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ACOM/SCICOM STEERING GROUP ON INTEGRATED ECOSYSTEM ASSESSMENTS

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First and Second Interim Reports of the Working Group on Ecosystem Assessment of Western European Shelf Seas (WGEAWESS)

9–13 March 2015

1. via WebEx and Correspondence
2. Cadiz, Spain

ICES
CIEM
International Council for the Exploration of the Sea
Conseil International pour l'Exploration de la Mer

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Contents

Executive Summary

The Working Group on Ecosystem Assessment of Western European Shelf Seas (WGEAWESS) met in Cadiz, Spain, from 9–13 March 2015. Under our three year Terms of reference, this was the second year. However, work in 2014 was by correspondence, and so is reported together with the 2015 meeting in this report.

Under WGEAWESS three-year terms of reference, the activity in the first year focused on cataloguing the datasets available that would be potentially valuable in an IEA. Metadata and descriptions were compiled into a series of databases by ecoregion and sub region. An important element was the identification of the main sector/human activity links to pressures imposed, and identifying pressure state relationships. Full ODEMM metadata compilations have been developed for the Celtic Seas, and for the Bay of Biscay, and the main data have also been compiled for the other subregions in Iberian waters. Examples of the metadata compilation exercise are provided under Section 4.

Under the work plan, the second year focused on carrying out the IEA analysis using ODEMM or another appropriate IEA tool. Full ODEMM analyses have been completed for the Celtic Seas and Bay of Biscay regions. In both cases, fishing emerged as the key pressure, and was the main focus for the Biscay analysis. The ODEMM approach is particularly useful for the identification of gaps and weaknesses in the data or support for conclusions. This is possible, because the approach attempts to describe ALL possible linkages. A key component is the "overlap" which indicates whether an interaction is likely, i.e. does a given structure generate a given pressure, and does that pressure impact on a given ecosystem component. The linkages are given values by panels of experts, and it is possible to identify where a linkage is identified as likely, but for which there is no data or literature support. The approach is therefore useful in clearly identifying where additional research and data collection is required. This also acts as a quality assessment for the analysis. Again, examples are shown for the Celtic Sea and Bay of Biscay regions, where analysis of results are also presented. Examples of these are presented in Section 4 as well. WGEAWESS have also explored the use of Integrated Trend Analyses in the Gulf of Cadiz, and for the Irish Sea. This approach has previously been used successfully in the Baltic and North Seas, but is operationally different from the ODEMM approach in that it only uses data for which there are good time series of quantitative data. Initial results from these are reported in Section 6.

Regional Ecosystem Overviews were developed for the different subregions under WGEAWESS in 2013. This and other information was used to produce Ecoregion Overviews by the ICES Secretariat. These have been reviewed by WGEAWESS and in Section 5 we present a development of the Ecosystem Overview Diagrams following the initial approach but using the ODEMM categories to populate the linkages.

A key ongoing task for WGEAWESS was the identification and reporting of ecosystem trends in the ecoregions and subregions. Extensive examples of this work are reported in Section 6. There is good evidence of a decline in fishing pressure across much of the area from the Celtic Sea to the Portuguese coast. However, there is evidence of an increase in fishing pressure in the Gulf of Cadiz. Fishery ecosystem states show a less clear picture. There is some evidence of a rise in key indicators such as the Large Fish Indicator in the Irish Sea and Bay of Biscay, but not in the Celtic Sea and Portuguese waters. Key non-fishing indicators are mainly dominated by climate change effects. Mean Sea Surface Temperature has increased in all areas of the Celtic Seas Ecoregion

over the last ten years at between +0.3 and +0.5°C, although there may be some evidence of a slower increase in recent years. New analyses of the zooplankton community using functional form pairings and wavelet analysis in the Cantabrian Sea suggests the possibility of a regime shift there between 2001 and 2006, however, this is still work in progress.

Finally, WGEAWESS will continue developing the IEAs already developed, and are exploring approaches to incorporate the human dimension along the lines proposed by the Working Group on the Northwest Atlantic Regional Sea (WGNARS). We are also planning to develop specific "demonstration" advice on specific aspects of the ecosystem across a number of the sub regions.

1 Administrative details

The ICES Working Group on Ecosystem Assessment of Western European Shelf Seas (WGEAWESS) could not meet in 2014 and worked via WebEx and by correspondence. Seven scientists from five countries, with the support of the ICES secretariat, participated at a WebEx conference. The group was able to meet in 2015 in Cadiz, Spain, 9–13 March 2015 (Table 1). As WGEAWESS has a three-year term of reference, and with the agreement of the secretariat, it was decided to present a single report for the first two years, and so this report represents the first and second interim reports for WGEAWESS.

Table 1. List of Participants showing national affiliations and e-mail addresses for 2015 meeting. Those marked with '*' worked both by correspondence and via WebEx conference call in 2014.

Participant	Country	E-mail address
Enrique Nogueira (Chair)*	Spain	enrique.nogueira@gi.ieo.es
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2 Terms of Reference a) – d)

ToR	Description	Background	Science Plan topics addressed	Duration	Expected Deliverables
a	Carry out metadata compilation for all ecosystem components available according to ODDEM framework. Preparatory to carrying out IEA	This is linked to the recommendation of a database	4.3	2 years	Database linked to ICES for Regional Sea Programmes

b	Carry out preliminary evaluation of data and trends for a regional Integrated Ecosystem Assessment;	Linked to SSGRSP guidance for methods	Benchmark 4.2	3 years	Report and articles on GES status of Regional Sea
c	Summarize and update the regional Ecosystem overviews	Linked to WKECOVER and ACOM- SCICOM advice	4.2	3 years	Articles, atlas.
d	Identify ecosystem trends relevant to stock assessment and management and report these accordingly	This would be linked to the commitment to provide advice in the context of EBAFM	4.1	Ongoing	

3 Summary of Work plan

Year 1	The main task will be to catalogue the datasets available that would be potentially valuable in an IEA (provisionally ODEMM approach. Metadata and description will be compiled into a database. This will particularly focus on identifying pressure state relationships that are appropriate to EBAFM. Ongoing identification of important trends in ecosystem indicators.
Year 2	Carry out provisional ODEMM (or other IEA) analysis, using WG membership, and reporting on results, gaps and weaknesses, and way forward. Ongoing identification of important trends in ecosystem indicators.
Year 3	Follow up on previous year IEA, refine including any new data acquired on the basis of the gaps analysis in the previous year. If appropriate, hold a workshop with a wider participation. Ongoing identification of important trends in ecosystem indicators.

Supporting information

Priority	Heavy pressure on shelf seas (biodiversity loss, climate changes, fisheries), lack in understanding of large marine ecosystem functioning and the context of ecosystem health indicators development for the Marine Strategy Framework Directive require to address those research topics at the relevant scale i.e. the regional approach. The EAWESS working group will focus on North Atlantic European continental shelf. Regional area of interest includes the Celtic sea, bay of Biscay and Western Iberia, involving five countries (Ireland, UK, France, Spain and Portugal). The choose of such limits is justified by: • bio-geographical (transitional region between subtropical and Subarctic gyres) • chemo-physical continuum: large opened and connected areas dominated by soft bottom, closely linked by regional ocean circulation process, offering 'coast-shelf-slope' and latitudinal environmental gradient • management unit (ICES, OSPAR) • already existing scientific networks (e.g. IBI-ROOS)

Resource requirements	There is no resource implication for ICES. Working group program is based on synthesis of data and results from existing scientific program, and coordination of surveys and observations networks. However, involvement of ICES data center would useful to help with sharing and harmonizing data.
Participants	The Group is normally attended by some 15 members and guests.
Secretariat facilities	None.
Financial	No financial implications.
Linkages to ACOM and groups under ACOM	Direct link to SSGIEA, ACOM-SCICOM advice.
Linkages to other committees or groups	There is a very close working relationship with all the groups of SSGIEA. It is also very relevant to the Working Group on WGECO and WGSAM
Linkages to other organizations	DC- MAP- DG MARE, MSFD DG ENV, OSPAR

4 ToR a: Carry out metadata compilation for all ecosystem components available according to ODDEM framework

4.1 The ODEMM approach

The complete ODDEM-like framework has been described in the previous report (ICES 2013). The group works on that framework have been mainly focused on implementation of some components (table: *"TabRef1_Components"*), MSFD descriptors and indicators (table: *"TabRef2_Descriptors"*) and to develop links with metadata table (table: *"Tab6_Metadata"*). An example of the components under S02 "fishing" are presented in Table 4.1.1. MSFD indicators are summarized in Table 4.1.2. Description and sources of those indicators are given below.

Table 4.1.1. Sub structure for the ODEMM framework under S02 "fishing".

CODE	LEVEL	DETAILED NAME	BIBLIOGRAPHY
S02	1	Fishing	
S0202	2	Benthic trawls and dredges - operations (interaction with seabed, catch, bycatch, waste products)	
S020201	3	Benthic trawls and dredges - operations-interaction with seabed	
S02020101	4	Total area fished	Piet and Hintzen 2012
S02020102	4	Proportion of the surface area fished	Piet and Hintzen 2012
S02020103	4	Proportion of the surface area fished by a specific proportion of effort	Piet and Hintzen 2012
S02020104	4	Proportion of the surface area fished at specific intensity	Piet and Hintzen 2012

CODE	LEVEL	DETAILED NAME	BIBLIOGRAPHY
S02020105	4	Cumulative proportion of the surface area not impacted over a specific period	Piet and Hintzen 2012
S02020106	4	Proportion of the surface area not impacted at a specific level of confidence	Piet and Hintzen 2012

Indicators relative to seabed integrity descriptor (MSFD06) have been mainly taken from recent report of dedicated ICES/JRC joint report (Rice *et al.*, 2010, Rice *et al.*, 2012). Regarding foodwebs indicators (MSFD04), we summarized those recommended by the ICES group dealing with the ecosystem effects of fishing activities (WGECO, (ICES, 2010)).

Table 4.1.2. Main new features included in ODDEM-like framework for MSFD descriptors and indicators.

CODE	LEVEL	SHORT NAME	DETAILED NAME	BIBLIOGRAPHY
MSFD01				
MSFD04	1	Foodwebs	Foodwebs	
MSFD0401	2	FWsize	Size based indicators	
MSFD040101	3	FWML	Mean length of surveyed community	ICES 2010
MSFD040102	3	FWSSS	Size spectra slope	ICES 2010
MSFD040103	3	FWLFI	Large fish indicator	ICES 2010
MSFD040104	3	FWPLF	Proportion of large fish	ICES 2010
MSFD040105	3	FWZSB	Zooplancton mean size and total community biomass index	ICES 2010
MSFD06	1	SFI	Sea-floor integrity	
MSFD0601	2	SFISUBST	Substratum	Rice, 2012 #2598/Rice, 2010 #2795
MSFD0602	2	SFIBIOENG	Bioengineers	Rice, 2012 #2598/Rice, 2010 #2795
MSFD0603	2	SFIOXYC	Oxygen concentration	Rice, 2012 #2598/Rice, 2010 #2795
MSFD0604	2	SFICONTAM	Contaminants and hazardous substances	Rice, 2012 #2598/Rice, 2010 #2795
MSFD0605	2	SFISPEC	Species composition	Rice, 2012 #2598/Rice, 2010 #2795
MSFD0606	2	SFISIZE	Size distribution	Rice, 2012 #2598/Rice, 2010 #2795
MSFD0607	2	SFITROPH	Trophodynamics	Rice, 2012 #2598/Rice, 2010 #2795
MSFD0608	2	SFIENERGY	Energy flow and life history traits	Rice, 2012 #2598/Rice, 2010 #2795

For each region covered by WGEAWESS, data sources and descriptions will be inserted into a metadata table. See Table 4.2.1.

The ODEMM analysis for Irish Waters, the main component of the Celtic Seas has been updated within the developed ODEMM framework described in Knights *et al.*, (2015). An example of the full linkage diagram for this is presented in Figure 4.1.1.

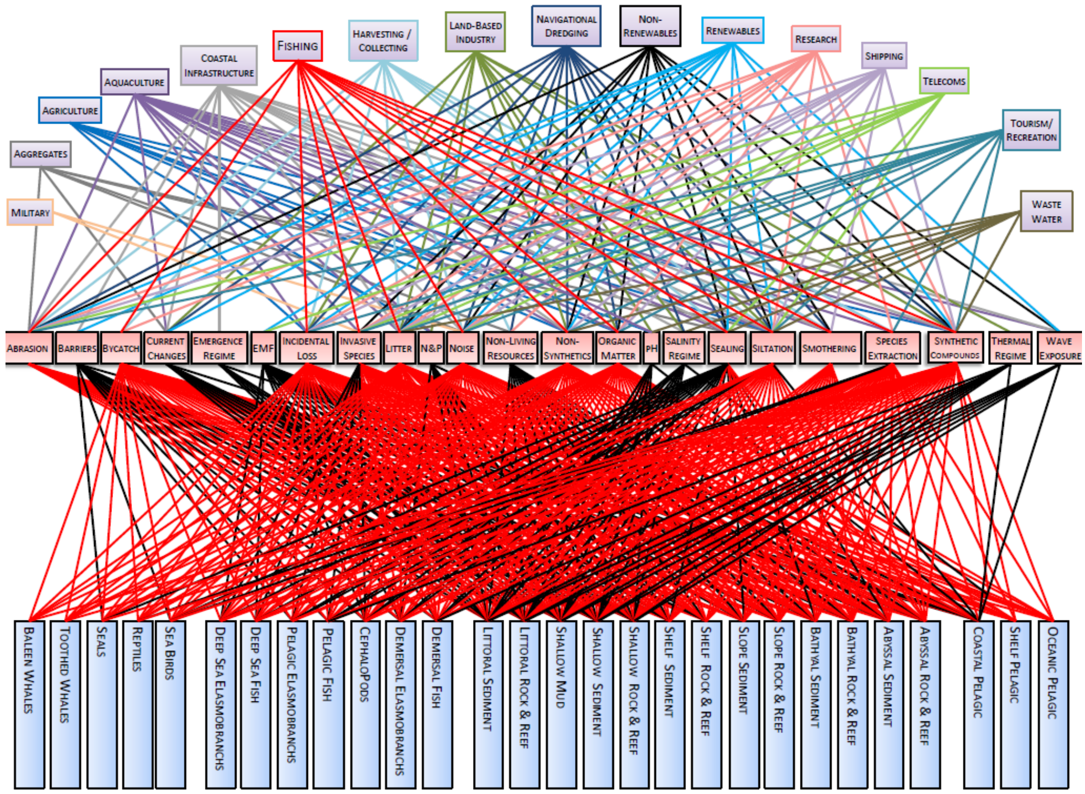

Figure 4.1.1. A full linkage diagram for Irish waters developed under the ODEMM framework. The top, curved line of boxes represent the sectors considered, the middle line represent the pressures imposed by those sectors, and the bottom line represents the ecosystem components evaluated. This figure is also often described as a "horrendogram" The red lines represent the linkages from the fishing sector.

The "horrendogram", described above, can be simplified to focus on a single sector, and the links to the pressures, and ecosystem components identified can be more easily understood. This is the so called "bow tie" diagram, and an example for the fishing sector is presented in Figure 4.1.2. The pressures generated from a given sector are in the left hand column, and the ecosystem components affected are presented in the right hand column. The MSFD descriptors relevant to the sector are present in the bottom centre column. The connecting lines can be used to express the strength and scope of the connection.

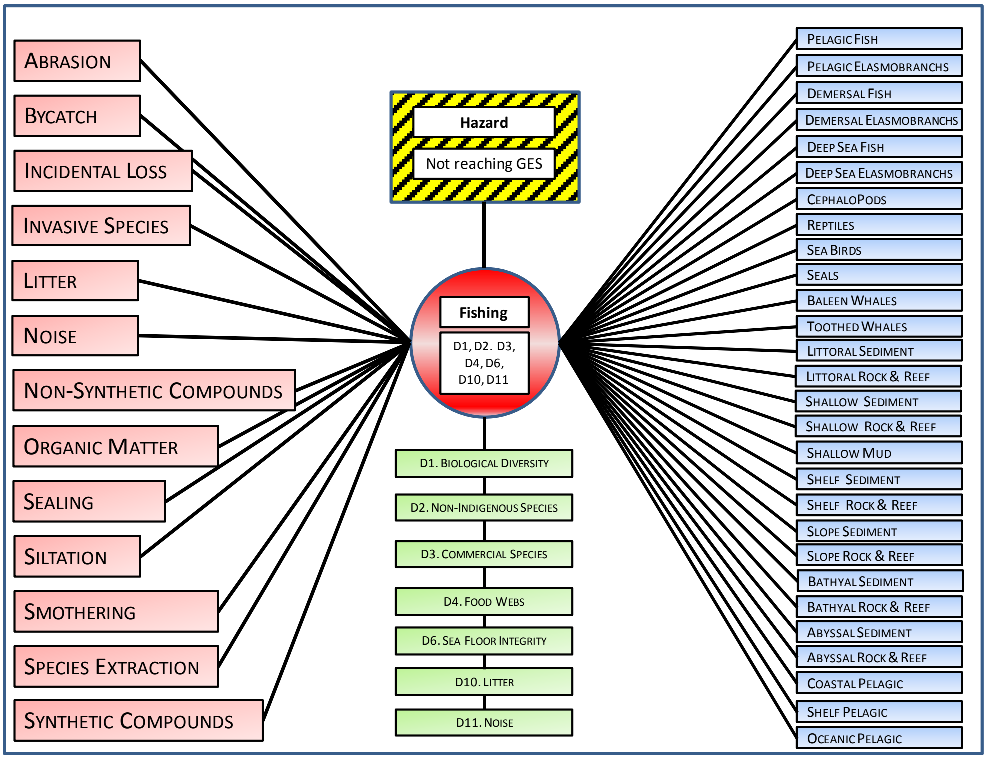

Figure 4.1.2. Bow tie diagram for fishing in Irish waters showing pressures, components affected and relevant MSFD descriptors.

From this compilation, we can then look at the proportional connectance between sectors, for instance in terms of both pressures and components illustrated in Figure 4.1.3. This shows the particularly strong connections for fishing, which shares approximately 14% of linkages with other sectors, probably reflecting the large number of pressure and component linkages for fishing.

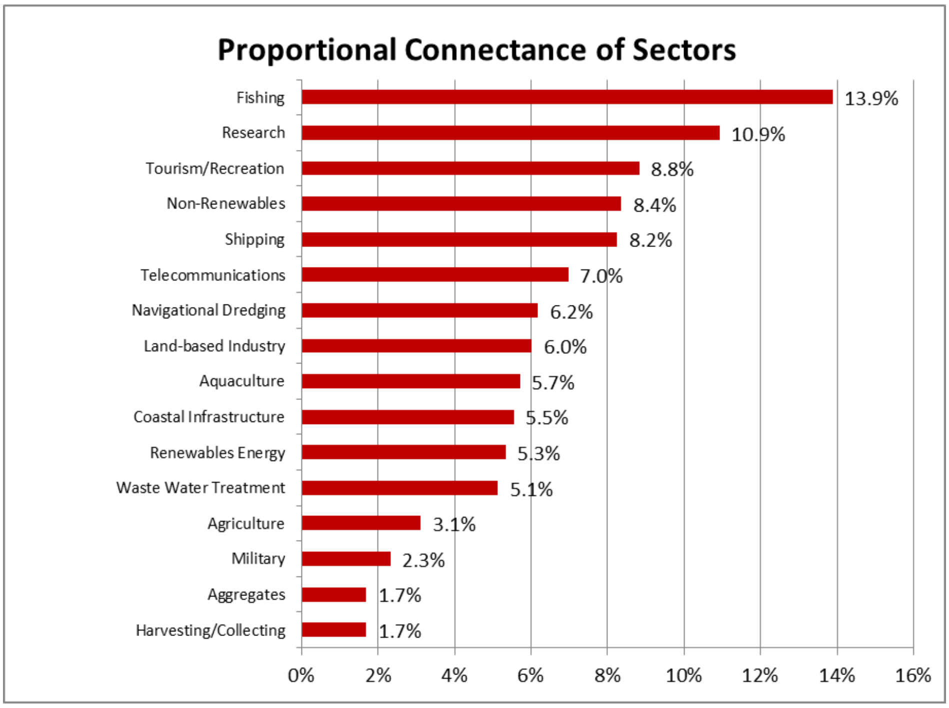

Figure 4.1.3. Proportional connectance of sectors in terms of linkages to both pressures and ecosystem components.

We can also then look at specific connections of a sector with another based on this series of connections, and find which sectors are closest in terms of, say, the pressures they exert. In Figure 4.1.4, sectors are grouped by their pressures. Sectors that cause similar pressures cluster together. Branch lengths indicate dissimilarity from other clusters. Height indicates similarity within a cluster. In this example for Irish waters, for instance, fishing links strongly with non-renewables, shipping and tourism, suggesting that management of these sectors would need to be linked.

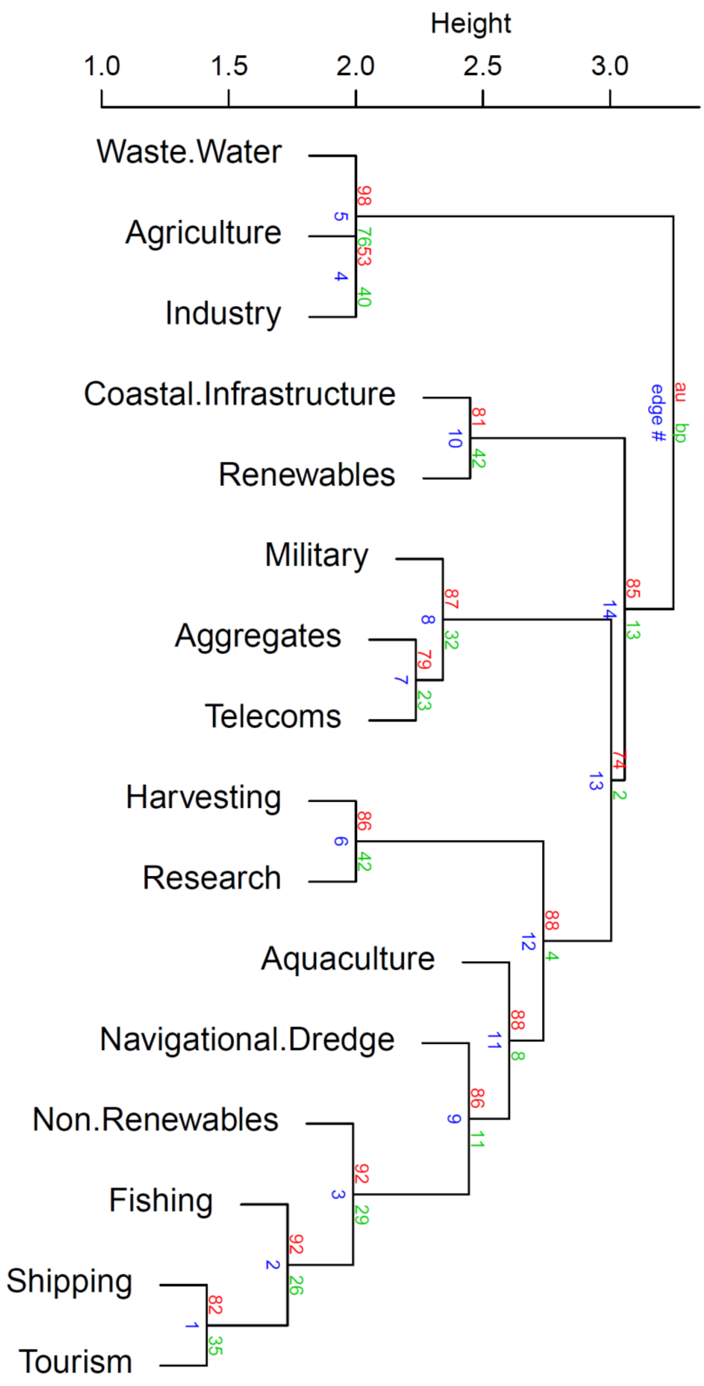

Figure 4.1.4. Linkage dendrogram by pressure for sectors in Irish waters.

4.2 Metadata compilation

A wide variety of sources can be utilized to support an ODEMM analysis. These range from time-series of data from surveys, remote sensing etc. through targeted studies in the literature, to reports, and published research. An example of the metadata compilation for the Celtic Seas ODEMM analysis is shown in Table 4.2.1. This example is for fishing as a sector, and selective removal of species as a pressure, across a range of ecosystem components including both biological groupings e.g. cetaceans and habitats e.g. sublittoral rock. The table includes the evaluation of Overlap, Frequency, Degree of Impact, Resilience and Persistence.

Table 4.2.1. Extract from the ODEMM metadata table for Irish waters.

Sector	Pressure	Ecological Characteristic	Overlap	Frequency	Degree of Impact	Resilience	Persistence		Data Support?	Type	Supporting	Controls? (monitor / legislation	Competent Authority / Contributing Agency	Nature of Interaction	Specifics	Reference
Fishing	Litter	Demersal Elasmo	W	P	C	M	C		Y	Map, Surveys, Research	Impact	Yes	MI, Coastwatch	Direct	IGFS surveys note litter	Map (paper in progress), Coastwatch (2013), Derraik (2002), Galgani *et al.* (2013),
Fishing	Litter	Pelagic Elasmo	W	P	C	M	C		Y	Map, Surveys, Research	Impact	Yes	MI, Coastwatch	Direct	IGFS surveys note litter	Map (paper in progress), Coastwatch (2013), Derraik (2002), Galgani *et al.* (2013),
Fishing	Litter	Deep Sea Elasmo	L	O	C	M	C		Y	Map, Surveys, Research	Impact	Yes	MI, Coastwatch	Direct	IGFS surveys note litter	Map (paper in progress), Coastwatch (2013), Derraik (2002), Galgani *et al.* (2013),
Fishing	Litter	Reptiles	W	R	C	M	C		Y	Map, Surveys, Research	Impact	Yes	MI, Coastwatch	Direct	IGFS surveys note litter	Map (paper in progress), Coastwatch (2013), Derraik (2002), Galgani *et al.* (2013),
Fishing	Litter	Cephalopods	W	P	C	M	C		Y	Map, Surveys, Research	Impact	Yes	MI, Coastwatch	Direct	IGFS surveys note litter	Map (paper in progress), Coastwatch (2013), Derraik (2002), Galgani *et al.* (2013),
Fishing	Litter	Deep Sea Fish	L	O	C	M	C		Y	Map, Surveys, Research	Impact	Yes	MI, Coastwatch	Direct	IGFS surveys note litter	Map (paper in progress), Coastwatch (2013), Derraik (2002), Galgani *et al.* (2013),
Fishing	Litter	Demersal Fish	W	P	C	M	C		Y	Map, Surveys, Research	Impact	Yes	MI, Coastwatch	Direct	IGFS surveys note litter	Map (paper in progress), Coastwatch (2013), Derraik (2002), Galgani *et al.* (2013),
Fishing	Litter	Pelagic Fish	W	P	C	M	C		Y	Map, Surveys, Research	Impact	Yes	MI, Coastwatch	Direct	IGFS surveys note litter	Map (paper in progress), Coastwatch (2013), Derraik (2002), Galgani *et al.* (2013),
Fishing	Litter	Seabirds	W	P	C	L	C		Y	Map, Surveys, Research	Impact	Yes	MI, Coastwatch	Direct	IGFS surveys note litter	Map (paper in progress), Coastwatch (2013), Derraik (2002), Galgani *et al.* (2013),
Fishing	Litter	Seals	W	P	C	M	C		Y	Map, Surveys, Research	Impact	Yes	MI, Coastwatch	Direct	IGFS surveys note litter	Map (paper in progress), Coastwatch (2013), Derraik (2002), Galgani *et al.* (2013),
Fishing	Litter	Toothed Whales	W	C	C	M	C		Y	Map, Surveys, Research	Impact	Yes	MI, Coastwatch	Direct	IGFS surveys note litter	Map (paper in progress), Coastwatch (2013), Derraik (2002), Galgani *et al.* (2013),
Fishing	Litter	Baleen Whales	W	C	C	M	C		Y	Map, Surveys, Research	Impact	Yes	MI, Coastwatch	Direct	IGFS surveys note litter	Map (paper in progress), Coastwatch (2013), Derraik (2002), Galgani *et al.* (2013),
Fishing	Litter	Oceanic Pelagic	W	P	L	H	C		Y	Map, Surveys, Research	Impact	Yes	MI, Coastwatch	Direct	IGFS surveys note litter	Map (paper in progress), Coastwatch (2013), Derraik (2002), Galgani *et al.* (2013),
Fishing	Litter	Shelf Pelagic	W	P	L	H	C		Y	Map, Surveys, Research	Impact	Yes	MI, Coastwatch	Direct	IGFS surveys note litter	Map (paper in progress), Coastwatch (2013), Derraik (2002), Galgani *et al.* (2013),
Fishing	Litter	Coastal Pelagic	W	P	L	H	C		Y	Map, Surveys, Research	Impact	Yes	MI, Coastwatch	Direct	IGFS surveys note litter	Map (paper in progress), Coastwatch (2013), Derraik (2002), Galgani *et al.* (2013),
Fishing	Litter	Bathyal Sediment	W	P	C	M	C		Y	Map, Surveys, Research	Impact	Yes	MI, Coastwatch	Direct	IGFS surveys note litter	Map (paper in progress), Coastwatch (2013), Derraik (2002), Galgani *et al.* (2013),
Fishing	Litter	Bathyal Rock & Reef	W	P	C	M	C		Y	Map, Surveys, Research	Impact	Yes	MI, Coastwatch	Direct	IGFS surveys note litter	Map (paper in progress), Coastwatch (2013), Derraik (2002), Galgani *et al.* (2013),
Fishing	Litter	Slope Sediment	W	P	C	M	C		Y	Map, Surveys, Research	Impact	Yes	MI, Coastwatch	Direct	IGFS surveys note litter	Map (paper in progress), Coastwatch (2013), Derraik (2002), Galgani *et al.* (2013),
Fishing	Litter	Slope Rock Reef	W	P	C	M	C		Y	Map, Surveys, Research	Impact	Yes	MI, Coastwatch	Direct	IGFS surveys note litter	Map (paper in progress), Coastwatch (2013), Derraik (2002), Galgani *et al.* (2013),
Fishing	Litter	Shelf Sediment	W	P	C	M	C		Y	Map, Surveys, Research	Impact	Yes	MI, Coastwatch	Direct	IGFS surveys note litter	Map (paper in progress), Coastwatch (2013), Derraik (2002), Galgani *et al.* (2013),
Fishing	Litter	Shelf Rock & Reef	W	P	C	M	C		Y	Map, Surveys, Research	Impact	Yes	MI, Coastwatch	Direct	IGFS surveys note litter	Map (paper in progress), Coastwatch (2013), Derraik (2002), Galgani *et al.* (2013),
Fishing	Litter	Shallow Mud	W	P	C	M	C		Y	Map, Surveys, Research	Impact	Yes	MI, Coastwatch	Direct	IGFS surveys note litter	Map (paper in progress), Coastwatch (2013), Derraik (2002), Galgani *et al.* (2013),
Fishing	Litter	Shallow Sediment	W	P	C	M	C		Y	Map, Surveys, Research	Impact	Yes	MI, Coastwatch	Direct	IGFS surveys note litter	Map (paper in progress), Coastwatch (2013), Derraik (2002), Galgani *et al.* (2013)
Fishing	Litter	Shallow Rock & Reef	W	P	C	M	C		Y	Map, Surveys, Research	Impact	Yes	MI, Coastwatch	Direct	IGFS surveys note litter	Map (paper in progress), Coastwatch (2013), Derraik (2002), Galgani *et al.* (2013)
Fishing	Litter	Littoral Sediment	W	P	C	M	C		Y	Map, Surveys, Research	Impact	Yes	MI, Coastwatch	Direct	IGFS surveys note litter	Map (paper in progress), Coastwatch (2013), Derraik (2002), Galgani *et al.* (2013)
Fishing	Litter	Littoral Rock & Reef	W	P	C	M	C		Y	Map, Surveys, Research	Impact	Yes	MI, Coastwatch	Direct	IGFS surveys note litter	Map (paper in progress), Coastwatch (2013), Derraik (2002), Galgani *et al.* (2013)

Data support was available for 1892 linkages. All had at least two different sources of supporting data. Those with only two sources represented 29% of the linkages, those with three, 44% of the linkages, and those with 4 or more, 26% of the linkages.

Similar metadata compilation is being carried out in the other areas of the Western Waters.

4.3 Analyses of data gaps and weaknesses

One key element of ODEMM based analyses is the possibility of highlighting situations where there are links identified, but there are little or no data to support the extent and importance of the linkages. An example is shown for the Biscay ODEMM analysis in Figure 4.3.1. Figure 4.3.1a shows all linkages relating to MSFD indicator - Mean length of surveyed community. The top layer represents those sectors, which will be expected to exert some relevant pressure. The second layer represents those pressures with links to the sectors producing them. The third layer represents the ecosystem components which would be affected by the pressures in layer 2, and that in turn are linked to the MSFD indicator, in layer 4. Figure 4.3.1b shows the links considered important and for which some data are available to support that linkage. Twenty different sectors were considered to exert a relevant pressure; of these eight were supported by data. 23 different pressure types were identified as relevant of which only two were supported by any data linking sector to pressure, and then to the ecosystem component.

For the Celtic Seas ODEMM assessment, the data support analysis was broken down for the different layers in the analysis.

- For the Sector/Ecological component linkage, we identified the Overlap between sector and the ecological component, using maps and monitoring data (e.g. surveys). We were able to locate supporting data for all of these linkages.

- The linkages between Sector and Pressure could be documented for around two thirds of the linkages identifies. Data support was mainly from literature and monitoring data.
- The linkages between a Pressure and an ecosystem component were the most difficult to substantiate from external sources, and we were only able to source data support for around one third of the linkages. This is essentially the question of "Does the pressure affect the ecological characteristic?" Leading on, is there a pressure-state relationship? Do we monitor for the pressure in the ecological component? In addition, do we know its response (in terms of resilience/persistence)? Understandably, this would require considerably more detailed in situ research to establish each linkage, than is the case for say, the simpler sector pressure overlap. Data sources for this set of linkages also came from literature and monitoring data.
- Finally, we evaluated the status of monitoring for each of the ecosystem components, and if ANY was conducted, did we have access to that material. In this case, we were able to establish data support for all ecosystem components to some degree.

Data support was therefore available for 1892 linkages. All had at least two different sources of supporting data. Those with only two sources represented 29% of the linkages, those with three, 44% of the linkages, and those with four or more, 26% of the linkages.

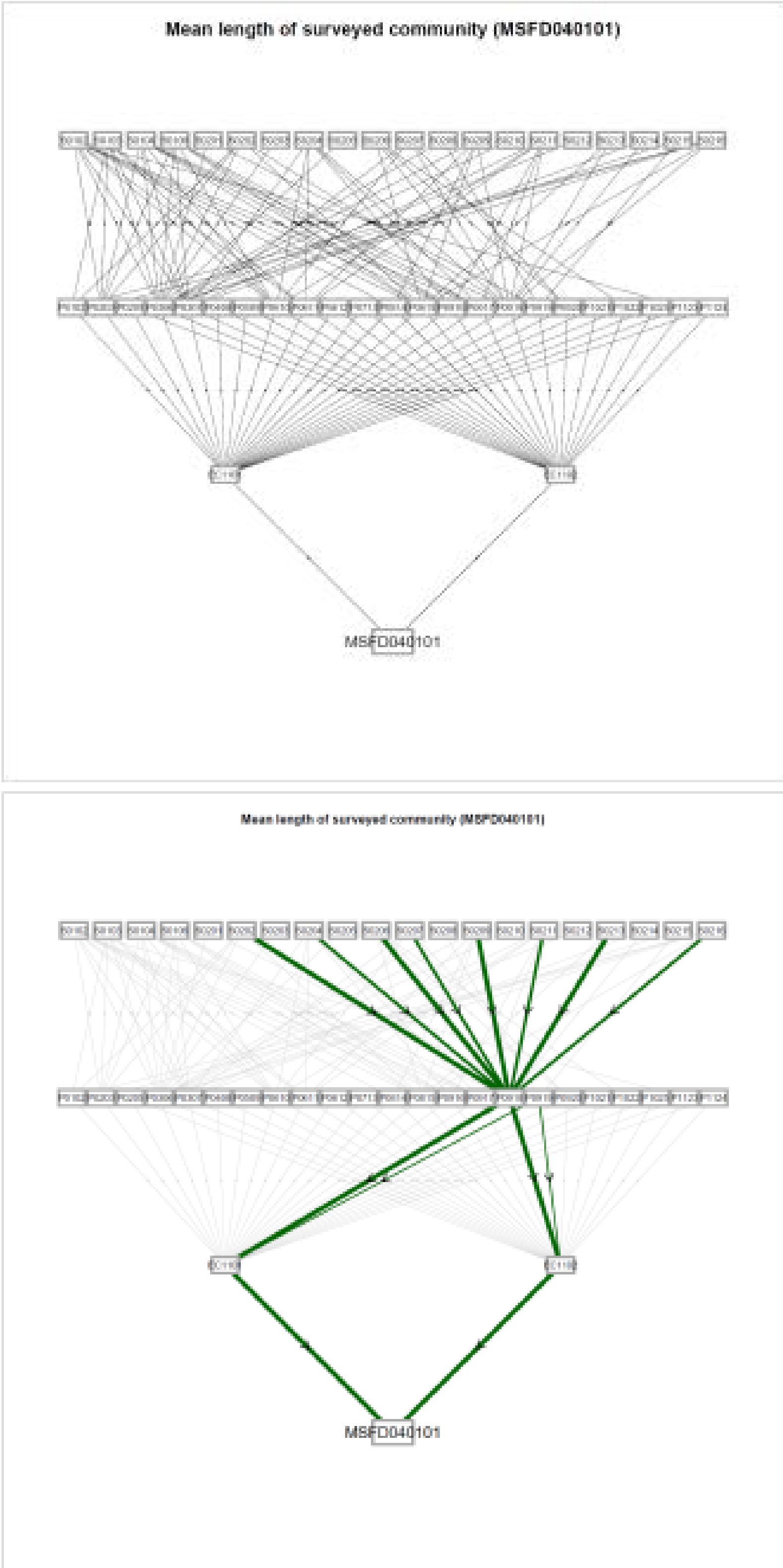

Figure 4.3.1. Relations diagram for MSFD indicator "Mean length of surveyed community" (MSFD040101) in the Bay of Biscay a) Complete interaction diagram, b) main "components" for considered region and indications of available dataset.

5 ToR c: Summarize and update the regional Ecosystem overviews

Full-scale ecosystem overviews have been prepared for both the Celtic Seas, and for Bay of Biscay/Iberian waters. Data from these and other sources have been collated into shorter Ecosystem Overview diagrams prepared by the ICES Secretariat, and example of which is presented in Figure 5.1).

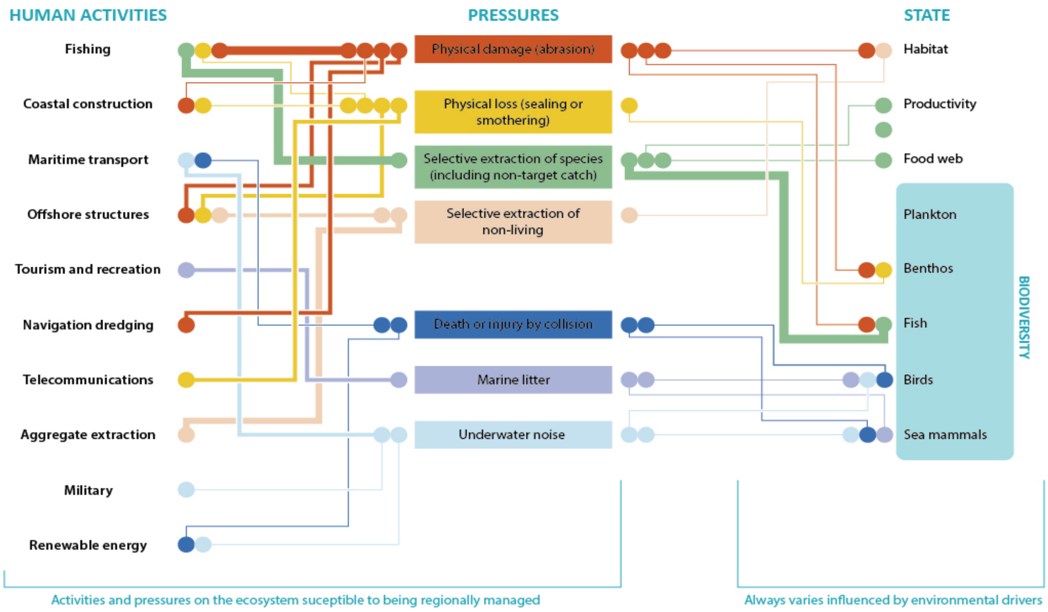

Figure 5.1. ICES Ecosystem Overview diagram. Each activity is represented by a colour; the scale of the pressure is represented by the thickness of the connecting lines, and the number of connections by the circles.

5.1 ODEMM analysis results

With the matrix of sectors (human activities), pressures, and ecosystem components having been compiled, (see Section 4), it is then possible to produce analytical outputs, and represent these in the same type of overview approach shown in Figure 5.1. The plot in Figure 5.1.1. shows one possible output, in this case for the Celtic Seas. The panel on the left shows the impact risk score by pressure, with Bycatch and Species Extraction coming out as the main pressures across all ecosystem components. The middle panel shows the same data but logged and ranked to provide more detail to the plot, again, Bycatch and Species Extraction can be seen to be important, but other features such as Abrasion and Smothering can also be seen to figure strongly. Impact risk is based on Overlap – the scale to which the pressure overlaps with the component; Frequency – how often the pressure is applied to the component in the year, and the Degree of Impact – the direct scale of that impact. The panel on the right shows the Recovery time expected in relation to each pressure. Recovery time is a combination of the Resilience and Persistence scores. Here quite different pressures predominate, notably: Current Changes, Synthetic and Non-synthetic Contaminants and sealing.

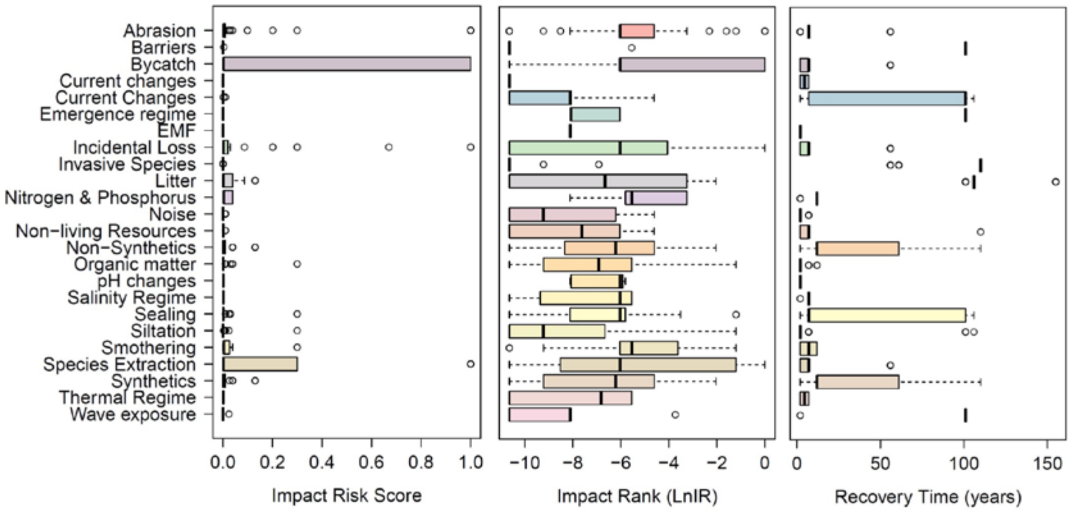

Figure 5.1.1. ODEMM analysis outcomes. Left: Impact Risk Score. Centre: Impact ranks, and right: Impact Recovery Time, by pressure for Irish waters.

The information developed by the ODEMM analysis can also be parsed into a similar format to that used in the ICES Ecosystem Overview Diagram in Figure 5.1. An example of this for the Celtic Seas is presented in Figure 5.1.2.

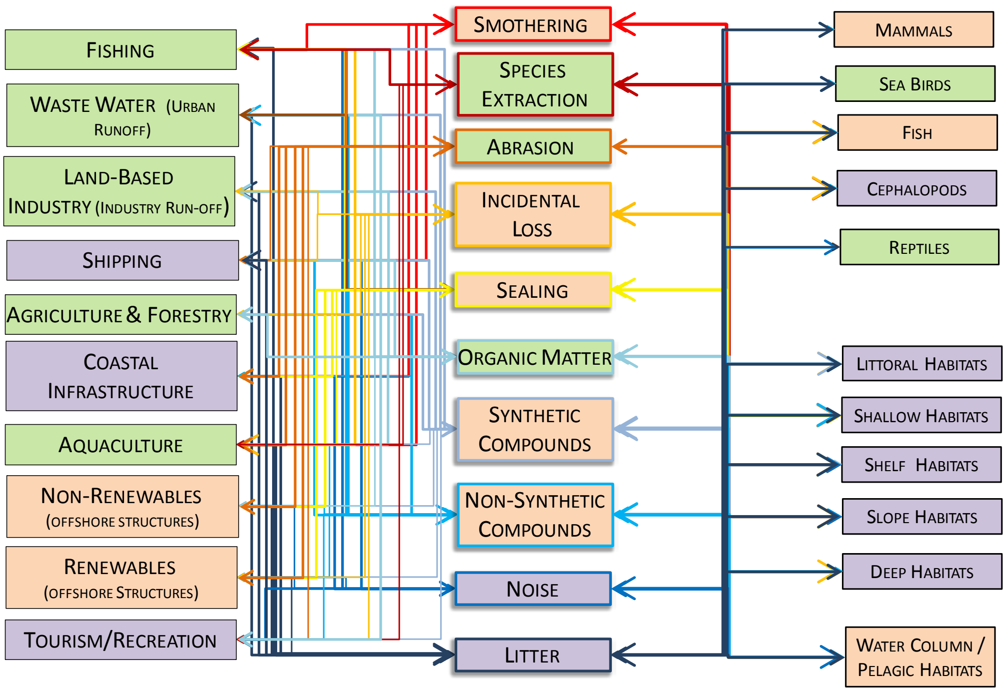

Figure 5.1.2. Ecosystem Overview diagram for the Celtic Seas Ecoregion based on the ODEMM analysis. Again, each activity is represented by a colour, and the scale of the pressure is represented by the thickness of the connecting lines. The above illustrates the top ten Sectors (human activities) and Pressures in the Celtic Seas. We have filtered down the Ecological Characteristics based upon the categories for MSFD listed by WGIAB (see Table 5.1.1), with the exception that we have split Seabed into 5 depth categories, and we have maintained Cephalopods as a separate group. All categories in green are found in the ICES Ecosystem Overview Diagram. Orange are those that are

covered in both, but with some changes in approach (e.g. offshore structures have been split into Non-renewables and Renewables). Purple are additional components that were found to be important in the Celtic Seas ODEMM analysis, but not used in the ICES Ecosystem Overview Diagram. Both the Sectors and Pressures are in order of their impact (most damaging at the top). Ecological characteristics are not in order of most affected, instead they are listed in more ecological order. On the left hand side, we have separated out the linkages individually. This has not been done yet for the pressure/state linkages.

Table 5.1.1. Interpretation of descriptor categories and sub categories from Ecosystem Overview Diagrams, WGIAB proposals, and Celtic Seas ODEMM analysis.

<table>
<tr><th>Categories in ICES Ecosystem Overview Diagram</th><th>Proposed MSFD reporting categories from WGIAB</th><th>Categories used in the ODEMM analysis</th></tr>
<tr><td>Foodwebs</td><td></td><td></td></tr>
<tr><td>Productivity</td><td rowspan="2">Water Column</td><td rowspan="2">Water Column</td></tr>
<tr><td>Plankton</td></tr>
<tr><td rowspan="2">Habitat</td><td rowspan="5">Seabed</td><td>Littoral habitats</td></tr>
<tr><td>Shallow Habitats</td></tr>
<tr><td rowspan="3">Benthos</td><td>Shelf habitats</td></tr>
<tr><td>Slope Habitats</td></tr>
<tr><td>Deep Habitats</td></tr>
<tr><td>Fish</td><td>Fish</td><td>Fish</td></tr>
<tr><td>Birds</td><td>Seabirds</td><td>Seabirds</td></tr>
<tr><td rowspan="2">Mammals</td><td>Mammals</td><td>Mammals</td></tr>
<tr><td>Reptiles</td><td>Reptiles</td></tr>
</table>

The diagram shown in Figure 5.1 is definitely not yet a useful product in terms of synthesis of the sectors, pressures and ecosystem components. The main issue is that the ODEMM analysis approach identified many more linkages than are summarized in the Ecosystem Overview Diagram. For instance smothering is linked to four different human activities, and litter to five. The issue is to determine how to construct an overview diagram that both summarizes the information in a way that is immediately accessible, as the Ecosystem Overview Diagram does, and that includes all the main linkages and their scale, as Figure 5.1.2 does.

6 ToR b: Carry out preliminary evaluation of data and trends for a regional Integrated Ecosystem Assessment; and ToR d: Identify Regional trends

Specific examples are given for the Bay of Biscay, the Celtic Sea, Cantabrian Sea, Portuguese waters, Irish Sea, West of Scotland and the Gulf of Cadiz.

6.1 Trends in fishing pressure, mean maximum length and LFI in three areas of the Western waters

While the main part of the analysis is being carried out for each subregion individually, it is also possible to develop an appreciation of the trends in the same parameter in a group of the sub regions. The data presented in Figure 6.1.1. a, b, and c, represent these trends in the Celtic Sea, the Bay of Biscay, and in Portuguese waters.

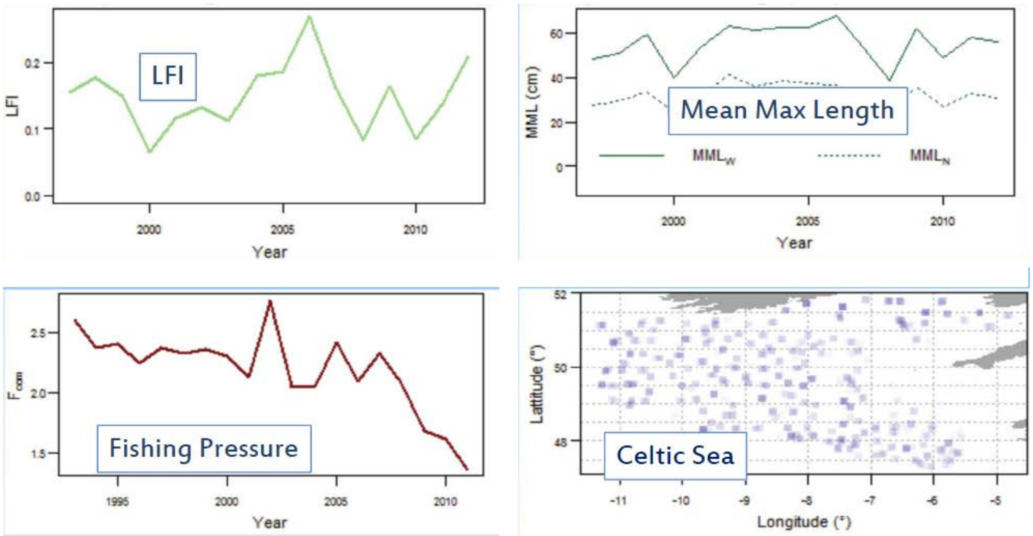

Figure 6.1.1.a. Trends in fishing pressure, mean maximum length and LFI in the Celtic Sea.

In the Celtic Sea, there is clear evidence of a reduction in fishing pressure since the middle of the 2000s, but with little corresponding change in either LFI or MML. In the Bay of Biscay, fishing pressure has also declined markedly since the early 2000s, but there also appears to have been some increase in the LFI, and possibly the MML, in contrast to the Celtic Sea. In Portuguese waters, fishing pressure has only decreased in the later part of the 2000s, and there has been no obvious change in either LFI or MML.

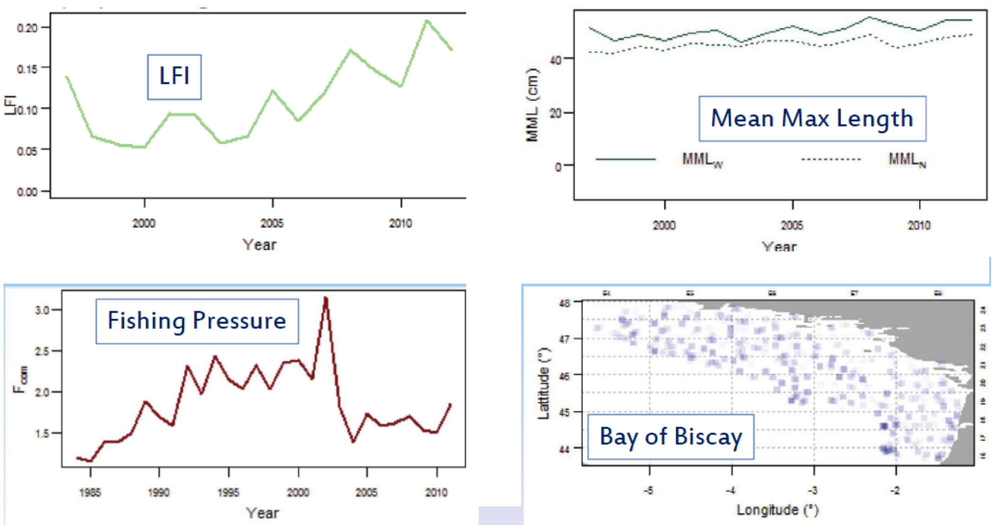

Figure. 6.1.1.b. Trends in fishing pressure, mean maximum length and LFI in the Bay of Biscay.

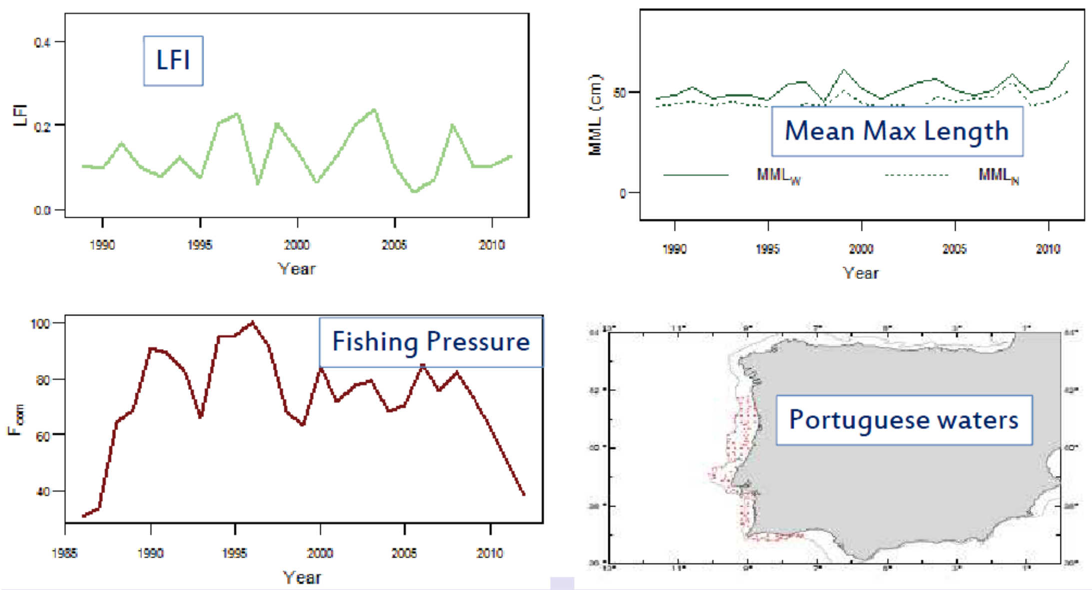

Fig 6.1.1c. Trends in fishing pressure, mean maximum length and LFI in Portuguese waters.

6.2 Trends in Fisheries footprint – Descriptor: linked to MSFD06 – Biscay

Analysed period (6 years from 2005 to 2010) shows significant reduction of total fishing effort for trawlers (2010 effort representing only 55% of 2005 effort level, Figure 6.2.1). When examining depth distribution of effort, diminution mainly occurs in areas deeper than 200 m, shallowest areas being rather stable. Those results contrast with longlines effort evolution that seems rather stable despite a specific increase in 2010 representing the most important fishing effort value of the time-series. In 2010, LLS fishing effort shows specific increase in the 200 to 600 m deep areas. Those LLS effort variations does probably not reflect an overall increase of longlines fishing effort but much probably changes of fishing distribution at Northeastern Atlantic scale (P. Lorance pers. com.).

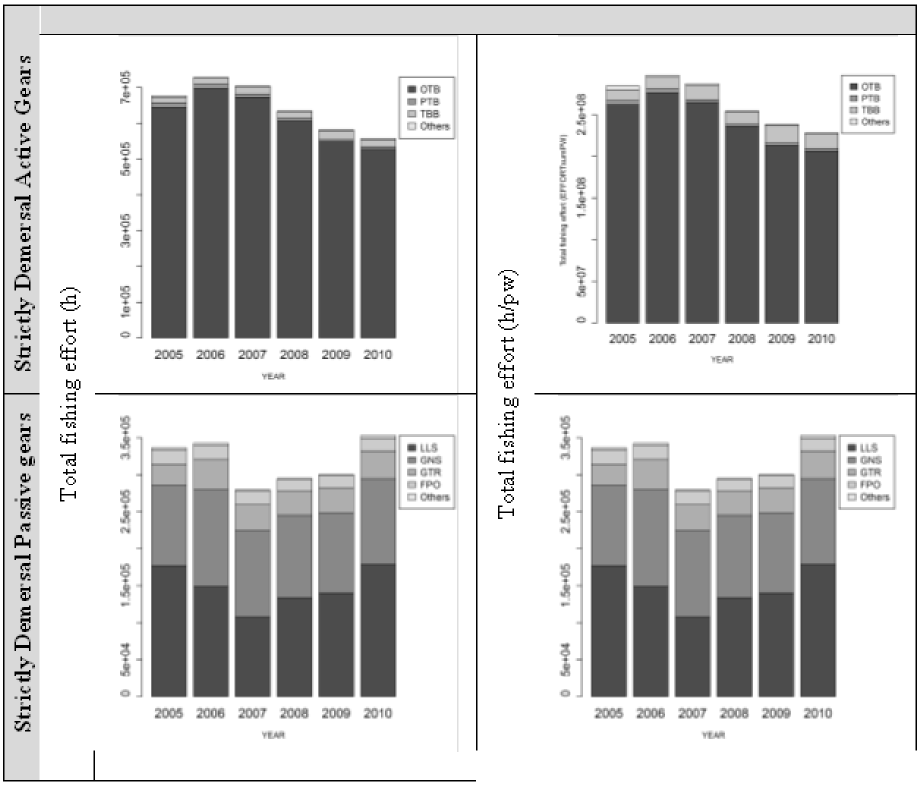

Figure 6.2.1. Total sum of yearly fishing effort (total duration of operating vessels expressed in (h)ours or hours by vessel power, h/pw) as derived from Vessel Monitoring System dataset (3'/3' scale) for selected strictly demersal active and passive gears in the whole Bay of Biscay. Only gear representing at least 2% of the total fishing effort for one of the years are indicated; gears with lower effort are aggregated into "others" category. Total fishing effort (Hours) for the two categories of gears (passive vs. active) are not directly comparable (figure adapted from Laffargue *et al.*, 2011).

6.3 Trends in Fisheries footprint - Descriptor: linked to MSFD06 - Celtic Sea

A similar analysis was carried out for the Celtic Sea for eight years from 2006 to 2013. Figure 6.3.1 shows little trend in total fishing effort for trawlers in general, but a small reduction in beam trawl effort. Passive gears (Figure 6.3.2.) also show no major temporal patterns, although potting increased slightly to 2010, and then declined again. Pelagic trawling (Figure 6.3.3) showed a much more variable pattern, presumably linked to the availability of pelagic species in the area, and no obvious trends.

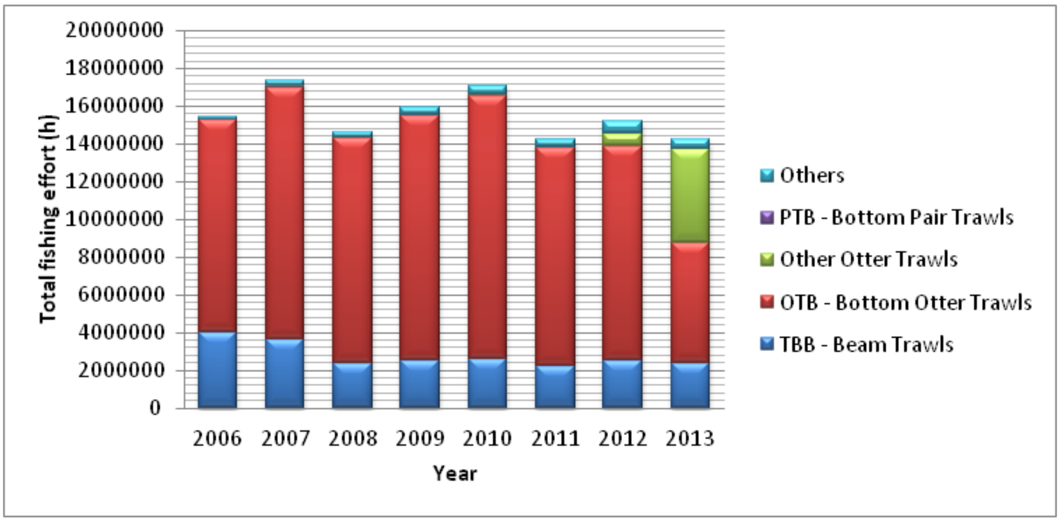

Figure 6.3.1. Total fishing effort by active demersal gears in the Celtic Sea Areas VIIg, VIIj and VIIh.

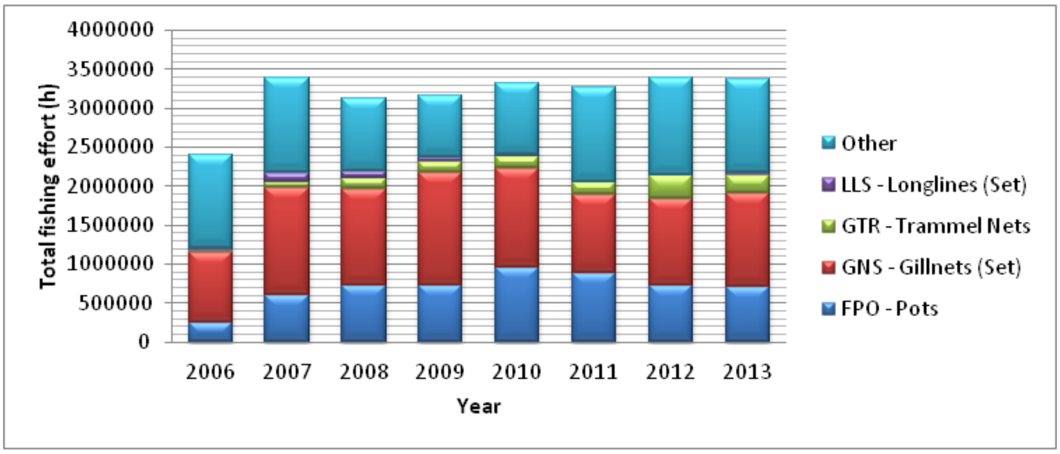

Figure 6.3.2. Total fishing effort by passive gears in the Celtic Sea Areas VIIg, VIIj and VIIh.

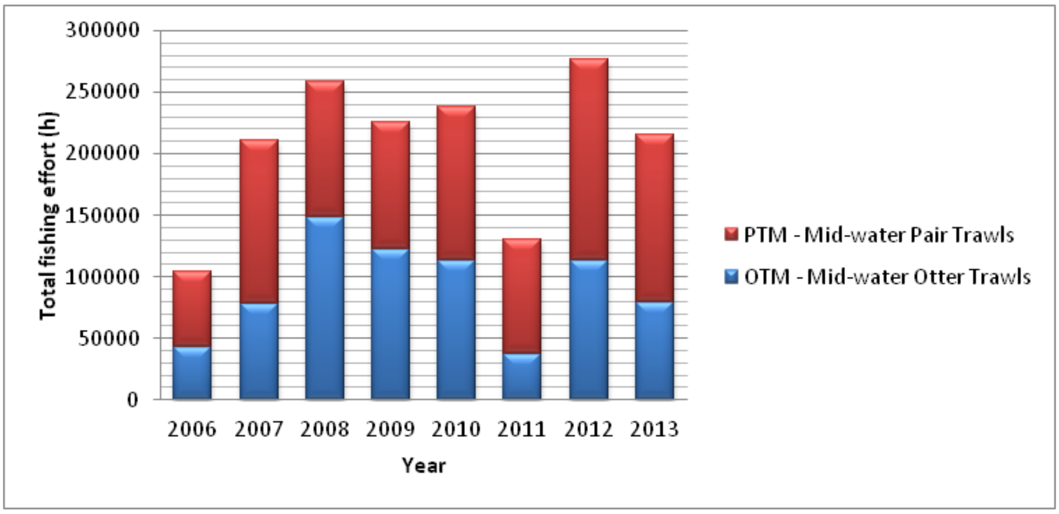

Figure 6.3.3. Total fishing effort by pelagic gears in the Celtic Sea Areas VIIg, VIIj and VIIh.

6.4 Climate trends in the Celtic Seas

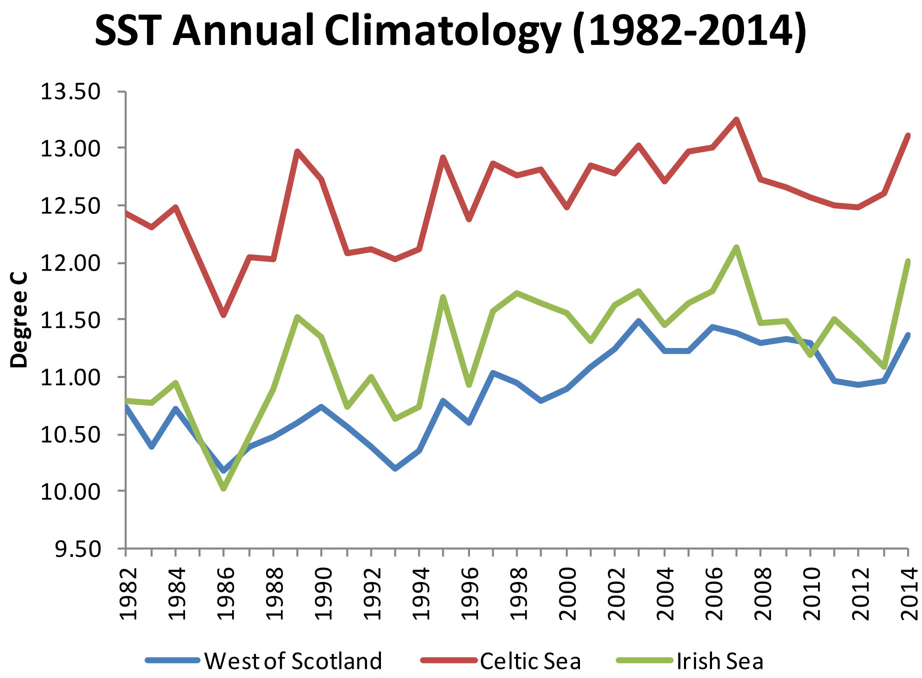

Figure 6.4.1. SST trends in three key areas of the Celtic Seas Ecoregion.

Over the last 30 years sea surface temperatures (SST) have risen in all the main areas of the Celtic Seas (Figure 6.4.1). In the last 10 years, the West of Scotland has increased in average by +0.5C (±0.57°C), the Celtic Sea by +0.3C (±0.29°C), and the Irish Sea by +0.4C (±0.31°C).

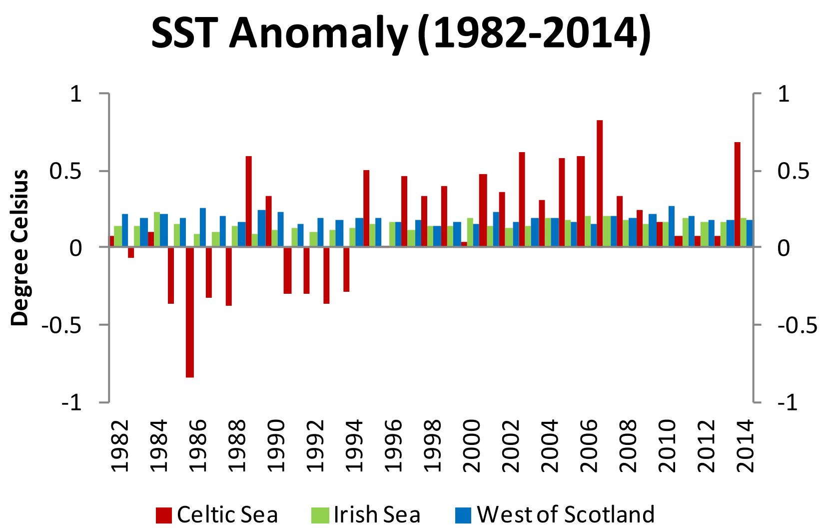

Figure 6.4.2. SST anomalies for the same three regions as Figure 6.4.1.

SST anomalies show a less clear pattern, but would appear to suggest some differences between the Celtic Sea proper, and the Irish Sea and West of Scotland (Figure 6.4.2).

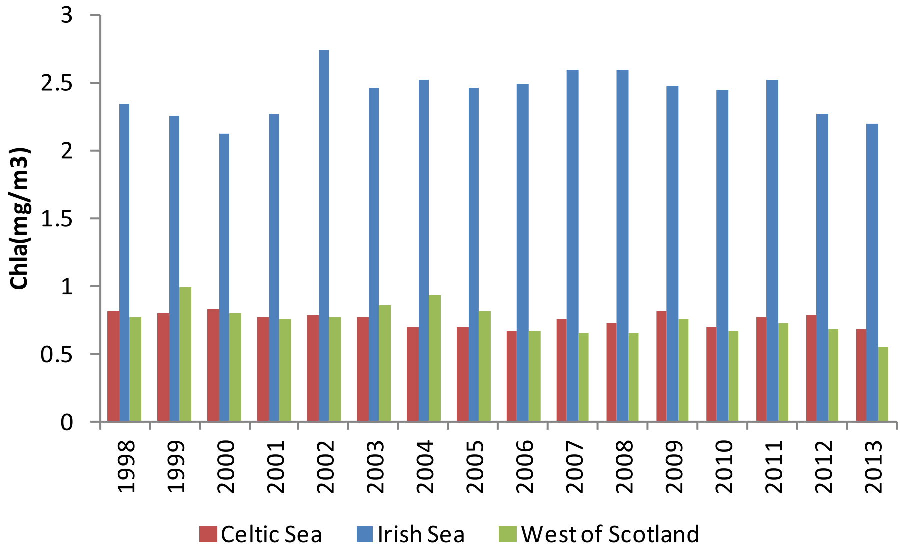

Figure 6.4.3. Chlorophyll a concentrations in three key areas of the Celtic Seas Ecoregion.

The concentrations of chlorophyll a across the three regions (Figure 6.4.3) seems to have varied relatively little over the last 20 years, with higher concentration in the Irish Sea than the other two, this can also be seen in the average data for 2013 mapped in Figure 6.4.4.

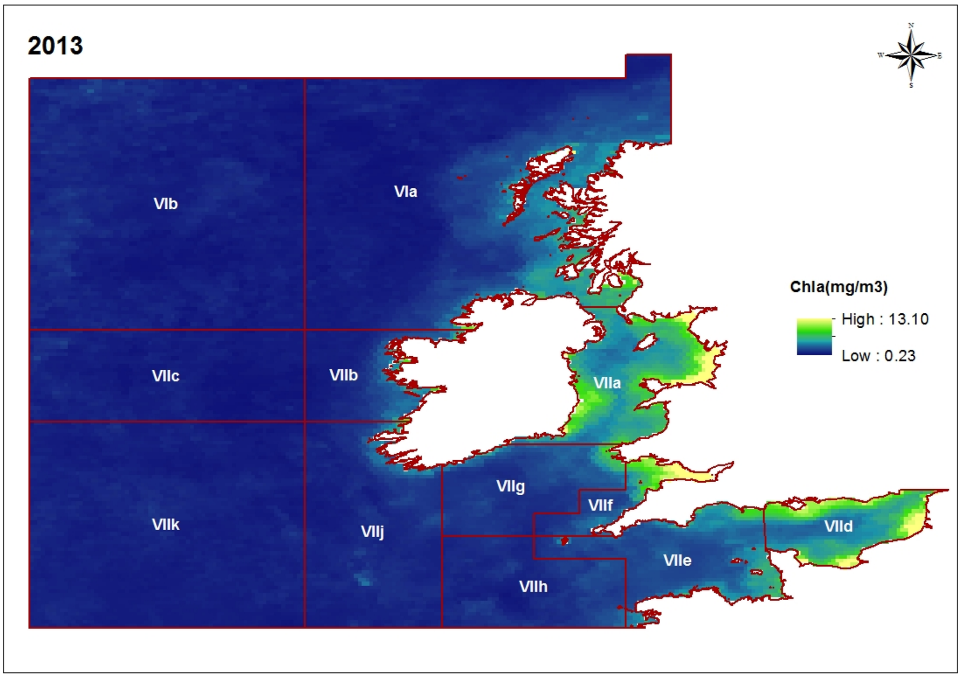

Figure 6.4.4. The Celtic Seas ecoregion showing areas of high and low chlorophyll a concentration averaged across 2013.

6.5 Integrated Trend Analysis in the Gulf of Cadiz

An initial exploration for an Integrated Trend Analysis was carried out for the Gulf of Cadiz. Some signals can be discerned, for instance, an increase in the fishing effort and a decline in anchovy abundance, although further work will need to be carried out on this. The traffic light plot in Figure 6.5.1 was developed in the context of the main features of the Gulf Cadiz foodweb summarized in Figure 6.5.2.

Figure 6.5.1. Traffic light plot showing the development of the demersal component, some environmental variables and fishing pressure over the last 18 years in the Gulf of Cadiz (see more details in ICES (2013)).

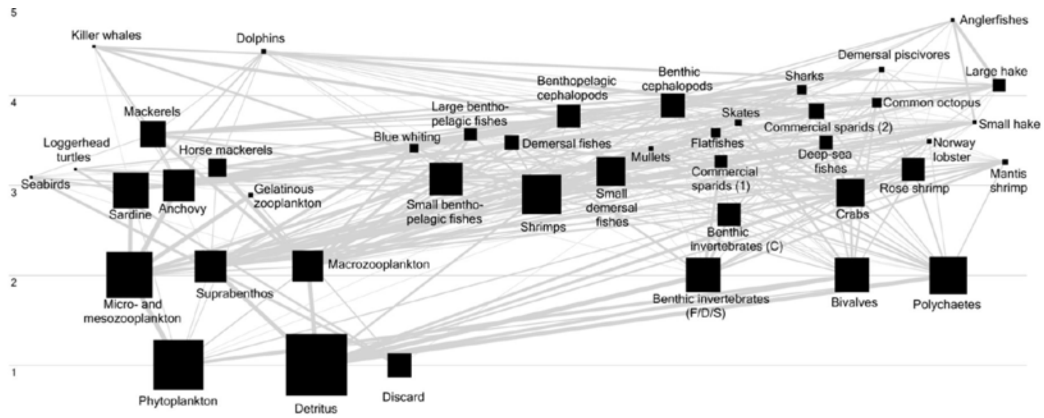

Figure 6.5.2. Foodweb diagram for the Gulf of Cadiz.

The foodweb diagram in Figure 6.5.2 was based on a an extensive Ecopath with Ecosim (EwE)analysis for the Gulf of Cadiz carried out by Marian Torres (Swedish University of Agricultural Sciences (SLU-Aqua), Institute of Coastal Research (ICR). One of the key outputs of the model was the decline in Mean Trophic level shown in Figure 6.5.3. Exploitation rates (F/Z) also showed high values ranging from 0.714 to 0.928 for target demersal species common octopus, anglerfish, mullets, skates, hake, sharks, and mantis shrimp. High levels of fishing mortality by trawling fleet (F) were identified on mullets, small hake, rose shrimp, anglerfish, and common octopus

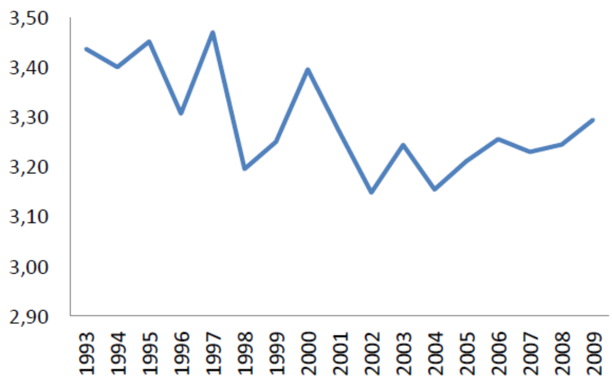

Figure 6.5.3. Mean Trophic level of the catch for the Gulf of Cadiz from EwE model output.

6.5.1 Integrated Trend Analysis in the Irish Sea

Data for a range of demersal fish indicators have been assembled from the groundfish surveys in the Irish Sea, (Greenstreet *et al.*, 2013) and these are summarized in Figure 6.5.1.1. Positive signs can be seen in, for example, the LFI, and Hill's N and N2 Biodiversity indicators in recent years. Length and age at maturity have also increased steadily over the last decade. Trends in fish numbers and biomass were less clear.

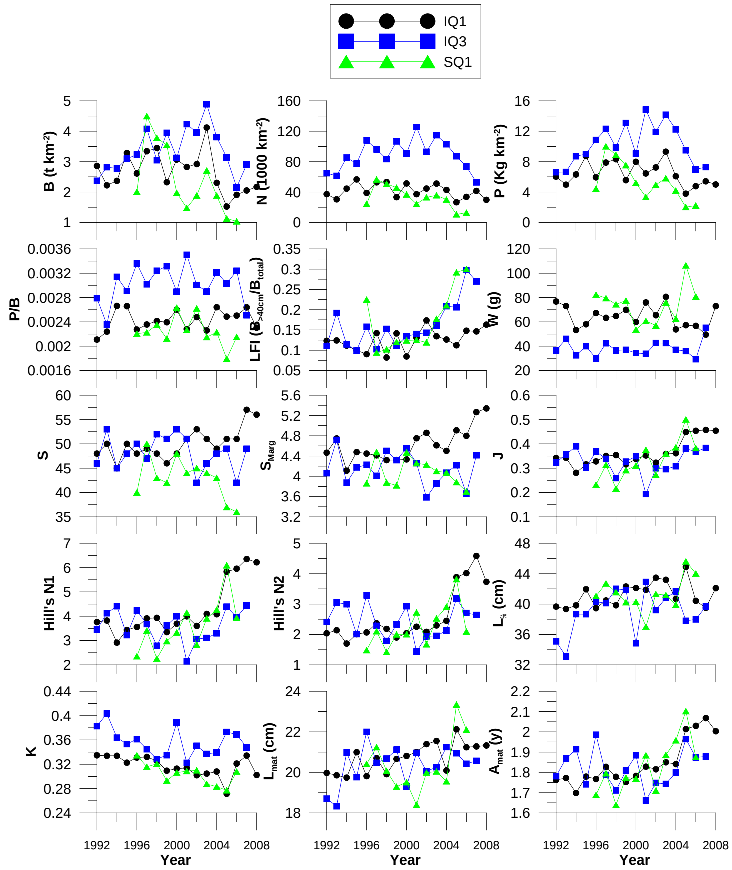

Figure 6.5.1.1. Trends in fifteen metrics quantifying different aspects of the composition, structure and functioning of the demersal fish assemblage in the Irish Sea subregion. The metrics are applied to data derived from ICES coordinated International Bottom Trawl Surveys carried out in the first (Q1) and third (Q3) quarters of the year. Trends suggest the state of the demersal fish community in the Irish Sea has improved over the last decade. (Greenstreet *et al.*, 2013).

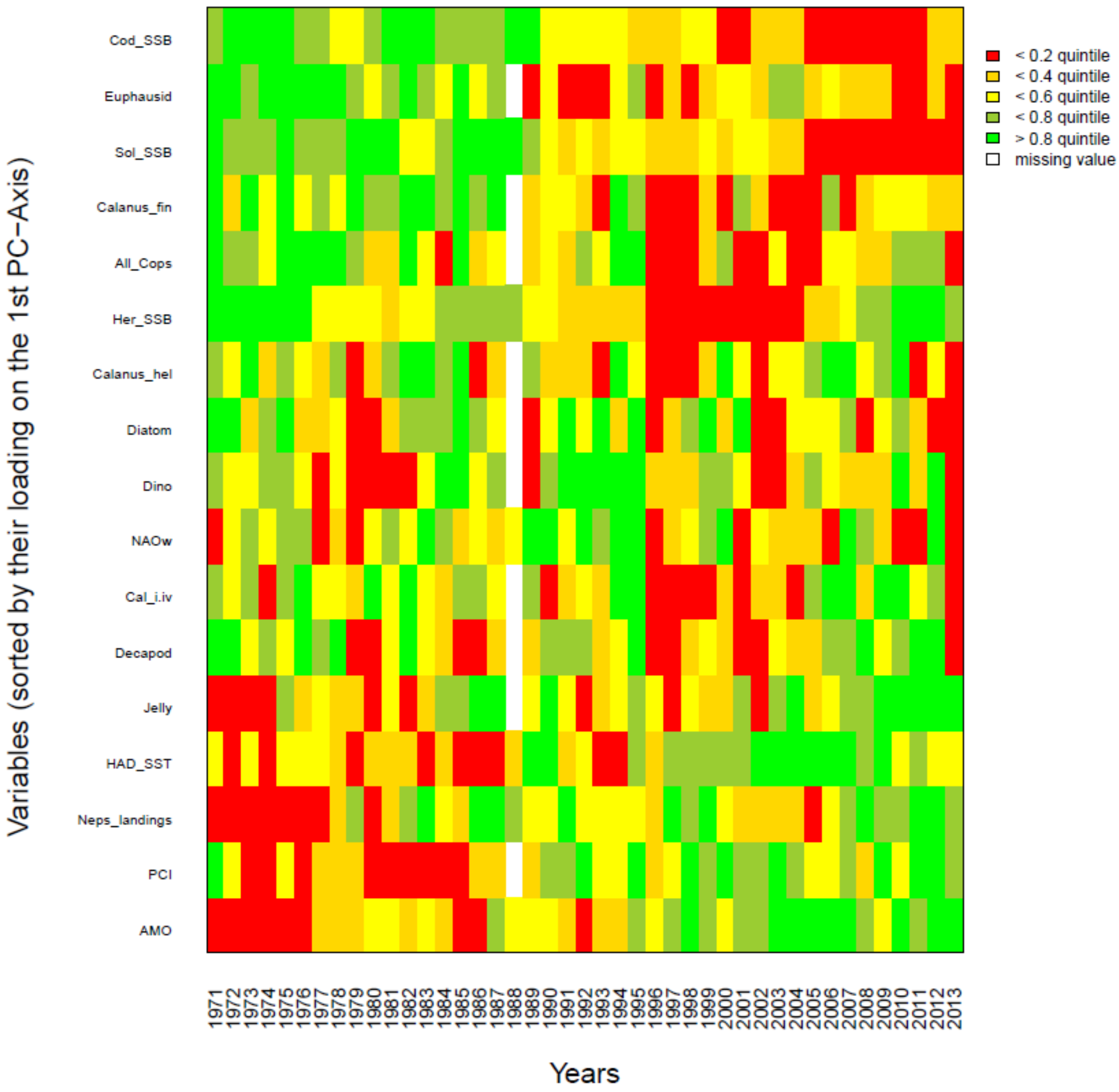

Figure 6.5.1.2 Traffic-light plot of the temporal development of Irish Sea time-series. Variables are transformed to quintiles and colour coded (red =low values, green = high values), and sorted in numerically descending order according to their loadings on the first principle component.

Using methods outlined in (Diekmann *et al.*, 2012) exploratory integrated trend analysis was carried out for the Irish Sea using a range of biotic and abiotic indicators. Time-series spanning 43 years (1971 to 2013) were collated and used in the analysis. They included climatic indictors, primary and secondary production indictors, primarily from CPR datasets in the subregion and fishery trends (SSB). A traffic-light plot was generated (Figure 6.5.1.2) which indicated an increase in climatic indictors (SST, AMO), gelatinous zooplankton and Nephrops landings. A decrease over the period was observed in cod and sole SSB, some zooplankton species. Finally, herring SSB showing a similar decline to cod and sole has recently shown signs of population growth. Further research is needed as well as the addition of important components of the ecosystem (nutrients, fishing mortality) to the analysis.

6.6 Proposed indicators to assess GES in pelagic habitats for descriptors D1 and D4 based on plankton components – NW and N Spanish shelf

Indicators for the state of the plankton community and hence GES values have been proposed by OSPAR and adopted by Spain to assess GES for descriptors D1 and D4 based on plankton components. Here we base a series of plankton indicators on those proposed by OSPAR and these are summarised below.

- HP/RT-Life-form. Changes in life-form (functional groups) pairs (OSPAR-PH1)
- HP-Abundance. Abundance / Biomass of plankton components (OSPAR-PH2)
- HP-Biodiversity. Diversity indices for plankton components (OSPARPH3)
- RT-Phytoplankton. Phytoplankton production (OSPAR-FW2)
- RT-Zooplankton. Abundance, biomass, species composition and
- spatial distribution of zooplankton (OSPAR-FW6)

Indicators based on life-forms pairs of plankton components, including the scientific basis and the pressure that can be detected, are illustrated in Table 6.6.1.

Table 6.6.1. Life form pairs for D1 Biodiversity andD4 foodwebs for plankton components of the pelagic foodweb in Iberian waters.

Descriptor	Lifeform pair 1		Lifeform pair 2		Lifeform pair 3	
D1: Biodiversity	Diatoms	Dinoflagellates	Large copepods	Small copepods	Copepod grazers	Non-copepod grazers
Reasoning:	Shift in algal community composition towards less trophically useful groups		Shift in size of secondary producers/primary grazers could have food web impacts		Energy transfer from primary producers to less trophically useful secondary producers	
Pressure(s):	Nutrient run off (point or non-point), hydrological change (from dredging, aggregate extraction, trawling, river damming), aquaculture, warm water outflows		Fishing		Nutrients, fishing	

Descriptor	Lifeform pair 1		Lifeform pair 2		Lifeform pair 3	
D4: Food-webs	Gelatinous zooplankton	Fish larvae	Copepods	Phytoplankton	Holoplankton	Meroplankton
Reasoning:	Energy flow pathway to top predators		Energy transfer from primary to secondary producers		Benthic-pelagic coupling	
Pressure(s):	Fishing		Fishing		Fishing (including pressure on benthos from trawling), nutrients	

To give an example of the analysis of one of the proposed indicators, we illustrate with an analysis of zooplankton abundance and composition, indicator for D1 (OSPAR-PH2) and D4 (OSPAR-FW6), in the NW Iberian shelf (off Vigo). Based on the time-series analysis of total zooplankton abundance and zooplankton abundance by taxa (13 taxonomic groups: euphausiacea, copepod, chaetognata, polychaeta, cladocera, larvacea, siphonophorae, doliolidae, larvacea, cnidaria, gasteropoda larvae, cirripedia larvae and decapoda larvae) using wavelet analysis.

The steps in the analysis are shown in Figures 6.6.1 to 6.6.3.

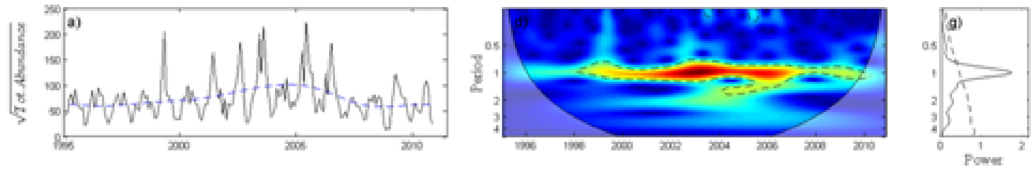

Figure 6.6.1. Shows (from left to right): the time-series of total zooplankton abundance (1995–2010), the wavelet power spectrum, that illustrates the interannual change in seasonal signal of zooplankton abundance, and the average power spectrum, highlighting the seasonality of the time-series.

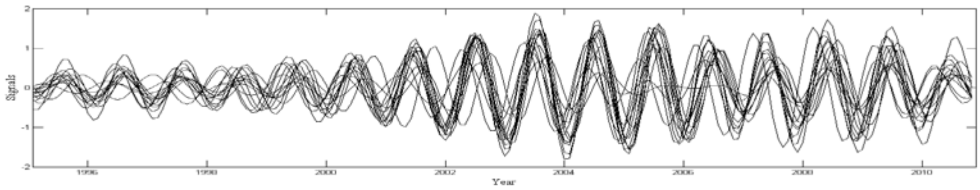

Figure 6.6.2. Shows the seasonal signal (extracted by wavelet analysis) of the abundance each of the 13 analysed zooplankton taxa, showing the interannual variability of the seasonal signal of each taxa and highlighting three different periods in the time-series regarding the abundance and annual phase of each taxa.

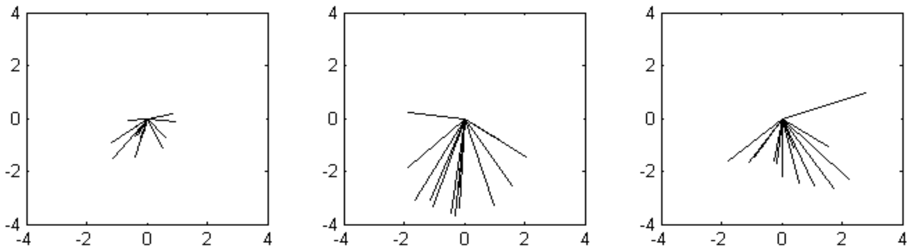

Figure 6.6.3. Polar representation (amplitude –length of each vector, and phase –angle of each vector) of the average amplitude and phase of each taxa in each of the selected time periods. The Shannon Entropy shows also the increased synchronicity between 2001–2006. Possible Evidence of a regime shift?

7 Planned future work for WGEAWESS

7.1 Delivery of IEA advice producing specific suggestions ("demonstrations") for ecosystem input in the context of management advice

In 2015/2016 WGEAWESS will identify, by sub region, examples where the IEA work carried out to date, or envisaged, can provide useful input information to wider management advice in the context of fisheries AND ecosystem trends and patterns. The types of advice we envisage would come ideally from modelling, empirical trends data, and from a wider multi-sectoral pressures assessment such as ODEMM or the approach used in DEVOTES. For each subregion where it is feasible, we will pick one key advice area, and volunteer information supporting management. For example, for Biscay this might be the ecosystem interactions with the sustainability of the sole stock in Division VIII. Another possibility would be the zooplankton analysis developed for the Cantabrian Sea. In the Celtic Seas, it will be based on feedback from the Expert

Groups WKIRISH, which will meet in Dublin in September 2015. The aim of this work will be to provide further demonstrations of how and where IEA type advice might be able to support management advice.

7.2 Inclusion of social and economic dimensions

WGNARS had considerable social and economic involvement in their recent meeting, and also charted out a new approach to IEA derived from Phil Levin's work in the west US, where they have adopted an approach where they cover both ecosystem integrity, and human wellbeing, as two "pillars" each with Focal components, Mediating components, and Drivers and Pressures.

WGEAWESS examined this at the 2015 meeting, where Phil Levin was also present. It was agreed that the framework was useful and appropriate and that WGEAWESS would aim to start developing a similar approach. At the 2015 meeting in Cadiz, we also had participation from social and economic scientists from Sweden, and from the University of Seville. This should be seen as the start of a process of integrating the human dimension of IEA. It was emphasized by one of the speakers that it was not sufficient to have the occasional socio-economic presentation. Ideally what was needed would a platform for this collaboration where there was significant numbers of participants involved in both IEA and in social and economic analysis in a similar context. WGEAWESS have proposed a joint meeting next year with WGRMES who are working on just these issues. It is also planned to expand the work with the University of Seville.

7.3 Expert judgement foodweb structure

During the joint meeting of WGEAWESS and WGIAB agreed to collaborate with Phil Levin from NOAA, USA on the development of the idea of foodweb linkages based on expert judgement rather than painstaking analysis of empirical data. The aim of the exercise was to see whether a group of experts, of varying skills could quickly develop a foodweb map that could be as robust as a more scientifically robust approach. This was also seen as valuable for the future involvement of stakeholders in such an exercise. Two approaches were taken, for the Baltic, all the WGIAB members were asked to make their best estimate of the main foodweb components and the direction and strength of their interactions. For WGEAWESS, it was agreed that we should use the Gulf of Cadiz as a test case. In addition, we agreed to use a list of foodweb components developed by an expert, in this case Marian Torres who has developed the EwE model for the Gulf of Cadiz (see Figure 6.5.2.). Each participant was then provide with a list of approximately 20 key foodweb components, and asked to describe the strength and direction of their interactions. The assembled interpretations have been passed to Phil Levin for amalgamation and analysis, along with personal details e.g. age, gender and nationality. If completed, WGEAWESS will examine the results in 2016.

7.4 References

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8 Next meeting

2013/MA2/SSGRSP02 The **Working Group on Ecosystem Assessment of Western European Shelf Seas** (WGEAWESS) chaired by Steven Beggs*,UK and Eider Andonegi*, Spain will meet in Belfast, UK, from the 14–18 March 2016 work on ToRs and generate deliverables as listed in the Table below.

	Meeting dates	Venue	Reporting details	Comments (change in Chair, etc.)
Year 2014	22-25 April	Gijón, Spain	Interim report by 2 June 2014 to SSGRSP	
Year 2015	9–13 March	Cadiz, Spain	Interim report by 17 April 2015 to SSGIEA	Will work back-to-back with WGIAB
Year 2016	14-18 March	Belfast, UK	Final report by 15 April 2016 to SSGIEA, SCICOM & ACOM	Change in Chairs for third meeting and the group will hold joint meeting with WGRMES

ToR descriptors

ToR	Description	Background	Science topics addressed	Plan	Duration	Expected Deliverables
a	Carry out metadata compilation for all ecosystem components available according to ODDEM framework. Preparatory to carrying out IEA	This is linked to the recommendation of a database	4.3		2 years	Database linked to ICES for Regional Sea Programmes
b	Carry out preliminary evaluation of data and trends for a regional Integrated Ecosystem Assessment;	Linked to Benchmark SSGRSP guidance for methods	4.2		3 years	Report and articles on GES status of Regional Sea
c	Summarize and update the regional Ecosystem overviews	Linked to WKECOVER and ACOM- SCICOM advice	4.2		3 years	Articles, atlas.

d	Identify ecosystem trends relevant to stock assessment and management and report these accordingly	This would be linked to the commitment to provide advice in the context of EBAFM	4.1	Ongoing

Summary of the Work Plan

Year 1	The main task will be to catalogue the datasets available that would be potentially valuable in an IEA (provisionally ODEMM approach. Metadata and description will be compiled into a database. This will particularly focus on identifying pressure state relationships that are appropriate to EBAFM. Ongoing identification of important trends in ecosystem indicators.
Year 2	Carry out provisional ODEMM (or other IEA) analysis, using WG membership, and reporting on results, gaps and weaknesses, and way forward. Ongoing identification of important trends in ecosystem indicators.
Year 3	Follow up on previous year IEA, refine including any new data acquired on the basis of the gaps analysis in the previous year. If appropriate, hold a workshop with a wider participation. Ongoing identification of important trends in ecosystem indicators.

Supporting information

Priority	Heavy pressure on shelf seas (biodiversity loss, climate changes, fisheries), lack in understanding of large marine ecosystem functioning and the context of ecosystem health indicators development for the Marine Strategy Framework Directive require to address those research topics at the relevant scale i.e. the regional approach. The EAWESS working group will focus on North Atlantic European continental shelf. Regional area of interest includes the Celtic sea, bay of Biscay and Western Iberia, involving five countries (Ireland, UK, France, Spain and Portugal). The choose of such limits is justified by: • bio-geographical (transitional region between subtropical and Subarctic gyres) • chemo-physical continuum: large opened and connected areas dominated by soft bottom, closely linked by regional ocean circulation process, offering ‘coast-shelf-slope’ and latitudinal environmental gradient • management unit (ICES, OSPAR) • already existing scientific networks (e.g. IBI-ROOS)
Resource requirements	There is no resource implication for ICES. Working group program is based on synthesis of data and results from existing scientific program, and coordination of surveys and observations networks. However, involvement of ICES data center would useful to help with sharing and harmonizing data.
Participants	The Group is normally attended by some 15 members and guests.
Secretariat facilities	None.
Financial	No financial implications.
Linkages to ACOM and groups under ACOM	Direct link to SSGIEA, ACOM-SCICOM advice.

Linkages to other committees or groups	There is a very close working relationship with all the groups of SSGIEA. It is also very relevant to the Working Group on WGECO and WGSAM
Linkages to other organizations	DC- MAP- DG MARE, MSFD DG ENV, OSPAR