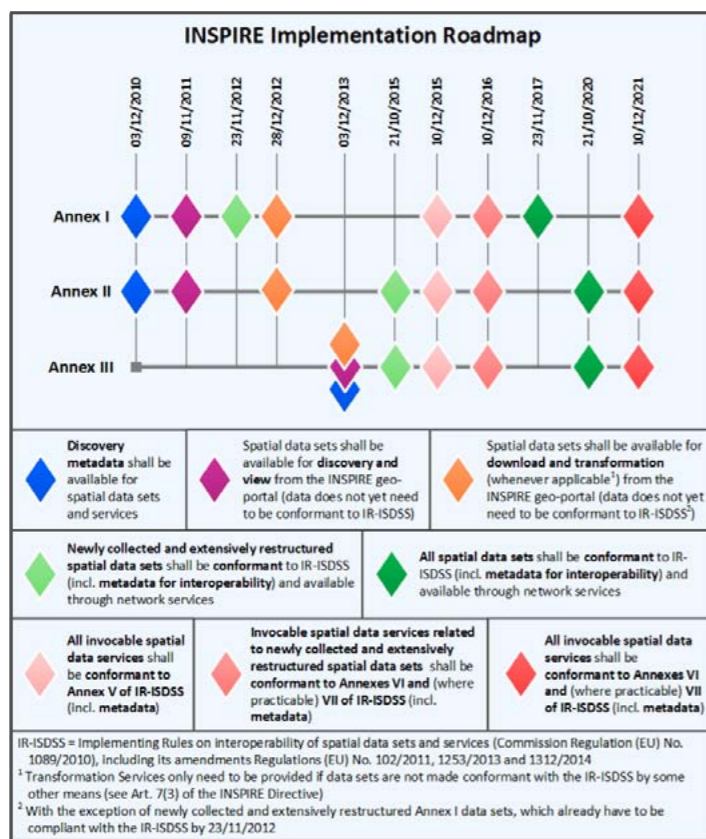


Figure 6: Roadmap to INSPIRE compliance.

data and metadata are becoming freely available. One of the most visible results of this process is the increasing amount of public information freely available on the web. These data are often placed on public data repositories such as [www.data.gov.uk](http://www.data.gov.uk) (with over 25,000 datasets) or [www.data.gov.ie](http://www.data.gov.ie) (which contains 1,176 datasets). These sites provide an enormous variety of data and information on many different themes in a variety of formats. While the technology to host and disseminate these data are evolving (spurred on by the legal requirements), less effort has been spent on interfaces to make the data more accessible to the public. However the level of compliance with the INSPIRE directive varies between member states, for example the mid-term evaluation report for the directive (EEA-JRC, 2014) indicates that for Celtic Seas nations the percentage of data services compliant with the INSPIRE Directive were 100%, 77%, and 53% for the UK France and Ireland respectively.

Although the INSPIRE Directive is now a major driver promoting data availability, in the context of the MSFD it is important to understand that much of the information relevant to the marine environment (like the legal and institutional framework discussed above) was developed in its own specific context and as such is to a certain extent targeted to its own specific audiences. In the case of the marine, the traditional target audience of the data has been the 'boffins' of figure 5. As such the language used and the specifications for different types of data

are often highly technical and difficult to interpret. Some examples are provided below.

### SEADATANET

SeaDataNet ([www.seadatanet.org/](http://www.seadatanet.org/)) is an international oceanography project with the aim of enabling scientists to access historical oceanographic datasets held by European national data centres. The project involves 45 national data centres in 35 countries and provides a suite of quality controlled and validated historical oceanographic datasets of parameters, some of which are relevant to the MSFD. Most data are provided freely. The data may be visualised by downloading the Ocean Data View software available at [www.odv.awi.de](http://www.odv.awi.de). Consider the challenge of unifying data from such a range of institutions spread across many nations. First of all each institution has its own unique setting and its own way of conducting research, institutions might use different instruments to measure different parameters, the data gathered may be reported with different units, with different formats and in different languages. Ensuring that data are accurately recorded and are comparable is a considerable task in itself. Developing a common language is an important challenge of compiling a large international database. One major technical achievement of the SeaDataNet project was the development of a common vocabulary for metadatabases, allowing distribution and harvesting of data among the centres

within the network. The project is largely aimed at the technical and analytical community to facilitate oceanographic and climatological research. For example SeaDataNet has a searchable directory ([http://www.bodc.ac.uk/data/information\\_and\\_inventories/edmed/search/](http://www.bodc.ac.uk/data/information_and_inventories/edmed/search/)), which facilitates many types of searches, using open queries, time and location stamps, specific seas or marine areas, specific oceanographic instruments, projects, institutions or nations. Figure 7 shows the results of a query for SeaDataNet for the term 'Celtic Sea'. The query results are highly technical, to the oceanographer, the importance of current metre data may be immediately

relevant and apparent for example to the MSFD descriptor of hydrography, to the non-technical user it may be meaningless. Similarly in order to interpret the fourth entry one must know for example that POL is the Proudman Oceanographic Library, and that CTD/STD stands for Conductivity Temperature Depth and Salinity Temperature Depth. SeaDataNet undoubtedly provides an invaluable tool for research and a valuable data repository but its target stakeholders are the scientific community, and while relevant data are freely available within the platform they may not easily be discovered by the average marine stakeholder.



Figure 7: Results from SeaDataNet query for 'Celtic Sea'.

### MYOCEAN/COPERNICUS

MyOcean/Copernicus is a European research initiative with the aim of establishing an integrated Europe-wide expertise in monitoring and forecasting in the marine environment. MyOcean was funded by the European Commission as a series of research projects between 2009 and 2014. The work of MyOcean is now carried out by Mercator Ocean under the Copernicus project (<http://marine.copernicus.eu/>). The Copernicus front page includes a list of geographic locations for which data are available, of particular relevance to the Celtic Seas are data on 'European North West Shelf Seas', these data are further searchable according to range of search criteria including temporal coverage and resolution, types of outputs (modelled or measured) as well as types of parameters such as physical, chemical and biological parameters. Access to the data requires registration. Figure 8 shows a screenshot of data for European North West Shelf Seas.

As with SeaDataNet, the Copernicus data portal is directed chiefly at the oceanographic research community and many of the products contained within it are quite technical in nature. For example some products

relevant to the MSFD include 'European North West Shelf Seas Ocean Biogeochemistry Non Assimilative Hindcasts' from various sources and for various periods as well as in situ real time data from various sources. Parameters of particular relevance to the MSFD include, remotely sensed, measured or modelled chlorophyll concentrations (which are particularly relevant to Descriptor 5, eutrophication and Descriptor 4, food webs), as well as modelled and measured biogeochemistry products including distributions of nutrients and oxygen (which are also relevant to several descriptors).

While the data contained within the portal are relevant to MSFD, in general, they have not been produced specifically for the purposes of MSFD, rather they come from oceanographic and environmental science research. However even knowing that these data are relevant in the first place requires a high degree of specialised knowledge. Copernicus has been designed to support Europe's environmental science and oceanographic modelling and monitoring communities. As such the site is quite technical and not necessarily directed at the interested citizen concerned about MSFD, or even more broadly, the health of the seas.

The screenshot shows the EMODnet online catalogue interface. On the left, there is a 'YOUR SEARCH' sidebar with filters for 'AREA' (All areas, Global Ocean (9), Arctic Ocean (9), Baltic Sea (13), European North-West Shelf Seas (32), Iberia-Biscay-Ireland Regional Seas (18), Mediterranean Sea (10), Black Sea (11)) and 'PARAMETER' (All parameters, Ocean Temperature (12), Ocean Salinity (7), Ocean Currents (6), Sea Ice (2), Sea Level (9), Winds (4), Ocean Optics (5), Ocean Chemistry (6), Ocean Biology (4), Ocean Chlorophyll (9)). The main content area shows 'Found 32 products matching your criteria.' The first product is 'ATLANTIC - EUROPEAN NORTH WEST SHELF - OCEAN PHYSICS ANALYSIS AND FORECAST' with a description of the FOAM AMM7 model and a map of the North West Shelf. The second product is 'ATLANTIC - EUROPEAN NORTH WEST SHELF - OCEAN BIOGEOCHEMISTRY ANALYSIS AND FORECAST' with a description of ocean chemistry and biology parameters and a map of the same region.

Figure 8: Screenshot from MyOcean page for European northwest shelf seas, showing the number of parameters available for download.

## OTHER PROJECTS

Oceanographers are not the only people with an interest in the seas, and there are many ongoing initiatives to aid in marine environmental management generally and the MSFD more specifically. One such initiative is the European Marine Observation and Data Network (EMODnet - <http://www.emodnet.eu/>). EMODnet has similar goals to both SeaDataNet and Copernicus, the centralisation harmonisation and distribution of data. Unlike Copernicus and SeaDataNet, the data are divided up under reasonably accessible categories, including bathymetry, geology, seabed habitats, chemistry, biology, physics and human activities. For each category there is a separate portal, which provides maps illustrating the data and links for the download of the data layers. The separate portals also allow users to access information of particular interest to their needs. Within EMODnet there has been clear effort in producing tools accessible to non-technical users. This is particularly evident in the human activities portal (<http://www.emodnet-humanactivities.eu/view-data.php>) but also in the choice of symbols used to illustrate, for example, the sea level rise portal (Figure 9).

At the European scale the challenges of data discovery have not gone unnoticed and the European Commission Joint Research Centre (JRC) has established a Marine Strategy Framework Directive Competence Centre <http://mcc.jrc.ec.europa.eu/index.py>. As well as providing relevant official policy documentation on each of the descriptors and their assessment the site provides links to a number of spatial data portals with information relevant to MSFD implementation. These official EU sites include the European Atlas of the Seas ([http://ec.europa.eu/maritimeaffairs/atlas/maritime\\_atlas/#](http://ec.europa.eu/maritimeaffairs/atlas/maritime_atlas/#)), The Environmental Marine Information System (EMIS - <http://mcc.jrc.ec.europa.eu/emis/>), which contains a range of oceanographic and biological parameters reported at 2km and 4km resolutions, also accessible as a web map service. The European Alien Species Information Network (EASIN) and the INSPIRE data portal (<http://data.jrc.ec.europa.eu/discovery/GeodataInventory>) currently under development, as well as the Copernicus marine monitoring service (described above) all hold information relevant to the implementation of the MSFD at the European scale, though none are specifically dedicated to it and all have other information only peripherally relevant to the MSFD.

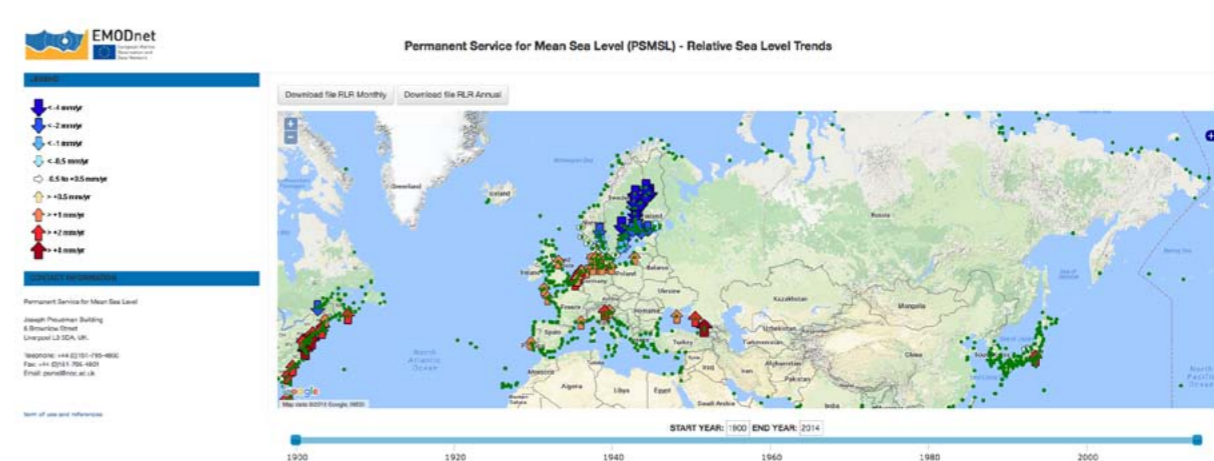


Figure 9: Screenshot of EMODnet mean seas level rise on the Emodnet physics portal (<http://www.emodnet-physics.eu/map/Products/PRPSMSL.aspx>)

With a responsibility for holding and disseminating environmental information, the European Environment Agency (EEA) also holds much data relevant to MSFD implementation. One particularly relevant initiative is discomap (<http://discomap.eea.europa.eu/home.html>) - this provides a list of over 40 environmental web map services containing official EU reporting data, which may be displayed on any geospatial portal.

The MSFD envisages a clear role for cooperation at the regional seas level and regional seas management organisations are contributing to efforts at data gathering and dissemination. The most developed example is in the Baltic Sea, that of HELCOM data and map services (<http://www.helcom.fi/baltic-sea-trends/data-maps>). This site provides a general data and map viewer along with six thematic portals, aimed at particular users or individuals with a specific interest. The six portals focus on: Environmental monitoring, Environmental status, Pressures and Human Activities, Biodiversity, Maritime and Response and Maritime Spatial Planning. The counterpart to HELCOM for the Celtic Seas region (and the northeast Atlantic as a whole) is OSPAR. OSPAR (<http://www.ospar.org/data>) provides a range of data directly relevant to MSFD descriptors for download. A new geospatially enabled web portal - the OSPAR Data and Information Systems (ODIMS) - designed to improve accessibility, discovery and visualisation of OSPAR data is under development and due to be launched in mid-2016.

At the national level there are a number of formalised initiatives developed for data sharing and INSPIRE compliance; these include the Irish Spatial Data Exchange (ISDE), the United Kingdom Directory of Marine Observing Systems (UKDMOS), the Marine Environmental Data and Information Network (MEDIN) and the European Directory of Marine Environmental Data (EDMED). These portals each contain metadata and data directly relevant to MSFD descriptors but

have not been designed specifically with MSFD in mind. As a result accessing relevant data requires considerable human effort as well as scientific judgement in determining which data sources are most relevant to implementation of the Directive. Appendix II summaries by descriptor (A) and by portal (B) the results of a systematic trawl through these portals in search of MSFD relevant data.

All the examples above have dealt primarily with various physical, chemical and biological characteristics, with a lesser emphasis on mapping of human pressures. Yet the MSFD mandates an ecosystem approach, which should incorporate human aspects of the system and in particular incorporate ecosystem services. The problem of lack of information about ecosystem services values in marine and coastal areas has been recognised by many authors (O'Higgins and Gilbert 2013; Pendleton, 2008). While attempts are currently being made to map ecosystem services around Europe (Maes, 2012, 2014) and some spatial information on ecosystem service supply is beginning to become available in web portals (<http://biodiversity.europa.eu/maes/maes-digital-atlas>) the methodologies and information required to effectively map ecosystem services at the relevant spatial scales are not fully established and only beginning to emerge. Nevertheless, in the absence of formally collected spatial data regarding ecosystem service supply and demand, participatory mapping exercises can contribute to the development of the ecosystem approach, as has been the case in the PISCES project. Within the Celtic Seas, the Finding Sanctuary project successfully demonstrated the use of participatory mapping in the development of marine conservation zones (<http://www.mczmapping.org/>). Other successful international examples of online participatory mapping exercises include data contributed to the California coastal atlas ([http://marineprotectedareas.noaa.gov/dataanalysis/atlas\\_ca/viewer/](http://marineprotectedareas.noaa.gov/dataanalysis/atlas_ca/viewer/)).

## USE CASE STUDIES

As discussed above the relevance of data depends on the context in which it is to be used. While diverse data are being collated from existing sources at the national level to meet statutory reporting requirements of the MSFD, specific marine management decisions regarding planning and development must be taken within the context of the MSFD but may actually occur on smaller spatial scales. For example a localised development decision on the scale of a single bay will require inputs from stakeholders and information on local use patterns of the system and patterns of ecosystem service supply and demand, but information gathered for statutory purposes contributing to the MSFD often occur at the regional or national scale. The following sections examine specific use case studies for data contributing to MSFD and how they may (or may not) be useful in implementation of an ecosystem approach. The following two use-case studies, examine the ease of accessibility of information relevant to two specific MSFD descriptors in the Celtic Seas region: Descriptor 3, 'Populations of commercially exploited fish stocks' and Descriptor 2, 'Non-indigenous species'. The case studies consider three specific aspects of MSFD data discovery for each of these descriptors.

1. Overall data availability: Are the data on MSFD descriptors, GES currently available?
2. Data delivery: Format of the data
3. Target audience: Are the data available easily understood?
4. Compatibility: Are the data easy to integrate and harmonise across member states within the Celtic seas?

### DESCRIPTOR 3 - FISHERIES

**Populations of all commercially exploited fish and shellfish are within safe biological limits, exhibiting a population age and size distribution that is indicative of a healthy stock.**

Descriptor 3 of the MSFD is firmly aligned with the objectives of the Common Fisheries Policy and the major objective of this descriptor is to achieve Maximum Sustainable Yield in commercially exploited fish stocks. As such the MSFD builds on a long history of management and data collection and each EU member state within the Celtic Seas region has developed a different organisational structure to meet the needs of CFP data collection and reporting.

For the Republic of Ireland data on landings and catch per unit effort (CPUE) come in the form of EC logbooks and are collected by the Sea Fisheries Protection Authority. These data are further analysed by the Fisheries Ecosystems Advisory Service (FEAS) of the Marine Institute. The FEAS also conducts the annual Irish Groundfish Survey and, historically, (2004-2009) the Biological Sampling Survey. Data from these surveys are downloadable from the Fisheries Resource Maps page of the Marine Institute website (<http://www.marine.ie/Home/site-area/data-services/interactive-maps/fisheries-resource-maps>). Data can be visualised on a map or downloaded - these include species-specific information on catch and CPUE for both the Groundfish and Biological sampling Surveys. Ireland's Marine Atlas also provides information on fishing pressure in hours, by gear type (for ships >15m) derived from Vessel Monitoring System data at the spatial scale of ICES rectangles. These data are available at <http://atlas.marine.ie/#/Map>

For the UK fisheries logbook data are gathered by several different fisheries administrations of the devolved authorities within the UK, the Marine Management Organisation (for England), Marine Scotland, the Department of Agriculture and Rural Development Northern Ireland (DARDNI), the Welsh Government and individual Departments in Jersey, Guernsey and the Isle of Man. In France Bureau des statistiques de la pêche et de l'aquaculture is part of the Ministry of Ecology, Sustainable Development and Energy.

Table 4 provides a list of institutions with statutory obligations for fisheries data collection in the Celtic Seas as well as institutions with statutory obligations to report for the MSFD; for the UK and Ireland these statutory bodies differ from those with responsibility for delivery of MSFD. Table 4 indicates a list of organisations providing data pertinent to descriptor 3 of MSFD. At the national level, several organisations provide spatial data online regarding the location of fishing activities. These include various products which do not contribute directly to MSFD reporting such as spatially aggregated fishing effort data for vessels over 15m in length as reported from Vessel Monitoring System (VMS). Data for vessels greater than 15m are generally available with higher resolution given that Vessel Monitoring Systems are now mandatory. Levels of fishing effort from smaller vessels are less clearly reported and methods of data collection vary between nations. For example in Irish waters, approximate coastal areas for static gear fisheries are depicted. For the UK and Wales less than 15m vessel sightings data methodology are used and are available for download from the Centre for Environment, Fisheries and Aquaculture Science, Cefas' contribution to the

MEDIN Fisheries (<https://www.cefas.co.uk/cefas-data-hub/fishdac/>). The types and formats of data available for each portal vary. For example while all the institutes in Table 5 provide web map services (WMS) where geospatial data can be displayed online or used within GIS software, the Marine Institute's fisheries resource maps also allow for querying and downloading of the raw data which, depending on user needs, may be useful for data analysis. Different sites also show similar, but subtly different types of data, which may be confusing to a

stakeholder or potential user of the data. In Figure 10 all examples appear to be based on the same type of VMS data but are aggregated at different spatial scales and in different maps and have isolated different subsets of data for different purposes. The Marine Scotland site has the greatest variety of different products derived from VMS, while the Welsh data viewer has only one layer and the exact information it is displaying is not clear, highlighting the importance of maintaining and reading metadata.

	CFP reporting	MSFD Reporting
Ireland	Irish Sea Fisheries Protection Authority	Department of Environment Community and Local Government
UK	Marine Management Organisation	Department of Environment Fisheries and Rural Affairs
France	Office of fishing and aquaculture (BSPA)	Ministry of Ecology, Sustainable Development and Energy

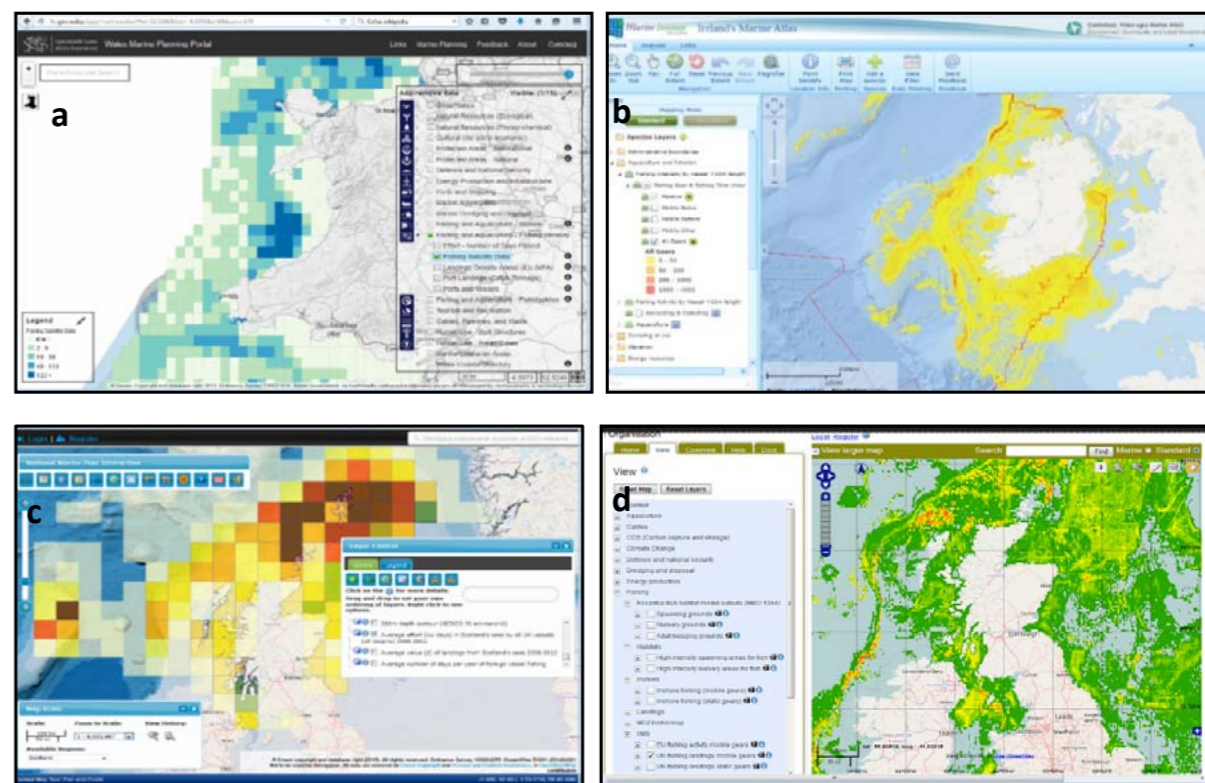
**Table 4:** Competent authorities responsible for reporting to the Commission under the Common Fisheries Policy and the MSFD for each of the Celtic Seas nations.

Amongst the MSFD descriptors D3 is unusual in that the fisheries industry, an economic sector in itself, has primary responsibility for providing some of the most important information contributing to GES, that of catch, or Fishing Mortality (F). Since a Common Fisheries Policy has been around in some form for over half a century (see Table 1) the infrastructure and reporting procedures for fisheries data has developed considerably over time. The primary indicator for fishing pressure (D3.1) is the level of fishing mortality, which should not exceed the level of Maximum Sustainable Yield (FMSY). While the fishing industry supply data on F, biological survey data are required to assess the status of the stocks and to assess the MSY at the scale of the Celtic Seas. Stock assessments are centralised by the International Council for the Exploration of the Seas (ICES). As such data from each member state is reported according to ICES statistical rectangles and since the Celtic Seas area is officially recognised by ICES, data for the region are particularly coherent. For the statutory initial assessment of GES for each member state in the Celtic Seas refer to ICES stock assessments (HM Government, 2012; Marine Institute, 2013).



Mapping information (also relevant to descriptors 1 and 6). Figure 11 shows the dedicated ICES popular advice page - which provides the MSFD-relevant information for locations in all seas throughout Europe. Users can select a species in a particular part of the Celtic seas (based on ICES subdivisions) and can chose a brief summary of the species, read the ICES advice digest (which where possible includes information on FMSY), the more involved user can follow links to the full ICES advice.

As such ICES maps and the spatial data information webpage (<http://ices.dk/marine-data/maps/Pages/default.aspx>) provide a comprehensive suite of products regarding the primary MSFD relevant data. These can all be viewed in one place using the ICES spatial facility (<http://gis.ices.dk/sf/>) and include the Datas Survey Area query tool, a station dictionary, ICES statistical rectangle and the ICES popular Advice and Marine Habitat



**Figure 10:** Comparison of different web portals. Note all data are fisheries effort data but not directly comparable, a) Welsh data are 'Fishing Satellite Data', b) Irish data show 'Fishing intensity by vessels >15m all gears' c) Scotland Average effort (kw days) in Scotland's seas by all UK vessels all lengths (2008-2012) d) Marine Management Organisations shows UK fish landings mobile gears.

Country	Institution	Site
England	Marine Management Organisation	<a href="https://planningportal.marinemangement.org.uk/#">https://planningportal.marinemangement.org.uk/#</a>
Scotland	Marine Scotland	<a href="https://marinescotland.atkinsgeospatial.com/nmpi/">https://marinescotland.atkinsgeospatial.com/nmpi/</a>
Ireland	Marine Institute	<a href="http://atlas.marine.ie/#">http://atlas.marine.ie/#</a>
		<a href="http://www.marine.ie/Home/site-area/data-services/interactive-maps/fisheries-resource-maps">http://www.marine.ie/Home/site-area/data-services/interactive-maps/fisheries-resource-maps</a>
Wales	Welsh Government	<a href="http://lle.gov.wales/apps/marineportal/#lat=52.5145&amp;lon=-3.91111&amp;z=8">http://lle.gov.wales/apps/marineportal/#lat=52.5145&amp;lon=-3.91111&amp;z=8</a>
France	IFREMER	<a href="http://sextant.ifremer.fr/fr/nos-services">http://sextant.ifremer.fr/fr/nos-services</a>

**Table 5:** National marine geospatial initiatives with the Celtic Seas region

At the central European scale much of the relevant social information is held in Eurostat, for Descriptor 3 information on many of the social and economic aspects of fishing can be found at the European Atlas of the Seas ([http://ec.europa.eu/maritimeaffairs/atlas/maritime\\_atlas/#lang=EN;p=w;](http://ec.europa.eu/maritimeaffairs/atlas/maritime_atlas/#lang=EN;p=w;)).

Overall, while data made publicly available on web-based sources for Descriptor 3 at the national level are not directly comparable, ICES provides the institutional structure necessary for integration and harmonisation of relevant data at the Celtic Seas scale.

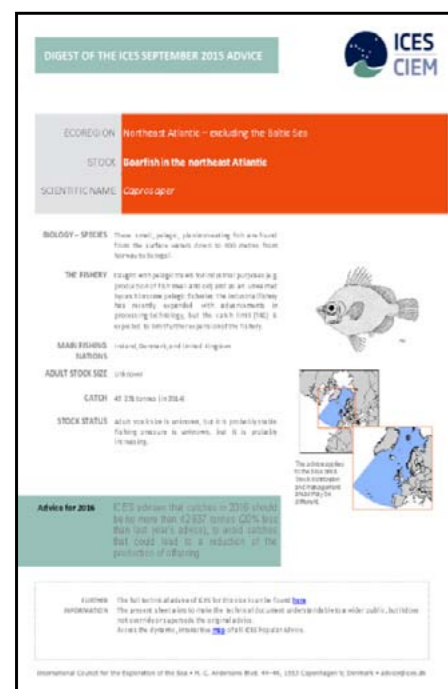
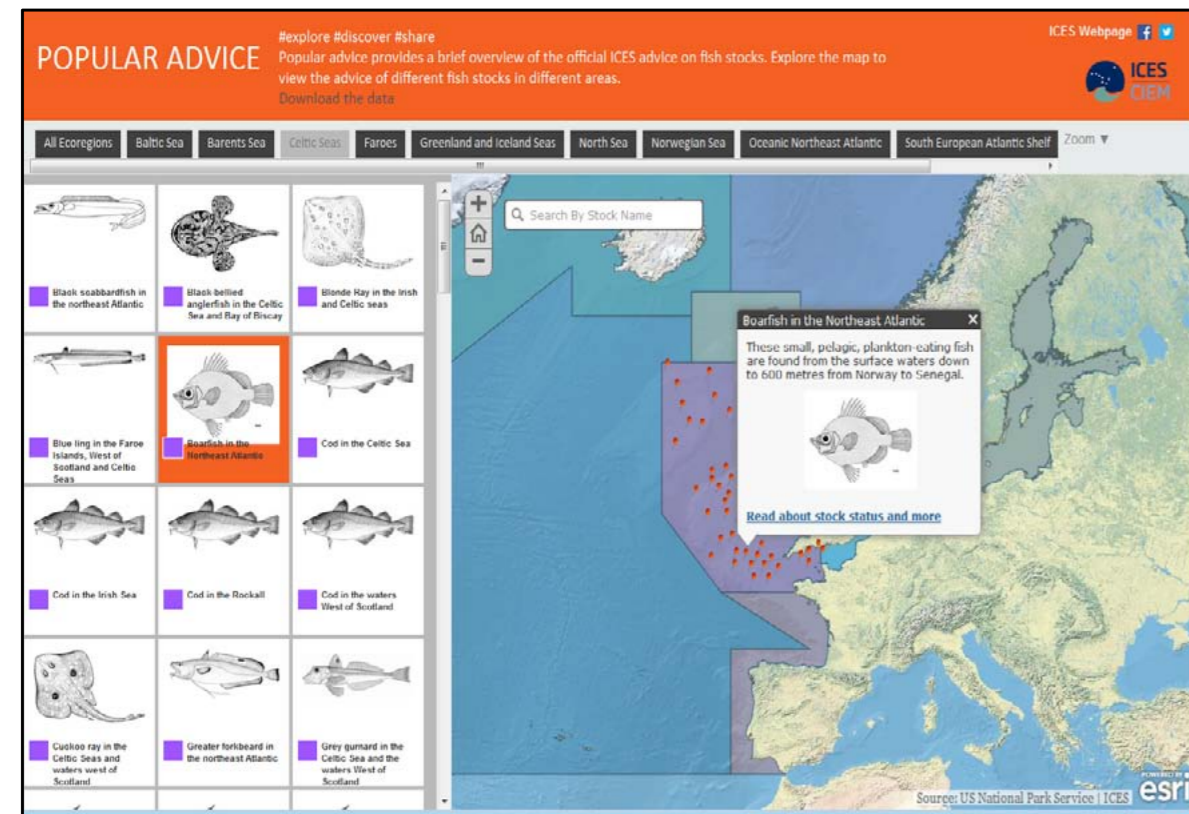


Figure 11: The ICES Popular Advice Map (<http://gis.ices.dk/popadvice/>) provides information on a diverse range of fish species from the entire ICES area including a specific tab on the Celtic Seas. A brief description of the area is available. Users can select a species of interest (above) and click on the species to receive a digest of the most recent ICES advice based on the most recent assessments. The information provided include Stock Size, Landings, Status and ICES advice. The popular advice page provides a link for the interested reader to the most recent full ICES advice on the stock including landings and stock size time series, of advice and landings by nation. Data are reported at the spatial scale of ICES areas.



## DESCRIPTOR 2 - NON - INDIGENOUS SPECIES

Descriptor 2: Non-indigenous species introduced by human activities are at levels that do not adversely alter the ecosystems. According to the EC decision on descriptors (EC, 2010) Descriptor 2 of the MSFD is to be assessed under two criteria and three separate sub-criteria. Criterion 2.1 covers the abundance and state characterisation of non-indigenous species, in particular invasive species, which is to be assessed by the sub-criteria on trends

- Trends in abundance, temporal occurrence and spatial distribution in the wild of non-indigenous species, particularly invasive non indigenous species, notably in risk areas, in relation to the main vectors and pathways of spreading of such species (2.1.1) Criterion 2.2 covers the environmental impact of invasive non-indigenous species, which is assessed based on two sub-criteria
- Ratio between invasive non-indigenous species and native species in some well-studied taxonomic groups (e.g. fish, macroalgae, molluscs) that may provide a measure of change in species composition (e.g. further to the displacement of native species) (2.2.1)
- Impacts of non-indigenous invasive species at the level of species, habitats and ecosystem, where feasible (2.2.2).

From a scientific perspective the nature of commercial fisheries in the previous example, to some extent lends itself toward the collection of data (given the long history of fisheries, and that the fish themselves are the vital component of an industry) by contrast the arrival

and spread of non-indigenous species is less readily assessed for a number of reasons. In many cases the arrival of non-indigenous marine species is accidental. Species may arrive to the Celtic Seas in ballast water or as fouling organisms on ships, via the international shipping industry. As such the exact timing of the release of the organism is unknown and first observations of the organism may also be accidental (an individual sees an unfamiliar organism and reports on it). As a result a particular non-indigenous organism may only be observed after it is present and generally after it has become established, the proliferation of the non-indigenous species is generally one step ahead of its known distribution. Further, once established widely, non-indigenous species are very difficult if not impossible to eradicate in the marine environment; given this problem management options for removal of the species are often limited. In other cases introductions of species have been intentional, for economic purposes, perhaps the most notable example in the Celtic Seas is that of Pacific Oyster (*Crassostrea gigas*). This is the oyster most commonly farmed and while it is of great economic importance to the aquaculture industry, it is a non-native species with the capacity to spread outside the zones where it is deliberately cultured. The dual identity of the pacific oyster, as both economically desirable and ecologically undesirable combined with private nature of the aquaculture industry, means that the spread to the wild of cultured populations will not necessarily be reported immediately by those most closely associated with oyster culture. This dual role is also reflected in EC legislation. The recent introduction of the EC Regulation on Alien Invasive Species (EC 2014) now mandates (in conjunction with the MSFD) the development of management and mitigation measure for the Alien Invasive Species but also has provisions for species (including Pacific Oyster) of importance to the aquaculture industry.

Country	Website
IRELAND	<a href="http://www.invasivespeciesireland.com">http://www.invasivespeciesireland.com</a> <a href="http://caisie.ie/">http://caisie.ie/</a> <a href="http://www.fisheriesireland.ie/Invasive-Species/invasive-species-list.html">http://www.fisheriesireland.ie/Invasive-Species/invasive-species-list.html</a> <a href="http://galwaycountybiodiversity.com/uplds/Field%20Guide%20to%20invasive%20species%20in%20ireland%20-%20ISI.pdf">http://galwaycountybiodiversity.com/uplds/Field%20Guide%20to%20invasive%20species%20in%20ireland%20-%20ISI.pdf</a> <a href="http://www.biodiversityireland.ie/projects/invasive-species/species-lists/">http://www.biodiversityireland.ie/projects/invasive-species/species-lists/</a>
UK	<a href="https://data.nbn.org.uk/imt">https://data.nbn.org.uk/imt</a> <a href="http://www.nonnativespecies.org/home/index.cfm">http://www.nonnativespecies.org/home/index.cfm</a>
European	<a href="http://easin.jrc.ec.europa.eu/">http://easin.jrc.ec.europa.eu/</a> <a href="http://www.europe-aliens.org/aboutDAISIE.do">http://www.europe-aliens.org/aboutDAISIE.do</a> <a href="http://ec.europa.eu/maritimeaffairs/atlas/maritime_atlas/#lang=EN;p=w;">http://ec.europa.eu/maritimeaffairs/atlas/maritime_atlas/#lang=EN;p=w;</a>
Global	<a href="http://www.issg.org/database/welcome/">http://www.issg.org/database/welcome/</a>

Table 6: National and international sources of relevant data on non-indigenous species.

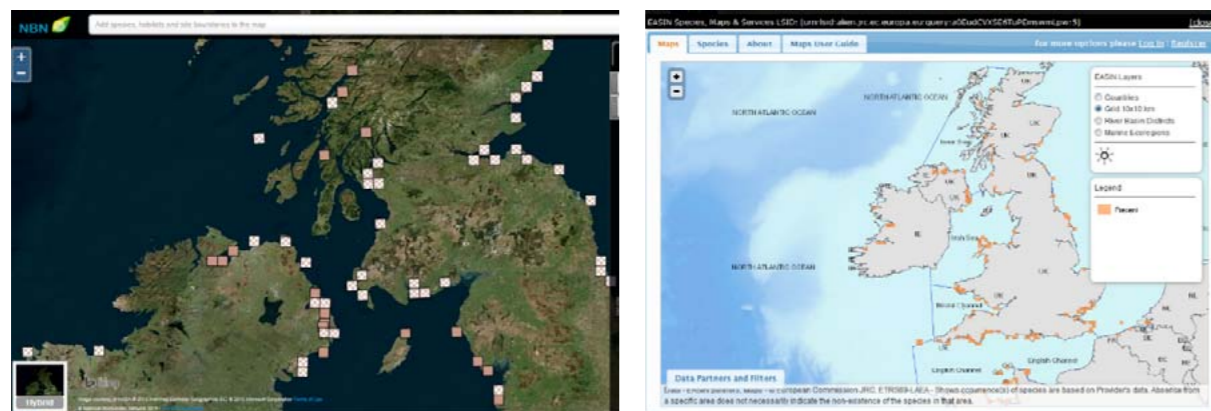


Figure 12: Screenshots from NBN and EASIN data portals showing search results for the Pacific Oyster.

Within the Celtic Seas region there are a number of national initiatives specifically designed to deal with the problem of non-indigenous species (though not directly focussed on MSFD implementation). Table 6 provides a list of national and international initiatives and their websites and gives links to the relevant information sources. The European Environment Agency has also collated information from various sources, indicating the trends in abundance of non-indigenous species. The major sources for spatial data on non-indigenous species within the Celtic Seas come from two initiatives, Biodiversity Ireland and the National Biodiversity Network in the UK Both provide for mapping of invasive species.

However as observed for many marine data sites, accessing and using the information in these portals requires a certain level of technical knowledge. For example while the spatial information on the location of non-native species is present, finding species relevant to the marine environment requires prior knowledge of those species within the marine environment. Thus, the interested non-specialist stakeholder cannot simply go to these sites and find the geographic location of non-indigenous species within the Celtic Seas, they must first know what these species are. To this end the DAISIE project provides a list of the 100 worst invasive species which can be organised by category (including

marine), this list includes 31 marine species, which an individual could subsequently interrogate on the national biodiversity websites for the UK and Ireland. For the marine stakeholder there is clear potential and benefit in collating these records in one place in an accessible format, with common names under the heading of non-indigenous.

At the global scale the World Register of Introduced Marine Species – (<http://www.marinespecies.org/introduced/>) provides information on non-indigenous species, at the European scale the European Environment Agency have collated information and the JRC have developed the European Alien Invasive Species Network (<http://easin.jrc.ec.europa.eu/>) which draws information from a range of sources (Table 7)

Table 7: Data sources contributing to EASIN

Data Source	Website
ICES/ WGBOSV:Working Group on Ballast and Other Ship Vectors	<a href="http://www.ices.dk/publications/library/Pages/default.aspx#k=wgbosv">http://www.ices.dk/publications/library/Pages/default.aspx#k=wgbosv</a>
AquaNIS, 2013. Information system on Aquatic Non-Indigenous species.	<a href="http://www.corpi.ku.lt/databases/index.php/aquanis/">http://www.corpi.ku.lt/databases/index.php/aquanis/</a>
BSASD - Baltic Sea Alien Species Database	<a href="http://www.corpi.ku.lt/nemo/">http://www.corpi.ku.lt/nemo/</a>
ELNAIS - invasive alien species data	<a href="https://services.ath.hcmr.gr/">https://services.ath.hcmr.gr/</a>
EASIN: European Alien Species Information Network	<a href="http://easin.jrc.ec.europa.eu">http://easin.jrc.ec.europa.eu</a>
NOBANIS - European Network on Invasive Alien Species	<a href="https://www.nobanis.org/">https://www.nobanis.org/</a>
MAMIAS - Marine Mediterranean Invasive Alien Species	<a href="http://www.mamias.org/">http://www.mamias.org/</a>
REABIC - Regional Euro-Asian Biological Invasions Centre	<a href="http://www.reabic.net/">http://www.reabic.net/</a>
EPPO lists and documentation on invasive alien plants	<a href="http://www.eppo.org/INVASIVE_PLANTS/ias_plants.htm">http://www.eppo.org/INVASIVE_PLANTS/ias_plants.htm</a>
ICES/ WGITMO :Working Group on Introduction and transfers of Marine Organisms	<a href="http://www.ices.dk/publications/library/Pages/default.aspx#k=wgitmo">http://www.ices.dk/publications/library/Pages/default.aspx#k=wgitmo</a>

While many of the resources listed above have information relevant to specific invasive species, the portals are sometimes aimed at specialist rather than generalist audiences. For example, sites like DAISIE are directed toward the general public, and list common invasive species. While sites like EASIN list occurrence by country or region for non-indigenous species (Figure 12).

More detailed spatial data are available on NBN mainly focussed on the UK but also including Ireland, however this portal is not specifically directed at non-indigenous species and requires some navigation. There are so many non-indigenous species, that one needs to have a very specific objective, to use these portals. Some sites require a familiarity with species Latin names or require a knowledge of taxonomy. This scattered nature of the records and databases is a major challenge in the integration and harmonisation of data across the Celtic Seas region.

## RECOMMENDATIONS - FOR THE CELTIC SEAS WEB PORTAL.

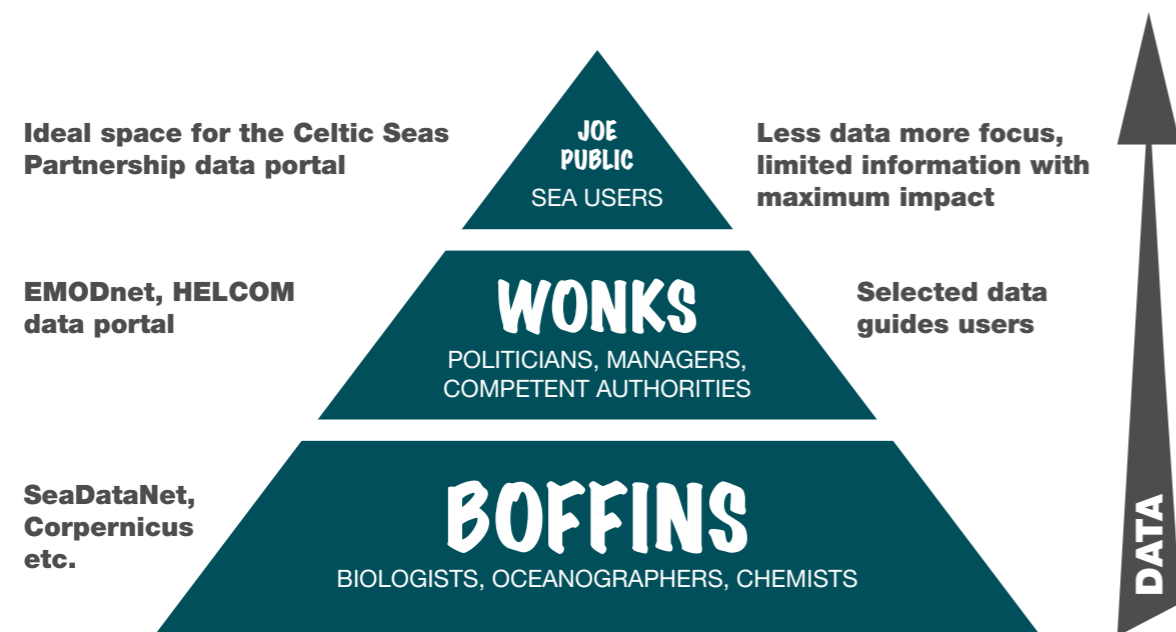
In addition to the officially published MSFD reports there are a huge array of data collection initiatives and many attempts to centralise information with relevance to the MSFD. These include projects on the European scale funded centrally through the European Commission, regional seas based initiatives, disciplinary and topic-based platforms. Though the text above does not provide a comprehensive list of data portals, 36 separate spatially enabled portals have been examined (see Appendix I for full list of links). The problem for the interested party is not then the lack of data but the bewildering profusion of it.

Not only are there a huge amount of data available to view on the web, but much data of direct relevance to implementation of MSFD in the Celtic Seas are also freely available to download. However one common feature of all portals discussed above is that, while they contain MSFD relevant data, they are not specifically designed to

meet the needs of the MSFD. Thus from the perspective of the manager with specific interest in MSFD, too much irrelevant information is present and distinguishing what is of use/interest from what is available becomes the major problem.

Of the portals described above there is a clear distinction between the oceanographic data sharing initiatives (SeaDataNet, Copernicus), which are specifically focussed for use by the scientific research community and carry very detailed information not relevant to the general public, and those sites attempting to deliver more coherent, topic specific information, for example: the MSFD topic centre aimed at environmental managers or the suite of Baltic topic maps administered by HELCOM, which are location and sector specific. With the notable exception of the ICES popular advice webmaps, despite the clear amount of technical effort and research time and the vast amounts of available data, there is still no truly focussed specific location for MSFD relevant geospatial data either at the centralised European level or at the Celtic Seas scale.

Figure 13: Infographic summarising some important considerations in design of geospatial portals.



Given the rapid increase in availability of data, thanks in part to the INSPIRE directive and to improved web mapping technology, it may seem surprising that no tool already exists to enable discovery of MSFD relevant data in the Celtic Seas, but there are several reasons why this may be the case. Firstly, web mapping technologies are relatively new and the software that enables online viewing of geospatial data is constantly developing. Since portals are relatively novel and often developed

as part of research projects, there is a tendency in development to stretch the technical capacity of software at the expense of the practical utility. Scientists are notoriously poor communicators and the technical detail, which is both important and interesting to the research scientist is not important or interesting to the general public. Delivering an effective portal in general requires several important considerations summarised in Figure 13.



### 1. CONSIDER THE TARGET AUDIENCE AND THEIR LEVEL OF TECHNICAL KNOWLEDGE:

Who is the ideal user of the information platform? What is their level of interest and technical knowledge? How little information do they require? Note the many examples above were overwhelmingly data rich. While geospatial data portals offer the ability to deliver vast amounts of data, not all users need all the data. If there is too much information the ease of use of the tool is reduced and the user may get lost looking at data that are not of specific relevance to their interests. Figure 13 summarises the relationship between data availability and data requirements for some existing portals and user groups.

### 2. CONSIDER YOUR MESSAGE:

A web portal never simply delivers data, it is a communication tool. Designing any information platform requires data, and while the data may represent objective measures of reality, the selection of data sets for presentation is not a value-neutral choice. For example, maps of cumulative human pressures, a collection of data on fishing pressures, cables, dredging, litter, energy, noise and ship traffic will tell a very different story to a compilation of data on marine mammal and sea bird abundances in the same region. The message is also reinforced by the visual style of the map- Figure 9 (EMODnet) provides a good example here - the red and blue arrows provide a strong visual cue as to the undesirability of sea level rise while also conveying objectively modelled data. Similarly there are now many different visual styles for background maps that can be used to influence the user (see Appendix III).

### 3. CONSIDER FUNCTIONALITY:

What do you need the portal to do? Many of the portals above are loaded with sophisticated search features and analytical tools to interrogate data. With the vast amount of data available and a range of analytical and search tools to select from some portal developers have opted for sophisticated tools over ease of use. As a general rule, if a particular function is not essential it should not be included.

With specific reference to a portal for the Celtic Seas:

#### 4. WHO ARE THE STAKEHOLDERS?

The Celtic Seas Partnership project has involved stakeholders of many types, bringing together environmental Non-Governmental Organisations, national governments, local governments, sectoral interests and the general public. Not all of these groups have the same interest in a geospatial data portal directed toward MSFD. For example, from the perspective of national government MSFD is being implemented through a process that combines information from many data sources and reports them directly to the EU, a data portal is at best ancillary to this process, at worst it is irrelevant. By contrast a recreational user of the sea may be interested in a geospatial portal but their interest may include information relevant to, but not directly gathered under, the MSFD (for example bathing water quality is a pressure to be considered under the Directive but not a descriptor to be reported). The specific aspects to be included in the final Celtic Seas Partnership portal should be assessed based on experiences in the project so far; certain descriptors and sectors hold more popular appeal and have provoked more attention through the course of the project. These preferences should be considered and a judgement should be made on whether the role of the portal is in promoting the less well understood or less popular aspects or whether the portal should target the more popular descriptors and sectors.

#### 5. WHAT IS THE LEGACY OF THE PORTAL?

Like any other web-based media, geospatial portals have a shelf life. For web portals this often corresponds to the duration of a project, beyond which funding is no longer available to update or maintain the site. In order to maximize the legacy value of the site it is important to consider which data sources are likely to remain in the same location and continue to be maintained. To this end, should the portal point to external resources such as web map services, it is necessary, where possible, to consider the potential longevity of the link, which may be higher in the case of institutional repositories such as EEA and JRC as well as national infrastructure such as MEDIN but lower in project-related websites such as EMODnet.

#### 6. WHAT DATA SHOULD BE INCLUDED?

The data to be included in the portal will depend on the considerations and questions above; a list of candidate data and their sources relevant to specific descriptors is provided in Table 8. Given the ongoing data collection of the Celtic Seas Partnership task groups and measures development work, it may also be desirable to include functionality within the portal to facilitate the uploading of data by stakeholders.

Data examined in this report of clear relevance include the EMODnet suite of data portals, which represent the most comprehensive and accessible source of information covering a broad variety of topics specifically relevant to the MSFD yet also reasonably comprehensible to the non-scientist. At a minimum, habitats, chlorophyll concentrations, dredging locations, seawater chemistry (nitrogen and phosphorus) and contaminant information should be taken from EMODnet as appropriate. Care should be taken to avoid duplication of effort with the forthcoming OSPAR ODIMS system.

A range of useful Web Map Services from the discomap site may also be easily incorporated to the portal, the WISE WMS in particular may be useful.

## CONCLUSIONS

There is a wealth of spatial information relevant to the MSFD available for discovery. The online availability of data is improving due to initiatives such as INSPIRE, as well as the rapidly developing technology for the delivery of data, yet the diverse institutional and legislative reporting requirements can be overwhelming. With so much data and information on the web how can the interested user find the right information for their purposes?

The scientific community is relatively well served regarding data requirements but the policy community and the interested stakeholder may have difficulty navigating the multiple data sources, parameters, organisations and websites currently holding relevant data. User needs and interests in data vary widely and developing an effective portal to communicate MSFD-relevant data - must focus on a target audience and consider carefully which data should be presented and how it should be displayed. Geospatial portals are communications tools as much as they are databases. The key is not to make all data accessible to everyone but to make sure that those who are looking for information get it at the level they need for their purposes.

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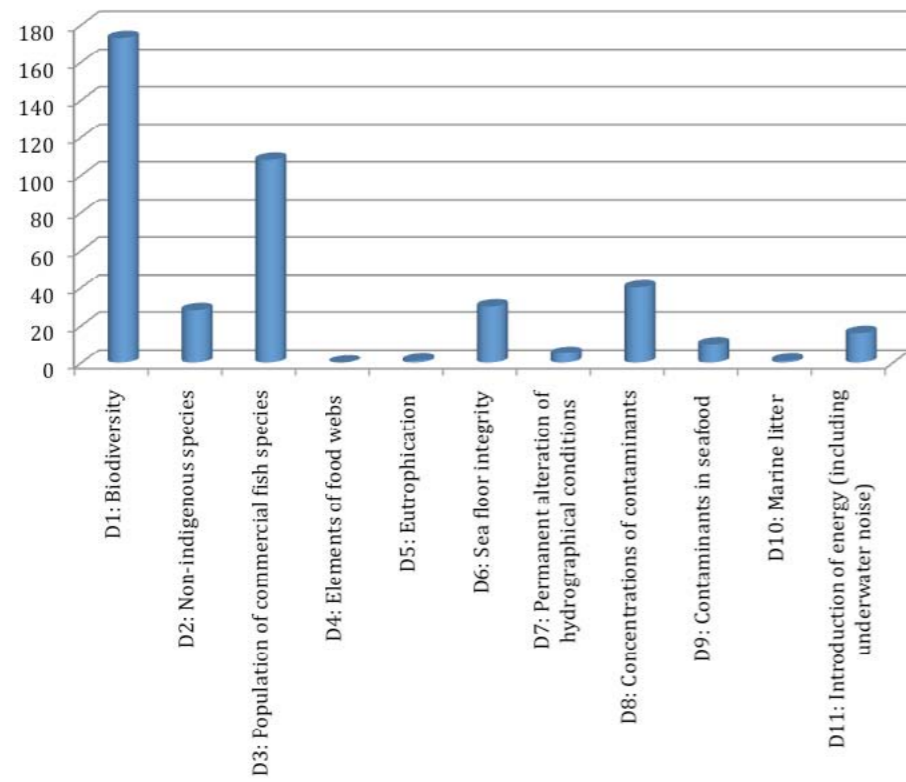
## APPENDIX I

List of links to spatially enabled websites encountered during the research

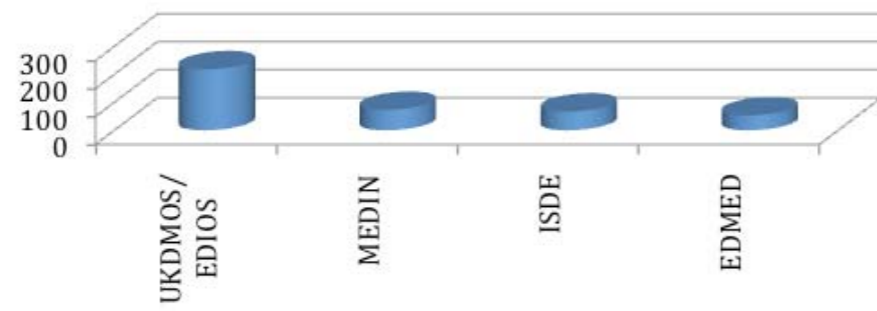
Organisation	Link
<b>EMODNET</b>	<a href="http://www.emodnet-bathymetry.eu/">http://www.emodnet-bathymetry.eu/</a> <a href="http://www.emodnet-geology.eu/emodnet/srv/eng/home">http://www.emodnet-geology.eu/emodnet/srv/eng/home</a> <a href="http://www.emodnet-seabedhabitats.eu/">http://www.emodnet-seabedhabitats.eu/</a> <a href="http://www.emodnet-chemistry.eu/">http://www.emodnet-chemistry.eu/</a> <a href="http://www.emodnet-biology.eu/portal/index.php">http://www.emodnet-biology.eu/portal/index.php</a> <a href="http://www.emodnet-physics.eu/map/">http://www.emodnet-physics.eu/map/</a> <a href="http://www.emodnet-humanactivities.eu/view-data.php">http://www.emodnet-humanactivities.eu/view-data.php</a>
<b>JRC</b>	<a href="http://mcc.jrc.ec.europa.eu/emis/">http://mcc.jrc.ec.europa.eu/emis/</a> <a href="http://mcc.jrc.ec.europa.eu/emis/">http://mcc.jrc.ec.europa.eu/emis/</a> <a href="http://data.jrc.ec.europa.eu/discovery/GeodataInventory">http://data.jrc.ec.europa.eu/discovery/GeodataInventory</a> <a href="http://easin.jrc.ec.europa.eu/">http://easin.jrc.ec.europa.eu/</a>
<b>EEA</b>	<a href="http://discomap.eea.europa.eu/home.html">http://discomap.eea.europa.eu/home.html</a>
<b>HELCOM</b>	<a href="http://maps.helcom.fi/website/mapservice/index.html">http://maps.helcom.fi/website/mapservice/index.html</a> <a href="http://www.helcom.fi/baltic-sea-trends/data-maps/sea-environmental-monitoring">http://www.helcom.fi/baltic-sea-trends/data-maps/sea-environmental-monitoring</a> <a href="http://maps.helcom.fi/website/SeaEnvironmentalStatus/index.html">http://maps.helcom.fi/website/SeaEnvironmentalStatus/index.html</a> <a href="http://maps.helcom.fi/website/Pressures/index.html">http://maps.helcom.fi/website/Pressures/index.html</a> <a href="http://www.helcom.fi/baltic-sea-trends/data-maps/habitat">http://www.helcom.fi/baltic-sea-trends/data-maps/habitat</a> <a href="http://maps.helcom.fi/website/MaritimeResponse/index.html">http://maps.helcom.fi/website/MaritimeResponse/index.html</a> <a href="http://www.helcom.fi/baltic-sea-trends/data-maps-temp/maritime-spatial-planning">http://www.helcom.fi/baltic-sea-trends/data-maps-temp/maritime-spatial-planning</a>
<b>BISE</b>	<a href="http://biodiversity.europa.eu/maes/maes-digital-atlas">http://biodiversity.europa.eu/maes/maes-digital-atlas</a>
<b>MMO</b>	<a href="http://www.mczmapping.org/">http://www.mczmapping.org/</a>
<b>NOAA</b>	<a href="http://marineprotectedareas.noaa.gov/dataanalysis/atlas_ca/viewer/">http://marineprotectedareas.noaa.gov/dataanalysis/atlas_ca/viewer/</a>
<b>MI</b>	<a href="http://atlas.marine.ie/#/Map?c=53.9108;-15.8972;6">http://atlas.marine.ie/#/Map?c=53.9108;-15.8972;6</a> <a href="http://www.marine.ie/Home/site-area/data-services/interactive-maps/irish-groundfish-surveys">http://www.marine.ie/Home/site-area/data-services/interactive-maps/irish-groundfish-surveys</a> <a href="http://www.marine.ie/Home/site-area/data-services/interactive-maps/fisheries-resource-maps">http://www.marine.ie/Home/site-area/data-services/interactive-maps/fisheries-resource-maps</a>
<b>CEFAS</b>	<a href="http://wavenet.cefas.co.uk/Map">http://wavenet.cefas.co.uk/Map</a> <a href="http://wavenet.cefas.co.uk/Smartbuoy/Map">http://wavenet.cefas.co.uk/Smartbuoy/Map</a> <a href="https://planningportal.marinemangement.org.uk/#">https://planningportal.marinemangement.org.uk/#</a>
<b>MS</b>	<a href="https://marinescotland.atkinsgeospatial.com/nmpi/">https://marinescotland.atkinsgeospatial.com/nmpi/</a>
<b>WG</b>	<a href="http://lle.gov.wales/apps/marineportal/#lat=52.5145&amp;lon=-3.9111&amp;z=8">http://lle.gov.wales/apps/marineportal/#lat=52.5145&amp;lon=-3.9111&amp;z=8</a> <a href="http://sextant.ifremer.fr/fr/nos-services">http://sextant.ifremer.fr/fr/nos-services</a>
<b>ICES</b>	<a href="http://gis.ices.dk/sf/">http://gis.ices.dk/sf/</a> <a href="http://gis.ices.dk/popadvice/">http://gis.ices.dk/popadvice/</a>
<b>DG MARE</b>	<a href="http://ec.europa.eu/maritimeaffairs/atlas/maritime_atlas/#lang=EN;p=w;">http://ec.europa.eu/maritimeaffairs/atlas/maritime_atlas/#lang=EN;p=w;</a>
<b>BI</b>	<a href="http://maps.biodiversityireland.ie/#/Designation/1/DesignationGroup">http://maps.biodiversityireland.ie/#/Designation/1/DesignationGroup</a>
<b>NBN</b>	<a href="https://data.nbn.org.uk/imt">https://data.nbn.org.uk/imt</a>

## APPENDIX II

A) Metadata Availability per MSFD Descriptor

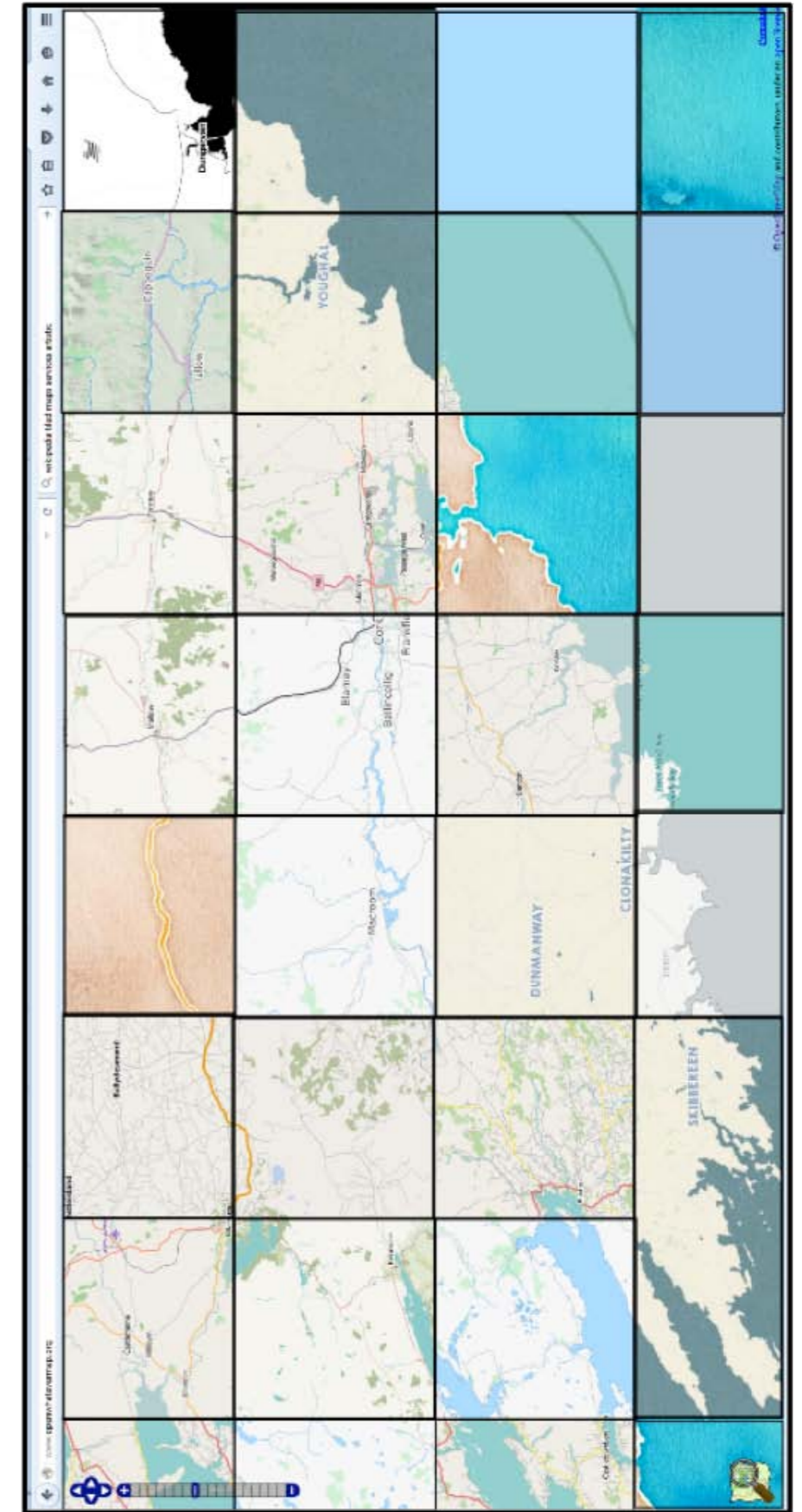


B) Metadata Availability Per Institute in the Celtic Seas



## APPENDIX III

Modified Screenshot from <http://www.openwhatvermap.org/> showing different tiled layers





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