WORKING GROUP ON ECOSYSTEM ASSESSMENT OF WESTERN EUROPEAN SHELF SEAS (WGEAWESS)

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Contents

i Executive summary

The ICES Working Group on Ecosystem Assessment of Western European Shelf Seas (WGEAWESS) aims to provide high quality science in support to holistic, adaptive, evidence-based management in the Celtic seas, Bay of Biscay and Iberian coast regions. The group works towards developing integrated ecosystem assessments for both the (i) Celtic Seas and (ii) Bay of Biscay and Iberian Coast which are summarized in the Ecosystem Overviews (EOs) advice products that were recently updated. Integrated Trend Analysis (ITA) were performed for multiple subecoregions and used to develop an understanding of ecosystem responses to pressures at varying spatial scales. Ecosystem models (primarily Ecopath with Ecosim; EwE) were developed and identified for fisheries and spatial management advice.

The updated Celtic Seas EO represents a large step forward for EOs, with the inclusion of novel sections on climate change, foodweb and productivity, the first application of the new guidelines for building the conceptual diagram, inclusion of socio-economic indicators, and progress made toward complying with the Transparent Assessment Framework (TAF). We highlight ongoing issues relevant to the development and communication of EO conceptual diagrams.

A common methodology using dynamic factor analysis (DFA) was used to perform ITA in a comparable way for seven subregions. This was supported by the design and compilation of the first standardized cross-regional dataset. A comparison of the main trends evidenced among subregions over the period 1993–2020 was conducted and will be published soon.

A list of available and developing EWE models for the region was also generated. Here, we report on the advances in temporal and spatial ecosystem modelling, such as their capacity to model the impacts of sector activities (e.g. renewables and fisheries) and quantify foodweb indicators. We also reflect on model quality assessment with the key run of the Irish sea EwE model. The group highlighted the hurdles and gaps in current models in support of EBM, such as the choice of a relevant functional, spatial, and temporal scales and the impacts of model structure on our capacity to draw comparisons from models of different regions. The group aims to address these issues in coming years and identify routes for ecosystem model derived information into ICES advice.

ii Expert group information

Expert group name	Working Group on Ecosystem Assessment of Western European Shelf Seas (WGEA-WESS)
Expert group cycle	Multi-annual Fixed Term
Year cycle started	2020
Reporting year in cycle	3/3
Chairs	Jacob Bentley, UK (2022–)
	Sigrid Lehuta, France (2022–)
	Marcos Llope, Spain (2020–2022)
	Debbi Pedreschi, Ireland (2020–2021)
Meeting venues and dates	29 June – 3 July 2020, virtual meeting (26 participants)
	5 – 8 July 2021, virtual meeting (24 participants)
	2 – 5 May 2022, virtual meeting (26 participants)

1 Terms of Reference and Workplan 2020–2022

ToR descriptors

ToR	Description	Background	Science Plan codes	Duration	Expected deliverables
a	Review and update the Bay of Biscay/Iberian Waters (BoB-IW) and Celtic Seas (CS) ecoregion Ecosystem Overviews (EO).	Linked to ICES advice and WKEO3.	6.1, 6.5, 6.6	Ongoing	Ecosystem overviews (EO)
b	Compare and contrast among sub-ecoregion level ITAs to identify and report on commonalities and divergences among areas, with a focus on climate variability.	Responding to requests for standardization of ecosystem advice products and inclusion of climate change information in Ecosystem Overviews. Linked to WKINTRA, WGS2D, WGOOFE and the commitment to provide advice in the context of EAFM.	1.4, 1.9, 6.5	3 years	Inform IEAs/EO. Results in the final report or/and as a collaborative paper
c	Investigate and report on the sub-regional spatio-temporal entities constituting the Bay of Biscay/Iberian Waters and Celtic Seas ecoregion, and the multiple pressures relevant at these scales in support of ecosystem-based management.	Linked to WKEWIEA, WKIRISH, ToR B and previous group ToRs. Investigation of scaling issues related to summarizing information from locally relevant scales/models.	1.3, 2.4, 6.5	3 years	Inform IEAs/EO. Results in the final report or/and as a collaborative paper.
d	Explore and describe the potential for incorporating additional products (e.g. MSFD indicators, model outputs, social indicators) from ICES EGs and other processes (e.g. OSPAR, EEA, STECF) into the Ecosystem Overviews	Strongly linked to ToR A, WGCERP, WGSOCIAL, WKEO3 and MSFD. Maximizing efficiency across relevant groups for EO development, eliminating redundancy.	4.1, 6.5, 6.6	3 years	Ecosystem overviews. Collaborative network with improved workflow.
e	High resolution Ecospace models for selected case studies within WGEAWESS ecoregions to identify opportunities to support marine spatial planning.	Working together with ToR C to explicitly incorporate spatial aspects into regional modelling work, investigating opportunities for trade-off analyses and inclusion of socioeconomic considerations	4.1, 6.3, 6.6	3 years	Regional modelling products

Summary of the Work Plan

Year 1	The main tasks will be related to drafting the outline for the papers/process for ToRs B&C, and identifying which group members can apply the agreed upon methodology (within their limited resources). Start the process for reviewing the BoB-IC Ecosystem Overviews. The group will continue to identify data and outputs that may be potentially valuable to IEAs, EAFM, and particularly the Ecosystem overviews (Tors A, D & E). The group will work

	to improve communication with other relevant groups (e.g. WGS2D, WGOOFE, WGSOCIAL, WGCOMEDA, WGIAB, WGMARS, WGBIE, WGIPEM).
Year 2	Continue with Year 1 activities while liaising with relevant ICES WG and external groups (e.g. OSPAR) as relevant. Progress agreed upon methodologies for ToRs B&C, write papers. Advance ToR E, developing regional models (scope of model development/ number of case studies will be dependent funding).
Year 3	Continue with Year 2 activities while liaising with relevant ICES WG membership. Finalise papers.

2 List of highlights from the WG in this period

- **Updated Celtic Seas Ecosystem Overview (led by Debi Pedreschi, Marine Institute).** A major 2-year (2020–2021) overhaul/update of the Celtic Seas EO was carried out in an effort to make the as EOs transparent as possible, update all sections, and include new sections. New additions included a climate change section, foodweb description, socio-ecological indicators, and an assessment of primary productivity.
- **Integrated Trend Analysis for the Celtic Seas and Bay of Biscay and Iberian Coast (Jed Kempf, Marine Institute).** Dynamic factor analysis (DFA) was applied to trends from each sub ecoregion to identify commonalities and divergences between them. Redundancy analysis was used to explore linear relationships between response and explanatory variables across multiple sub ecoregions.
- **West Coast of Scotland Ecospace advancement (Natalia Serpetti, JRC).** The West Coast model was used to simulate (1) the expected impacts of a Multi-Purpose Platform (renewable energy and aquaculture) and (2) the impacts of shipping noise on harbour porpoises. The research highlights the value of ecosystem models as decision support tools for spatial management.
- **Demersal and pelagic fish trends across contrasted habitats in the Bay of Biscay (Morgane Travers-Trolet, Ifremer).** This study assessed whether ITA trends remained valid at smaller spatial scales, showing how trends may vary between different habitat types if drivers are spatially divergent (e.g. different inshore than offshore).
- **Ecosystem-based fishing mortality reference point (F_{eco}) (Jacob Bentley, Natural England).** Using the Irish Sea Ecopath with Ecosim case study, members of the group illustrated how stock-specific ecosystem indicators can be used to set F_{eco} within the “Pretty Good Yield” ranges for fishing mortality which form the present precautionary approach adopted in Europe by ICES. WGEAWESS (in collaboration with Joint ICES/HELCOM Working Group on Integrated Assessments of the Baltic Sea (WGIAB)) will be further developing the approach in the coming years.
- **Integrated Ecosystem Assessment of the Gulf of Cadiz (Marcos Llope, IEO).** Assessment revealed the effectiveness of regulatory measures and highlighted that the Gulf of Cadiz is a highly resilient ecosystem, able to quickly respond to the implementation of regulatory measures.
- **Building networks with large Atlantic research projects to inform Ecosystem Overview development (WG session, 2022).** During the 2022 WG meeting, time was set aside for presentations from invited members of recently funded projects (SeaWise, Mission Atlantic, Ocean ICU, EcoScope) so that we may identify potential avenues for new research early in the development stage. All projects will be using ecosystem modelling and may thus also inform ToRs for the coming years.

3 ToR A) Review and update the Bay of Biscay/Iberian Coast and Celtic Seas ecoregion Ecosystem Overviews and ToR D) Explore and describe the potential for incorporating additional products from ICES EGs and other processes into the Ecosystem Overviews

3.1 EO review and update – Debbi Pedreschi Marine Institute

In year 1, the group reviewed and discussed the presentation of BoB-IC EO to the Advice Drafting Group (ADG). Issues were flagged in relation to proposals originating from the group (including aspects of the wire diagram) not being accepted by the ADG – seemingly down to a lack of understanding, but this led to serious concerns about transparency. The group raised these through the IEASG (Integrated Ecosystem Assessments Steering Group) Chair, and the ACOM Vice Chair Henn Ojaveer along with the latterly established Ecosystem Overview Operational Group have worked hard to improve communication and address these concerns.

The Celtic Seas EO was reviewed and a major 2-year (2020–2021) overhaul/update was carried out in an effort to make the as EOs transparent as possible, update all sections, and include new sections. An initial ambition to apply the Transparent Assessment Framework (TAF) was not possible due to a range of issues including resourcing, however instead the Data Profiling Tool (DPT) was piloted, enabling metadata collection for all figures, and a fully referenced version of the report was developed. The consistency of the EO was also improved with consistent terminology and subsections for each pressure.

Over 30 other ICES groups were contacted and asked to contribute updated content, and requested to fully reference the text. Twenty-four groups responded and contributed, some of these groups were unaware of the EOs as an ICES product and so these represented first time contributors. Some groups were very receptive, and interested in continuing contributions to the EOs. A list of contacted and willing groups with responsible individuals (where provided) has been made available on the EO SharePoint for other IEA groups. WGEAWESS would like to extend their thanks to the following groups for their engagement, support and contributions; Benthos Ecology Working Group (BEWG), Working Group on Zooplankton Ecology (WGZE), Working Group on Cephalopod Fisheries and Life History (WGCEPH), Working Group on Marine Mammal Ecology (WGMME), Working Group on Bycatch of Protected Species (WGBYC), Workshop on EU regulatory area options for VME protection (WKEUVME), Working Group on Deep-water Ecology (WGDEC), Working Group on Oceanic Hydrography (WGOH), Working Group on Marine Habitat Mapping (WGMHM), Working Group on Marine Litter (WGML), Working Group on Phytoplankton and Microbial Ecology (WGPME), Joint ICES/IOC Working Group on Harmful Algal Bloom Dynamics (WGHABD), Working Group on Biological Effects of Contaminants (WGBEC) Working Group on Marine Sediments in Relation to Pollution (WGMS), Marine Chemistry Working Group (MCWG), International Bottom Trawl Survey Working Group (IBTSWG), Working Group on Social Indicators (WGSOCIAL), Working Group on Economic Indicators (WGECON), Working Group on Balancing Economic, Social and Ecological Objectives (WGBESEO), Joint OSPAR/HELCOM/ICES Working Group on Seabirds (JWGBIRD), Working Group on Operational oceanographic products for fisheries and environment (WGOOFE), Working Group on Recreational Fisheries Surveys (WGRFS), and Working Group on Introductions and Transfers of Marine Organisms (WGITMO).

The EO conceptual diagram was reviewed and updated by WGEAWESS (details below) and was the first EO to use the new agreed upon Technical Guidelines (2021) emerging from WKTRANSPARENT (Workshop on methods and guidelines to link human activities, pressures and state of the ecosystem in Ecosystem Overviews).

Additional sections were added to the CS EO to bring it in line with other EOs (e.g. climate change, circulation, foodwebs, and productivity sections). Intersessional meetings along with assigning task-specific subgroups were critical in ensuring all tasks could be met. Additional new sections were also developed and submitted to the ACOM 'pipeline' for consideration/inclusion in future EO's through collaborations with other WGs (e.g. socio-economic indicators of commercial fisheries with WGSOCIAL/ECON, VMEs with WKEUVME/WGDEC). Both proposals were well received and approved for development. These represent the first ever contributions to the EO pipeline, and the new sections were included in the CS update in 2021.

Importantly, particularly in the context of the Strategic Initiative on the Human Dimension (SIHD), the Celtic Seas EO made substantial strides forward in incorporating social and economic information. A new management section details relevant subregional management entities and agencies, and outlines the policy landscape. A new section on socio-economic indicators of commercial fisheries provides fishing effort and landings by weight information for each fishing port around the coast showing the location of fishing communities. Associated text outlines the national structure of the fleet and their contributions to catches. Information on the North Western Waters fisheries management region which overlaps with the Celtic Seas ecoregion provides fisheries economic information, including days at sea, a potential indicator of dependence. Additionally, current socio-economic issues affecting the fleet such as the COVID-19 pandemic, and the withdrawal of the United Kingdom from the European Union (Brexit) were detailed, with potential consequences highlighted. This progress and these contributions would not have been possible without collaboration and engagement with WGBESEO, WGSOCIAL and WGECON.

WGEAWESS also discussed a range of other potential future developments that may be considered in future ToRs and/or collaborations:

- Ecosystem indicators from modelled outputs. This will depend on developments in WKEWIEA (Workshop on operational EwE models to inform IEAs) as questions surround ability to integrate across models to provide signals at ecoregion level.
- Related to the above – Foodwebs for the EOs, how to include and build on the indicator work of WGECO (Working Group on Ecosystem Effects of Fishing Activities), WKFooWI (Workshop to develop recommendations for potentially useful Food Web Indicators), etc. Workshop proposed under IEASG for 2023.
- Sub-ecoregional level analyses where relevant (being investigated under Tor E)
- Objectives (collaborating with WGBESEO work)
- Ecosystem Services – exploratory work linking ODEMM to ES has been carried out in WGEAWESS. A workshop WKASCAPES (Workshop on ASsessing CAPacity to supply Ecosystem Services) planned for 2022 will directly address this topic, and the WGEAWESS work can contribute to that workshop.

- Social and economic sections with details on key parameters highlighted as important by stakeholders through conceptual modelling (conceptual models may also inform food-web section). This work has begun with the inclusion of socio-economic information on fisheries in the EO.
- Inclusion of socio-economic priorities identified through mental modelling with stakeholders. This would follow the guidance produced by WKCCMM (Workshop on the Necessity for Crangon (brown shrimp) and Cephalopod Management).
- Cumulative Effects assessments working with WGCEAM (Working Group on Cumulative Effects Assessment Approaches in Management).
- WGINOSE (Working Group on Integrated Assessments of the North Sea) and NOAA (https://apps-st.fisheries.noaa.gov/dismap/index.html) pressure mapping approaches
- Inspiration for improved transparency: https://nefsc.github.io/READ-SSB-DePiper_Summer_Flounder_Conceptual_Models/sfconsmod_riskfactors_subplots.html

3.1.1 Conceptual Diagram Process Update – Debbi Pedreschi, Marine Institute

The EO conceptual diagram has been continuously revisited at each annual meeting since 2019. The bulk of the work done to amend the Celtic Seas ODEMM to an ICES style diagram/assessment was detailed and presented in the WGEAWESS 2019 report. A series of issues and criticisms of the approach were also provided, leading to the development of the WKTRANSPARENT workshop to improve the approach. Many of the issues and criticism raised by WGEAWESS in that report have since been addressed by the WKTRANSPARENT workshop, and the subsequently updated EO Technical Guidelines.

During the 2020 meeting, WGEAWESS discussed options about how to present the ICES diagrams in order to address criticisms highlighted at the ADG for the Bay of Biscay/Iberian Coast EO, such as providing all linkages that occur, with the ‘minor’ linkages (lower scoring) in grey. The primary concern raised was that omission of some indication of the existence of these connections is most likely to be assumed by readers of the EOs to mean that it does not occur in that ecoregion, which is not the case. Additionally, it could be seen as an omission, and as such, undermine the legitimacy of the advice product in the eyes of the advice recipient. These suggestions were taken on board and proposed at WKTRANSPARENT, included in the Technical Guidelines and in the updated diagram for the Celtic Seas ecosystem overview. However, they did not make it into the final EO due to technical issues and a concern from ACOM that it may be confusing for readers. An agreement between the ADG and ACOM recommendations still needs to be found. A potential solution is to include a link in the legend to the full assessment, either through a link to the WGEAWESS report, or to an interactive version such as those illustrated below (Figure 3.1).

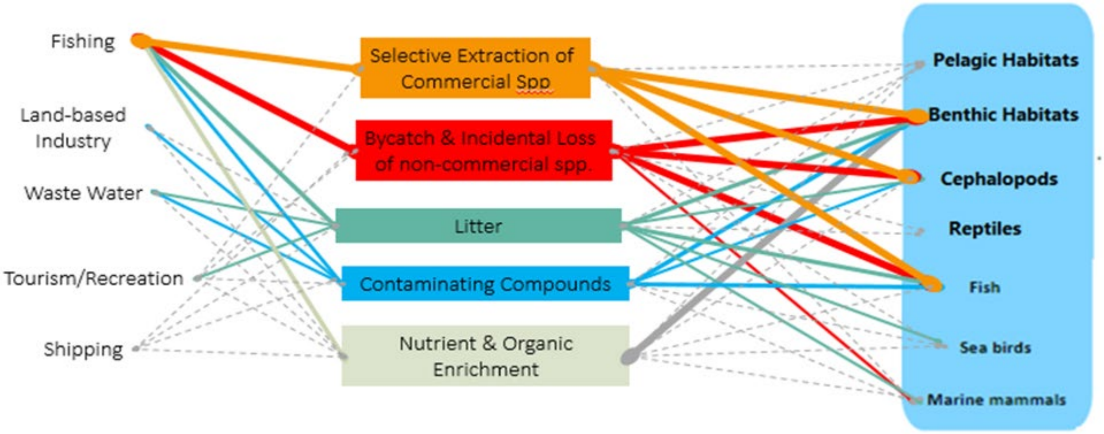


Figure 3.1. The proposed conceptual diagram drafted by WGEAWESS to the Advice Drafting Group. Celtic Sea ecoregion overview with the major regional pressures, human activities, and ecosystem state components. The top linkages (those that contribute >1% to the risk score; 21 linkages/4.5% of those assessed) responsible for 55% of the overall risk score are illustrated in solid lines. Thickness is an indication of magnitude. Dashed lines indicate pressures that exist but do not contribute to the top risks. Each Sector and Pressure are listed in decreasing order of their relative contribution to the total risk score. For methodology and definitions, see ICES ecosystem overviews Technical Guidelines.

The initial diagram (Figure 3.1) drafted by WGEAWESS was not accepted by the ADG for two reasons. First, the definition of the pressure 'Selective extraction of species' in the Technical Guidelines includes bycatch. WGEAWESS propose that if that is the case, it is not selective, and as such, should be labelled 'Species Extraction'. Additionally, we must consider that there are aspects of incidental loss that are not captured by bundling 'Bycatch and incidental loss' into 'Selective extraction of species', such as ship strike on marine mammals or reptiles (e.g. loggerhead turtles), or collisions of marine birds with offshore wind turbines. Losing this pressure as a separate category means there is currently no way to capture those impacts in the assessment.

The second issue was around the pressure 'abrasion' which was no longer in the top pressures using the WKTRANSPARENT assessment approach. The approach includes only the top 5 pressures, and abrasion appeared 6th and so was excluded (Figure 3.2; Table 3.1). However, the bundling of 'Bycatch and incidental loss' into 'Selective extraction of species' raised it up the list. In addition, the definition of 'abrasion' was questioned. In the Technical Guidelines 'Abrasion pressures relate to disturbance of the substrate at or below the surface of the seabed' and does not refer to the biota. ADG participants felt that this was misleading to EO readers, and that the indirect/associated impacts of abrasion should be included in this pressure. After much discussion, it was decided that the pressure should be changed to 'Physical Seabed Disturbance'. As detailed in the Celtic Seas EO; "Physical seabed disturbance can occur via abrasion (the scraping of the substrate), resuspension of the substrate (siltation), removal of the substrate, and deposition (smothering). The impacts associated with such disturbances include the biotic impacts linked to the physical action and include additional mortality through, for example, collisions with bottom-contacting mobile and set fishing activities. Other activities such as aquaculture, tourism/recreation, coastal infrastructure, hydrodynamic dredging, shipping (anchoring), and cable burial may also contribute." This definition is more in line with other ongoing efforts (e.g. VME work and WGFBIT (Working Group on Fisheries Benthic Impact and Trade-offs)) and a recent EU request to advise on a seafloor assessment process for physical loss (D6C1, D6C4) and physical disturbance (D6C2) on benthic habitats. This change in definition required a change in the assessment, merging scores from 3 different pressures; abrasion, smothering/siltation, sealing/substrate loss into one. This results in a loss of nuance between the pressures. Furthermore, the impacts of collateral damage on benthic habitats due to abrasive actions that would have been encompassed in the 'incidental loss' category, were now subsumed into 'Physical Seabed Disturbance'.

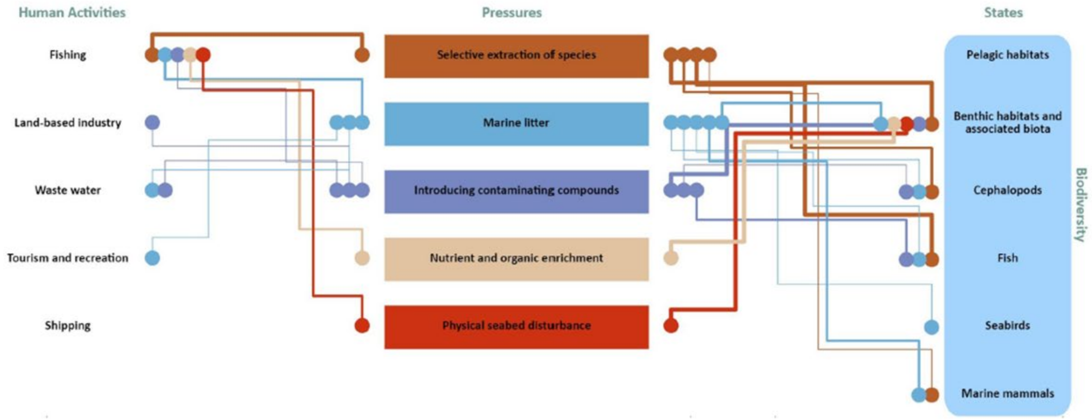


Figure 3.2. The figure published in the Celtic Seas EO. Celtic Seas ecoregion overview with the major regional pressures, human activities, and ecosystem state components. The top linkage chains (those that contribute > 1% to the risk score; 23 linkages/5% of those assessed) are responsible for 66% of the overall risk score and are illustrated in solid lines (line thickness is an indication of the magnitude of the illustrated elements). Each human activity and pressure is listed in decreasing order of their relative contribution to the total risk score. Shipping and Pelagic habitats were assessed but do not contribute to the top impact chains. For methodology and definitions, see ICES ecosystem overviews Technical Guidelines.

Table 3.1. The published diagram illustrates 66% of the identified top linkages for sectors, and 59% of the top linkages for pressures. Looking across the entire assessment, the listed top sectors are responsible for 93% and the listed pressures are responsible for 86% of the impact risk score. This provides strong support for the diagram, as it clearly captures the most critical sectors and pressures affecting the ecoregion.

	Sectors			Pressures	
	% relative contribution			% relative contribution	
	Top linkages	Entire Assessment		Top linkages	Entire Assessment
Fishing	53.4	60	Species Extraction	22	22.9
Land-based Industry	4.6	11	Litter	13	21.7
Waste Water	4.6	9	Contaminating compounds	9	18.2
Tourism/Recreation	3.6	7.0	Nut & Org enrichment	8	11.9
Shipping		6	Physical Seabed Disturbance	8	10.9
Grand Total	**66**	**93**	**Grand Total**	**59**	**86**

While many of these issues boil down to differences of opinion or perspective, outstanding issues remain in that these changes to definitions, particularly in relation to the new ‘Physical Seabed Disturbance’ pressure have not been updated in the Technical Guidelines, meaning that there is a strong risk that the old approach disliked by the ADG will be perpetuated through the groups that update their EOs this year, and remain in the newly updated EO until the next review 5 years from now - maintaining inconsistency across the EOs.

On a smaller note, the heading of ‘State’ in the diagram was also supposed to be updated to ‘ecosystem component’ in line with the updated Technical Guidelines.

The published EO diagram is based on an assessment of 17 sectors, 17 pressures, and 7 ecological components. See figure 3.3 for the full list of assessed components. Out of a potential 2023 pressure pathways, 447 (22%) were found to occur. The network is illustrated in Figure 3.3, with further details on the scores and ranking visible in Figure 3.4.

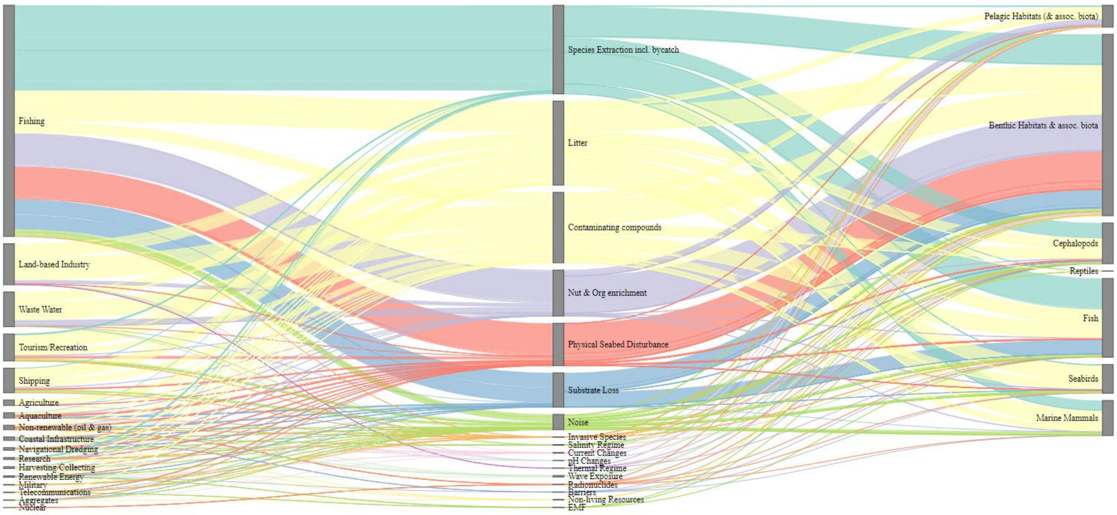


Figure 3.3. Sankey Diagram illustrating the full network of sectors, pressures and ecological components considered for the Celtic Seas risk assessment. Magnitude of contribution of each sector and pressure, and effect on ecosystem component is indicated through the thickness of each grey bar. Individual elements can be highlighted in the online version, available here: http://rpubs.com/DebbiPedreschi/CSEO2.

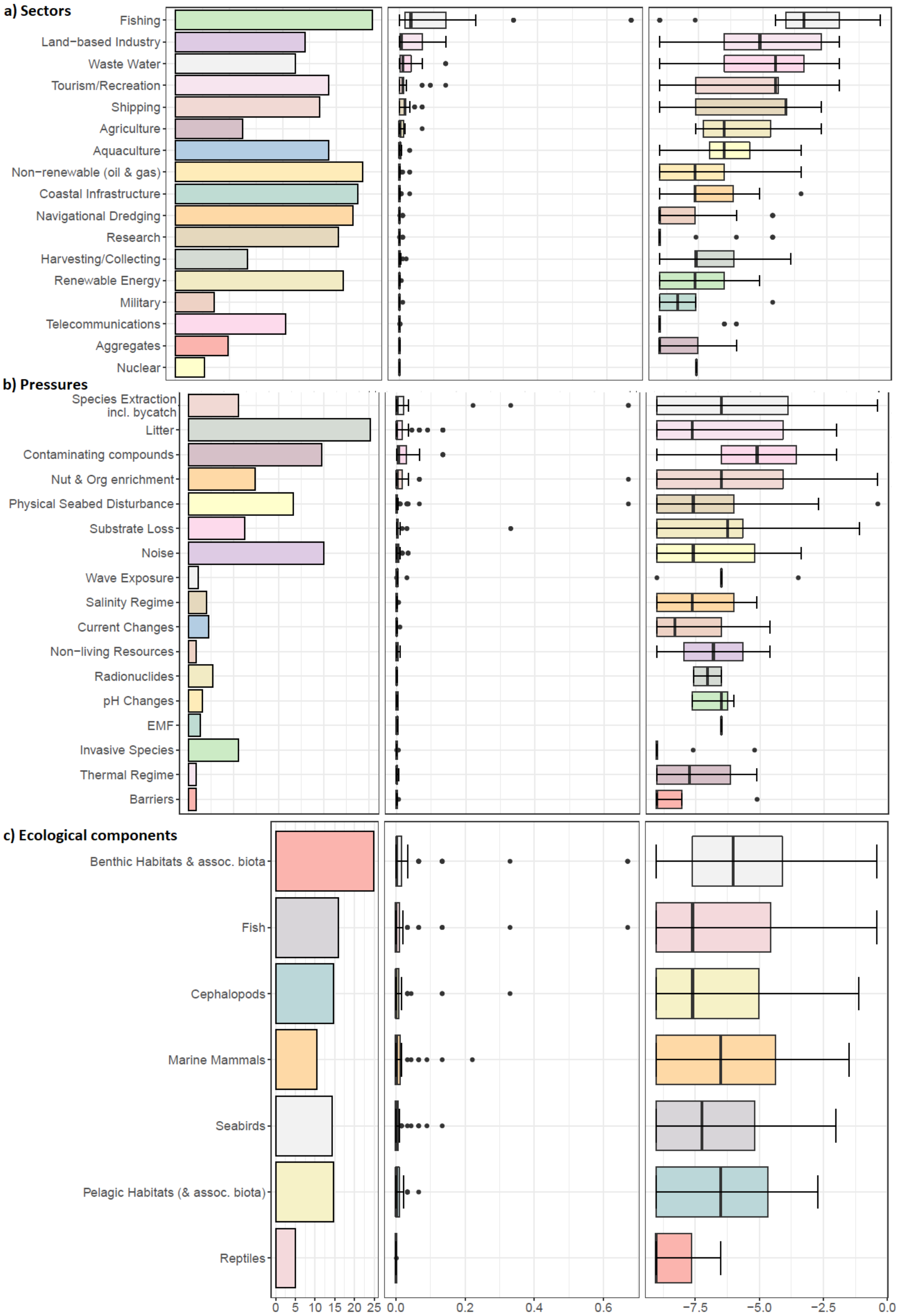


Figure 3.4. Proportional Connectance, Impact Risk, and Impact Rank Boxplots. Each component assessed is listed in order of its average Total Risk Rank on the y-axis (top=high, bottom=low) to aid interpretation. The thick black vertical lines on

the boxplots indicate the median values, with the box lengths representing the 25% quartiles and the whiskers representing 1.5 times the interquartile range. Outliers are shown as black dots. The small Impact Risk scores have been log-transformed ('Impact Rank') to allow visual comparison between the assessed components.

Additional proposals were put forward such as the used of Sankey diagrams using R code rather than the current diagrams as they are reproducible and transparent, and also indicate magnitude between the linkages (see Figure 3.3 or for the top linkages only see here: http://rpubs.com/DebbiPedreschi/CSEOtopSecPres) or even more interactive diagrams that illustrate the full assessed network so that advice recipients can identify their area of interest and see which elements they may need to take into account: https://debbi-pedreschi.shinyapps.io/CS_EO_diagram/. These suggestions were not taken forward at this point and discussions are ongoing to see how these could be made available to customers without making EO too dense.

3.1.2 Details on new sections

Climate Change

(Clive, Dave, Morgane). Issues were encountered with multiple models available but none covering the whole ecoregion. Figures were shown that the group felt showed the long-term trends better than the current maps. WKCLIMAD (Workshop on pathways to climate-aware advice) could help, but the timing was too late for inclusion in this EO. The available information also changed a lot from region to region. A relevant report on climate change for the Irish Government was published during the development and proved useful (Walther *et al.*, 2021). There seems to be a lot of ongoing progress in this section/direction, which makes the current update quite challenging. Despite this the group produced a comprehensive section that delivers a summary of environmental trends, and sections outlining climate change impacts and/or relevant trends related to primary production, phytoplankton, zooplankton, and fish, along with potential socio-economic impacts and highlighting knowledge gaps for the ecoregion.

Foodwebs

(Eider, Jacob, Dorota, Clive, Fatima, Morgane, Marian, Xavier, Jacob, Izaskun). A broad description of the foodweb was produced, highlighting changes experienced due to human activities, environmental drivers and ecological interactions. The foodweb section combined information from recent publications with details from Ecopath with Ecosim models of the multiple Celtic Seas subregions (Irish Sea, Celtic Sea, West Coast of Scotland). Differences in foodweb structure and the prevailing system drivers were found between subregions, however commonalities suggest that changes in the environment have suppressed the overall production of commercial finfish and dampened the rate of stock recovery.

Productivity

(Jed). The modelled data availability presented numerous challenges in relation to coverage (CPR), comparability (Copernicus uses different models: NWS CMEMS covers just partly Iberia, IBI missed west of Scotland) or accuracy (Eppley, cloud cover). For example; for the same time frame and spatial coverage (2003–2019) Eppley and Copernicus data don't match very well for the same area. No consensus was reached on the best product, but the oceanographers we contacted internally in the Marine Institute tended to favour Eppley (but no winter data). As a result, we needed to contact WGOOFE to discuss and ground our proposal below and check it was using the most appropriate product. **WGEAWESS recommends that WGOOFE provide guidance (or even better outputs) to IEA groups to be included in the EOs based on their expert knowledge.**

Celtic Seas Ecoregion Overview Productivity Proposal

- **Variable:** Net primary production (mg C/m^2/day)
- **Unit:** NPP (mg C/m^2/day)
- **Data product**: OSU Eppley VGPM MODIS based estimate
- **Downloaded:** 2 June 2021 by Joe McGovern
- **URL:** http://orca.science.oregonstate.edu/1080.by.2160.monthly.hdf.eppley.m.chl.m.sst.php
- **Time coverage:** 2003–2020
- **Temporal resolution:** Monthly (February to November only)
- **Spatial coverage:** Global coverage subset to the Celtic Seas Ecoregion (subset using ICES shape file)
- **Spatial resolution:** 2160 x 4320 pixels (1/12th of a degree)
- **Missing data**: August and September monthly values in 2020 are not available.
- **Contributor:** Jed Kempf (e-mail: jed.kempf@marine.ie)

About the data

The Eppley VGPM MODIS net primary production (NPP) product provides estimates of NPP from the surface to the euphotic zone depth. NPP estimates are derived from satellite observations of chlorophyll which is input data into the Eppley VGPM equation with ancillary parameters such as daylength, temperature-dependent photosynthetic efficiencies and the euphotic depth. Clouds have been filled in the input data using OSU software. The Eppley VGPM equation can be found here.

Comments:

- The dataset was converted from HDF to netcdf4 file by Joe McGovern in the Marine Institute (02/06/2021).
- The dataset was analysed and plotted in R v3.6. All code and data available from jed.kempf@marine.ie
- The satellite did not cover the West of Scotland from November to January so values from these months were excluded from all data analysis.
- Values for August and September in 2020 are not available. No interpolation has been done.
- The cells/pixels in 2003 and 2004 were not evenly spaced and were removed from the spatial-temporal plot (Figure 3.8) of annual NPP per cell but included in all other temporal analysis (Figure 3.5–3.7).
- The anomaly plot is based on the difference between mean NPP of the time-series (2003–2020) and the NPP of a given year.

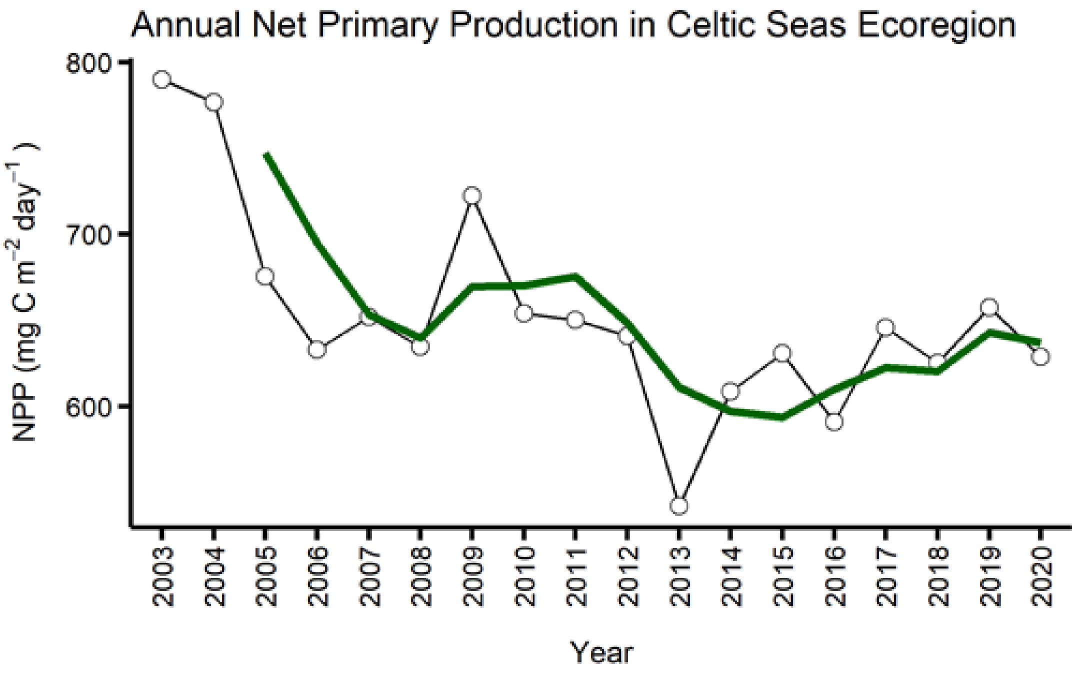


Figure 3.5. Annual means of NPP in the Celtic Seas ecoregion (black line with open circles) and the 3-year moving average of NPP (green line).

Description: NPP decreased from 2003 to 2008, experienced a sharp increase in 2009 and then decreased to its lowest value in the time-series in 2013. NPP has been increasing from 2013 to 2020

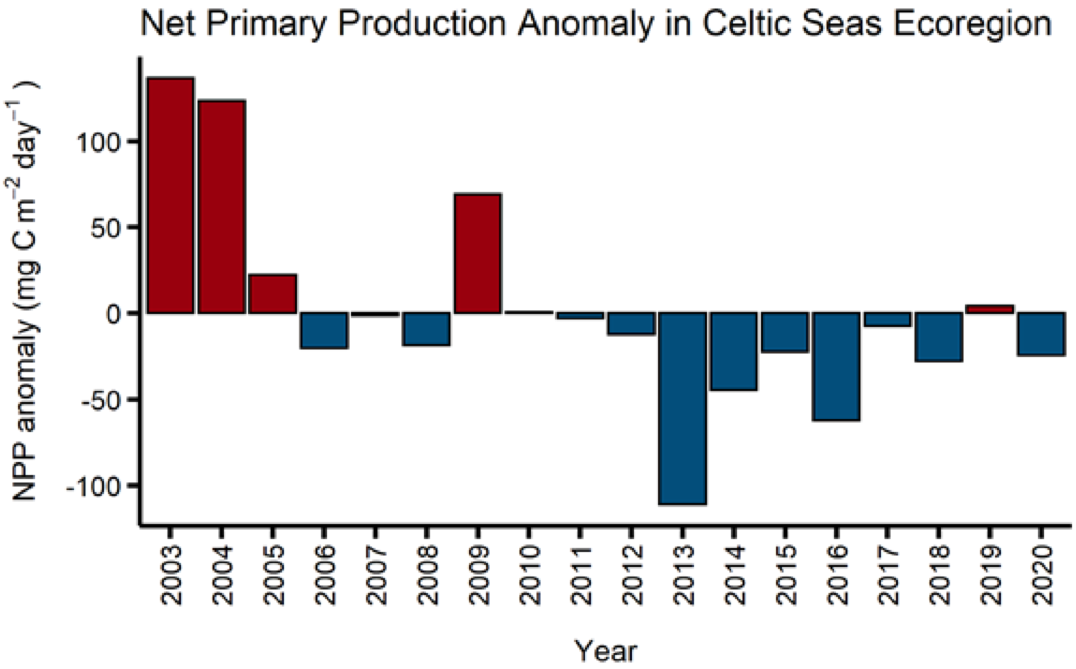


Figure 3.6. Anomaly plot of NPP in the Celtic Seas Ecoregion. The mean NPP of the entire time-series was used (2003–2020).

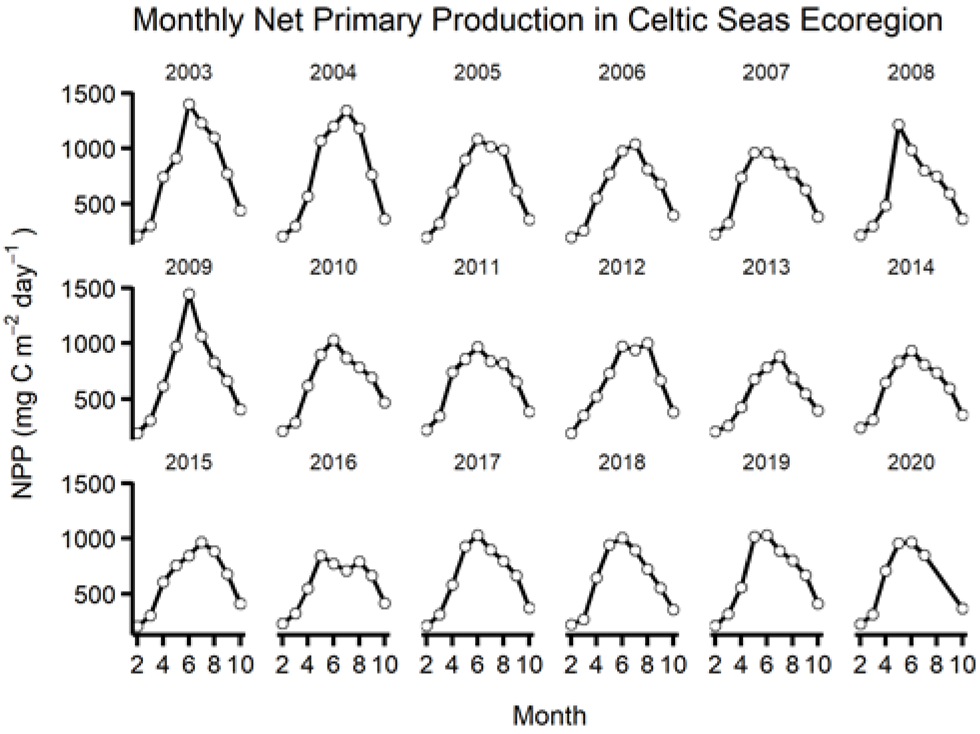


Figure 3.7. Monthly means of NPP in the Celtic Seas ecoregion from February (2) to October (10). Note: August and September values in 2020 are not currently available.

Description: NPP monthly means generally peak in May/June and then begin to decrease in August. The years of 2003, 2004, 2008 and 2009 experienced a more pronounced bloom.

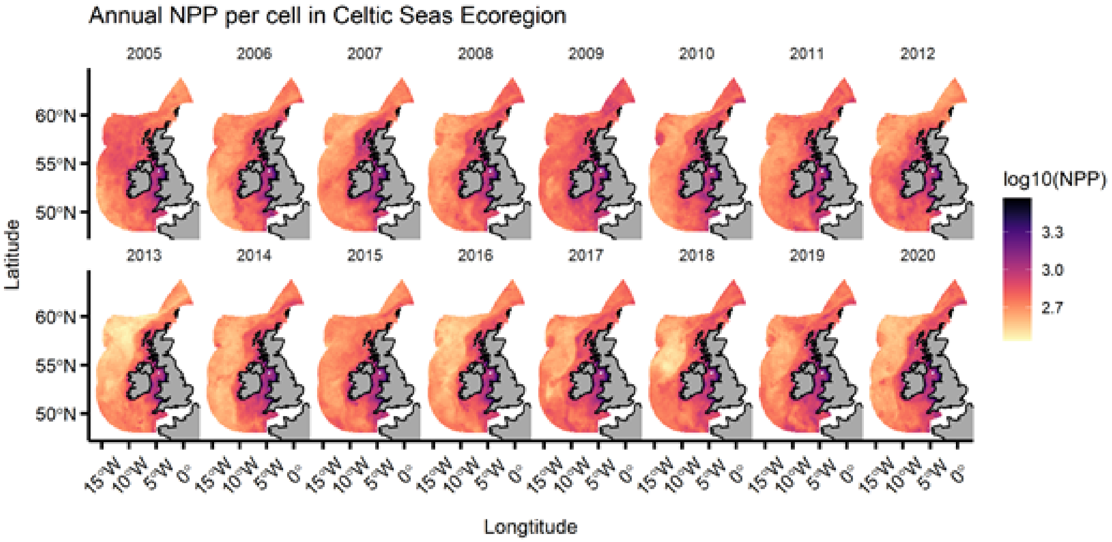


Figure 3.8. Annual means of net primary productivity for each cell from 2005 to 2020. NPP values were log10 transformed.

Description: NPP is greatest in the Irish Sea, along the shelf break and within the shelf seas.

Oceanographic Conditions and Circulation

A substantial contribution from WGOH resulted in detailed updates to this section, including subregional descriptions, recent trends (informed by the IROC report), and a map of the key circulation and oceanic features.

An additional contribution (below) was received from Fatima Abrantes, however not all text could be included in the final EO.

Climate variability profoundly impacts the environment and, consequently, various trophic levels in varying ways, either directly via Sea Surface Temperature (SST) changes or via climate-mediated changes.

In the northern hemisphere the dominant large-scale climate mode is the North Atlantic Oscillation (NAO - Hurrell, 1995). With a strong influence on the climate of the North European region, as on a wide range of physical, ecological, and social parameters in the Atlantic (Hurrell *et al.*, 2003), NAO is mainly a winter season mode which phases are defined from the strength and positions of the Icelandic low and the Azores High-pressure systems (NAO index). It determines the position and intensity of the Atlantic storm track, westerly winds, and wave climate across the Atlantic, as well as oceanic circulation. In addition, it has an indirect effect on sea surface temperature (SST) and salinity (SSS) on a wide range of time-scales (days to decades). At the Celtic Seas, stronger westerly winds generate stronger turbulence and higher waves during positive phases, while a negative NAO is associated with slacker westerly winds (Scherrer *et al.*, 2006).

The decadal-scale North Atlantic temperature variability that goes beyond the influence of neighbour continents is defined as the Atlantic Multidecadal Oscillation/Variability (AMO/AMV - Wang and Dong, (2010)) and linked to the NAO index by Yamamoto and Palter (2016). The AMO/AMV has also been related to changes in the subtropical and Subpolar Gyres circulation. Häkkinen *et al.*, (2011a, b, 2013) show that incursions of warm subtropical waters into the Subpolar Gyre are stronger and facilitated by the weakening of the subtropical and Subpolar Gyres during AMV positive phases. Danabasoglu *et al.*, (2012) applies the CCSM4 model to evaluate the unforced intrinsic AMOC variability on multidecadal time-scales. Their results highlight AMOC association with AMO, particularly with AMO positive anomalies, by establishing density anomalies in the Subpolar Gyre that lead to AMOC intensification. An association between AMOC weakening and the advection of warm subtropical waters from lower latitudes has also been proposed by e.g. Delworth and Mann, (2000) or Häkkinen *et al.*, (2011). AMO is also thought to control variations in the position of the ITCZ with its displacement poleward of its annual mean position when AMO is anomalously high.

The Celtic Seas comprise the shelf area west of Scotland, the Irish Sea, west of Ireland, the proper Celtic Sea and the western Channel, and are a transition zone between the Atlantic Ocean and coastal waters. The most prominent pattern of the region's circulation is the persistent poleward flowing slope current running from Brittany to the Bristol Channel, and oceanographic fronts (the Irish Shelf, the Celtic Sea, and Ushant fronts). Fronts represent boundaries between water masses with differing properties (e.g. temperature, salinity, density, nutrients), and currents on either side of the front induce vertical flow and result in biogeochemical and production hot spots, aggregations of plankton and higher trophic levels, and carbon export that sustain bottom communities.

Due to freshwater input from rivers and land run-off, low salinities characterize the shallow shelf of the west coast of Scotland, otherwise marked by the Scottish Coastal Current. On the contrary, the Faroe-Shetland Channel exhibits complex oceanographic features resulting from the encounter of waters from the Atlantic and Arctic Ocean basins (Bett, 2003 and references therein).

Most of the Celtic Sea is thermally stratified between May and November (e.g. Brown *et al.* 2003), but a subsurface residual cold saline dome of water is found in the Celtic Deep. The density gradient across these two water masses creates a baroclinic circulation (Brown *et al.* 2003; Fernand *et al.* 2006) and strong cold jet-like flows (located at ~25–30m) that spread offshore in a cyclonic sense during summer. In the shallower coastal areas, tidal forces overcome stratification creating a tidal front between the stratified and tidally mixed water masses. A frontal system between the Celtic and Irish Seas develops in late spring and breaks down with the onset of winter cooling and wind mixing. Similarly, a tidal front exists at the entrance to the English Channel between France and the UK.

The Irish Sea, which consists of an open-ended deep channel in the west and shallower bays in the east, is connected to the Atlantic Ocean, in the south, via the Celtic Sea and the St George's Channel and in the North, via the North Channel and the Malin Shelf Sea. Its distinctive feature is the Irish Shelf Thermohaline Front, located south and west of Ireland that separates coastal from oceanic waters (transition surface salinity signature of ~35.3) year-round but strengthens with warming from late spring to late summer. Furthermore, tidally driven fronts separate the Irish Sea from the Malin Shelf and the Celtic Sea (the Islay Front and Celtic Sea Front).

Recent trends in SST and SSS

The regions of the Celtic Seas under a strong influence of the subpolar North Atlantic Basin surface waters were cooler than average in 2020 (-0.6 and -0.4 ºC anomalies in the Faroe-Shetland Channel and upper Rockall Trough, respectively). An effect likely to reflect the extreme freshening observed in the eastern subpolar North Atlantic between 2012 and 2016 and the diversion of Arctic freshwater from the western boundary into the eastern basins (Holliday *et al.*, 2020).

In the intermediate waters of the Rockall Trough (1500–2300 m depth), waters were extremely warm and saline in 2020., but the origin of this signal is currently uncertain.

On the shallow south shelf, in the Western Channel Observatory, surface waters were warmer and less saline than average has also been observed at the Bay of Biscay. Ocean temperature on the Malin shelf was above average in 2019, but no data are available for 2020 as yet. A time-series of temperatures is available from the M3 weather buoy. However, it is still too short to be standardized to a 30-year climatological average.

3.2 Presentation summaries relevant to ToRs A and D

Throughout the 3-year term, a number of presentations were provided to inspire the ongoing and future work/development within the EOs. Summaries are provided below.

3.2.1 Social, Economic and Ecological Objectives for the Celtic Sea – Gerben Vernhout, WGBESEO

As a first step into developing a method for balancing economic, social and ecological objectives (ESE objectives) research was done on the ESE objectives and indicators in the fisheries policy for the Celtic Seas ecoregion, both on a national level and at the EU level. This research was done on behalf of the Working Group on Balancing Economic, Social and Ecological Objectives (WGBESEO) and the Marine Institute Ireland and aims to also contribute to WGEAWESS and WGSOCIAL. It was part of my internship for the Bachelor on coastal and marine management at the University of applied sciences Van Hall Larenstein in Leeuwarden, the Netherlands. Due to language and time restrictions it was chosen to exclude French fisheries policy. Examples of EU level policy that was included are: the common fisheries policy (CFP), the Marine strategy framework directive (MSFD) and the European Maritime and Fisheries Fund (EMFF). Examples of national level fisheries policy that was included are: Harnessing Our Ocean Wealth (HOOW) and National Marine Planning Framework Consultation Draf (NMPF) for Ireland and Our seas – a shared resource, High level marine objectives (Os-asr) and The UK Marine Policy Statement (UK-MPS) for the UK.

First an overview of all the objectives was created using an excel worksheet. These objectives were then checked on their fisheries relevance, aquaculture relevance and Celtic Seas ecoregion relevance. After that the objectives were categorized in categories such as Biodiversity, employment and food safety. Finally, the "level" of the objectives was specified in either low, medium or high level objectives. The Lowest level objectives were very specific, had obvious and easily quantifiable indicators and a clear geographical area. The Highest level objectives were the vaguest, had no obvious quantifiable indicators and had no clear geographical area. The medium level objectives had some of the before mentioned traits but not all. During the development of the overview it became clear that most of the Social and economic objectives were very high level and had no clear indicators. This was especially the case for the EU level objectives. Therefore, it was decided to do a second exercise in formulating candidate indicators for the social and economic objectives. Members of WGSOCIAL and WGBESEO helped during this process by reviewing the candidate indicators and giving feedback on them. As a result of this exercise candidate indicators were added to the before mentioned overview of ESE objectives and it added to the conclusion that most objectives were too vague to formulate very clear, non-biased indicators. Finally, the difference in the implementation of the criteria of good environmental status (GES) from the MSFD between Ireland and the UK was looked at. It was chosen to look at the criteria for descriptor 3 (commercial fish stocks) and descriptor 6 (seafloor integrity). This illustrated the fact that both countries implemented them in totally different ways which shows the "directive" nature of the MSFD and the freedom each nation gets to implement it in their own way.

3.2.2 Potential EwE modelling products for Ecosystem Overviews (WKEWIEA and WKIrish) – Jacob Bentley (Natural England)

Ecopath with Ecosim is an ecological/ecosystem modelling software suite, used globally to simulate the dynamics of marine foodwebs in order to build better ecosystem understandings and provide ecosystem advice. EwE outputs have been operationally used to simulate the impact of proposed fishery management plans, provide advice on gear selectivity and bycatch reduction devices, inform Ecosystem-based management, and support environmental impact assessments. EwE has also been used to estimate indicators of foodweb structure and function, track pollutants as they move through the foodweb, and simulate the impacts of IPCC climate scenarios. As such, EwE models have the utility to provide insightful qualitative and quantitative products for ICES Ecosystem Overviews (EOs).

EwE models exist for most ICES statistical areas; however, they are not always available at the ecoregion level. For example, EwE models exist for the Southern Celtic Sea, Irish Sea, and West Coast of Scotland, however there is no EwE model for the entire Celtics Sea Ecoregion as defined by ICES. This means EwE derived outputs for this ecoregion would have to be broken down to a more regional level unless a model is developed to cover the entire area.

EOs include three sections, all of which could be enhanced by EwE outputs: (1) Key signals within the environment, (2) Pressures, (3) State of the ecosystem.

(1) Key signals within the environment

A key strength of EwE models lies in their capacity to be used to identify the key drivers (anthropogenic, environmental, and trophic) underpinning ecosystem and commercial stock dynamics and quantify their impact (Figure 3.9). EwE can also be used to quantify the flow of energy throughout the ecosystem and determine the strength of top-down (fishing, predation) or bottom-up (primary and secondary production) trophic drivers on the structure of the foodweb and commercial stock production.

Figure 3.9. Drivers of the key commercial stocks in the Irish Sea.

As part of the ICES Workshop on an Ecosystem-based Approach to Fishery Management for the Irish Sea (WKIrish), an EwE model of the Irish Sea was used to identify key drivers of commercial stocks to produce ecosystem-based fishing reference points (F_{eco}) for those stocks. Using the 'pretty-good yield' ranges from single stock assessments, F_{eco} can be used to scale fishing mortality down when the ecosystem conditions for the stock are poor and vice versa. This approach provides a streamlined way of incorporating ecosystem information into catch advice and provides an opportunity to operationalize ecosystem models and empirical indicators, while retaining the integrity of current assessment models and the F_{MSY}-based advice process. EOs would be a suitable place to provide an overview of the links between ecosystem drivers, the foodweb, and commercial stocks, as derived from EwE models.

(2) Pressures

EwE models can predict and quantify the temporal and spatial impacts of anthropogenic, environmental, and trophic pressures on the foodweb. The impacts of these pressures can be measured as changes in biomass, catch, revenue, or foodweb indicators of the structure and function of the system (Figure 3.10). EwE models can also simulate pressure trends for individual species or functional groups (e.g. demersal fish). This may be of interest in relation to unassessed species for which little pressure data may be available. EwE can produce retrospective trends of fishing mortality and predation mortality over space and time. It is also important to note that, due to the data intensity of constructing an EwE model, modellers may have access to, or may have generated, additional pressure data which could contribute towards the EOs. For example, during WKIrish workshops, stakeholders recreated fishing effort trends for multiple gear types going back to 1970. These trends were needed to drive fishing effort within the model, however data were unavailable for many gear types prior to 2003.

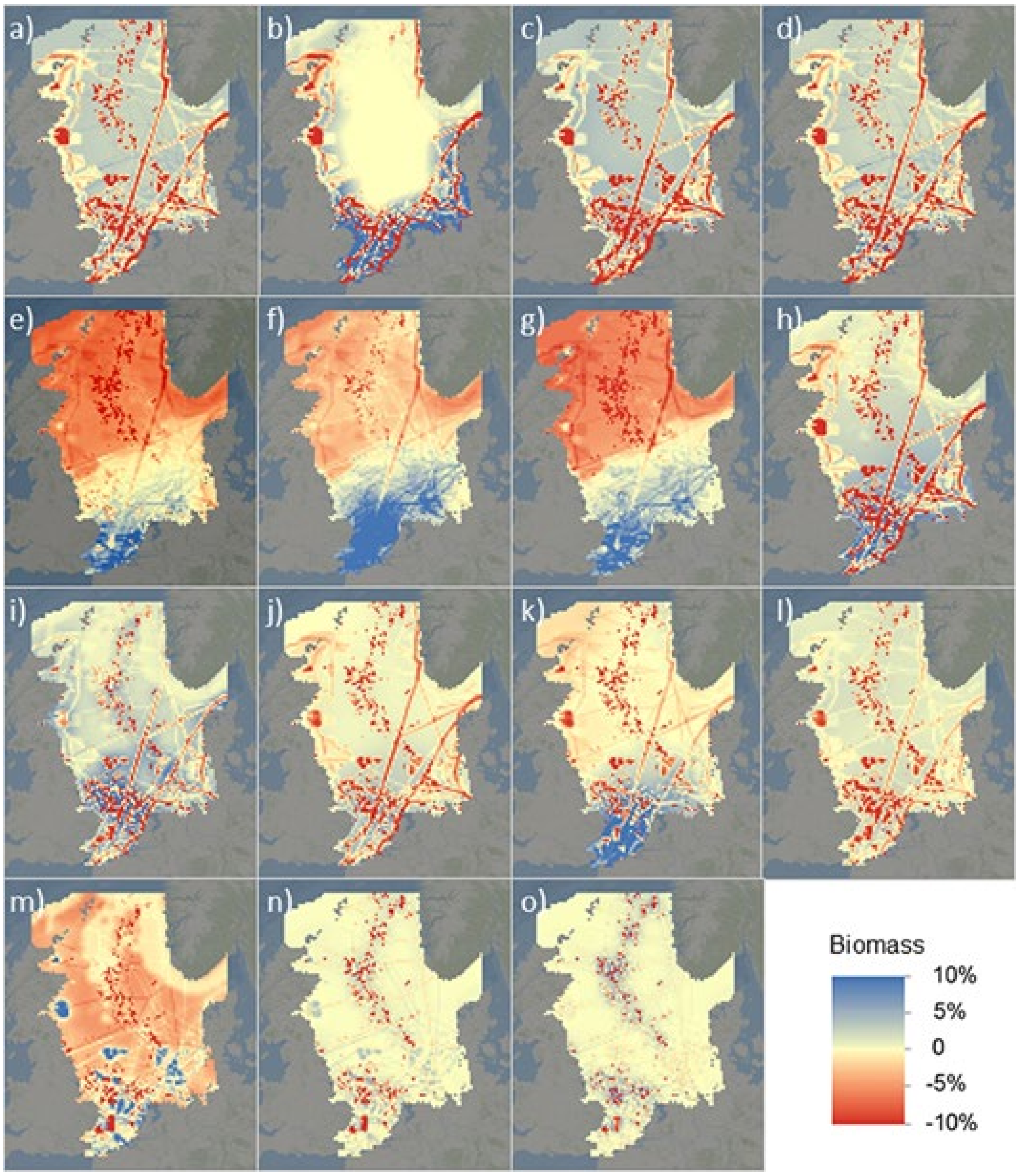


Figure 3.10. North Sea biomass distribution and intensity changes simulated using EwE, in response to the introduction of marine spatial planning pressures (shipping, fishing, renewables, noise, disturbance). (A) Cetaceans. (B) Seals. (C) Windfarm-avoiding seabirds. (D) Windfarm-indifferent seabirds. (E) Cod. (F) Commercial gadoids. (G) Demersal predators. (H) Herring. (I) Sandeel and sprat. (J) Mackerel. (K) Flatfish. (L) Large demersal fish. (M) Large crabs. (N) Large benthic invertebrates. (O) Small benthic invertebrates. ***Taken from Steenbeek, J., et. al., 2020. Combining ecosystem modelling with serious gaming in support of transboundary maritime spatial planning. Ecology and Society 25(2):21. https://doi.org/10.5751/ES-11580-250221***

(3) State of the ecosystem

EwE can be used to produce comprehensive diagrams of the flow of energy between species/functional groups (Figure 3.11). These diagrams provide a snapshot of the ecosystem, identifying the strength of interactions between predators, prey, and fishing fleets.

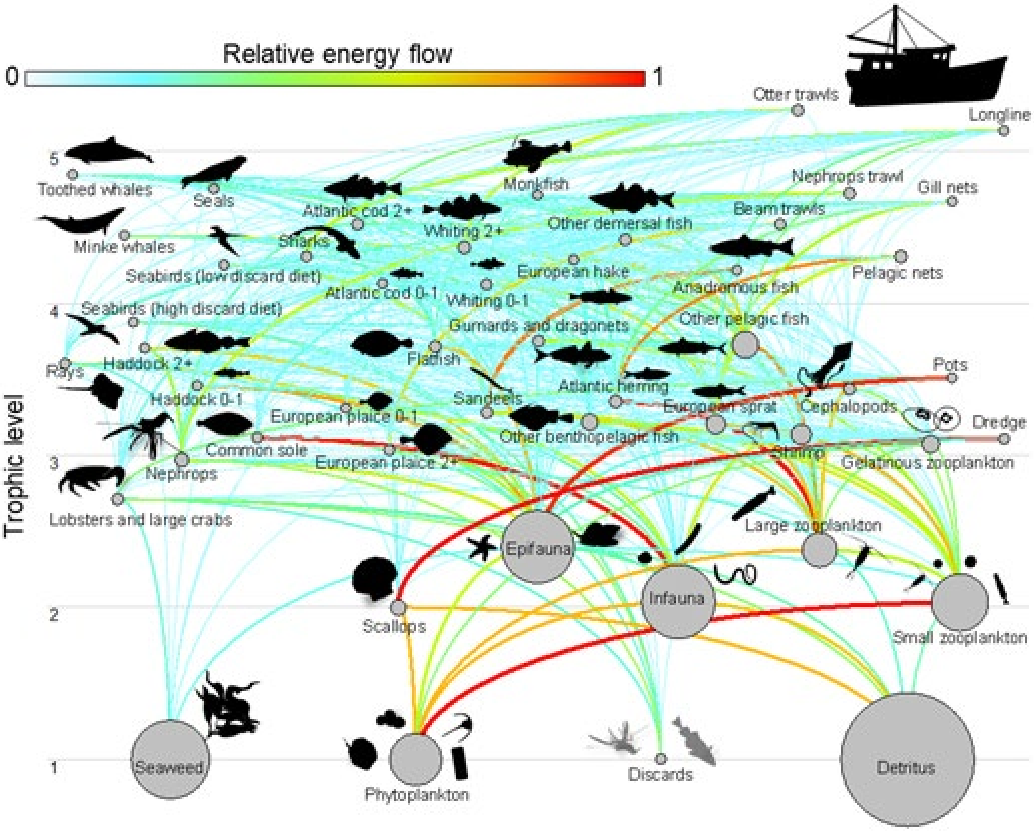


Figure 3.11. Energy flow and biomass diagram for the Irish Sea Ecopath foodweb model. Functional groups and fleets are represented by nodes. The relative size of functional group nodes denotes their biomass while the size of fleet nodes denotes the size of their catch. Lines represent the flow of energy and are scaled to reflect the relative energy flow. The y-axis denotes group trophic level.

EwE can also produce temporal and spatial simulations (retrospective and predictive) for assessed and unassessed functional groups. Again, this may be of interest for unassessed groups for which little is known regarding their historic biomass dynamics. Simulations can be provided for species biomass, catch, fishing mortality, predation mortality, and prey proportions (i.e. how diets change over time). These species level simulations can be aggregated to provide more general trends regarding the state of the ecosystem (e.g. overall biomass, fish biomass, fish/invert biomass ratio etc.).

EwE also has a strong background in producing ecosystem indicators which quantify the structure and function of the ecosystem along with indicators of trophic level, system production, and diversity. Figure 3.12 provides an overview of some of the indicators which can be produced using EwE. In this example, indicator percentiles for the year 2016 have been calculated relative to values from 1973–2015. This provides a snapshot of the ecosystem condition in 2016 relative to previous years, identifying which indicators are currently high (e.g. Invertebrate catch) and which are relatively low (e.g. system production). Again, these indicators can be produced at spatial and temporal scales.

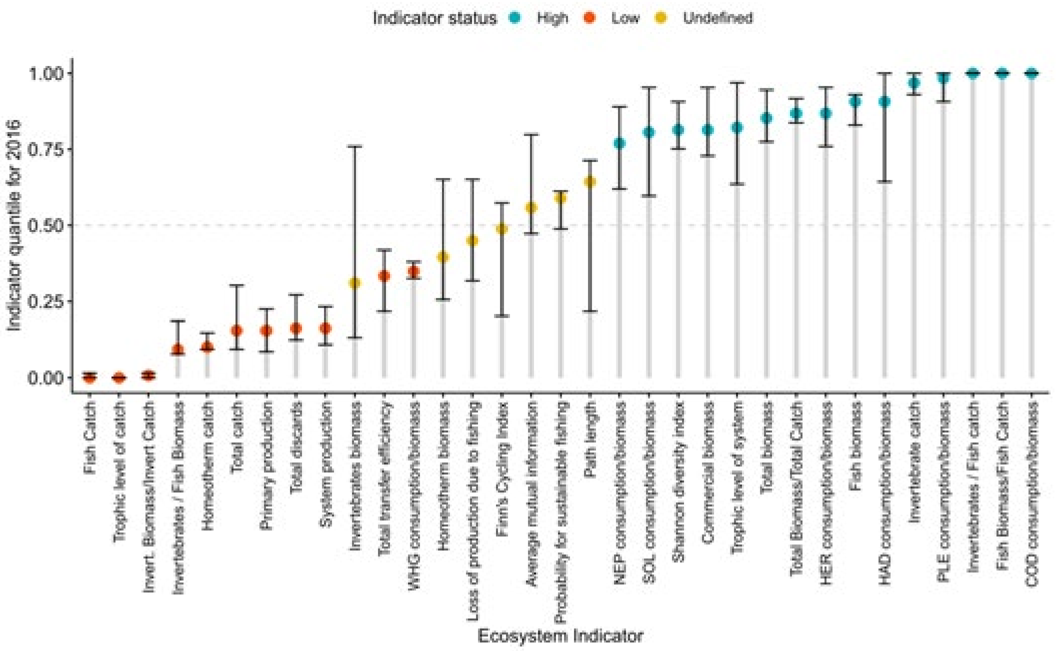


Figure 3.12. Irish Sea ecosystem condition in 2016 as derived from indicators produced using EwE. Indicator percentiles for 2016 reflect indicator status in comparison to values from 1973–2015. Consumption/biomass indicators were calculated for stock assessed species in the Irish Sea: COD=Atlantic cod; PLE= European plaice; HAD=haddock; HER=Atlantic herring; SOL=common sole; WGH=whiting; NEP=Nephrops. Consumption/biomass decreases with worsening species condition; therefore, the inverse of this indicator was used so that higher values indicate better condition.

Finally, when looking to use outputs from EwE models it is important that the models have been through a formal or informal review for quality assurance. In 2019, the ICES Working Group on Multispecies Assessment Methods (WGSAM) produced a quality protocol for models intended to be used in ICES advice. The protocol includes a checklist of questions to address:

- Is the model appropriate for the problem?
- Is the scientific basis of the model sound?
- Is the input data quality sufficient for the problem?
- Does the model compare well with observations?
- Has uncertainty been addressed?

If possible, it is desirable to present a model 'key-run' at a WGSAM meeting. A 'key-run' refers to a model parameterization and output that is accepted as a standard by ICES WGSAM, and thus serves as a quality assured source for scientific input to ICES advice products.

3.2.3 CMEMS standardized data products extraction tool – Olga Kalinina (Marine Institute, Ireland)

A tool for extracting data from CMEMS in usable formats (from netCDF files) through an R Shiny application, and a simple interactive clickable area selection interface, was demonstrated to the group. The tool provides the ability to easily access/review key CMEMS datasets, with standardized outputs and reports. Such a tool could be very valuable to IEA groups and the Secretariat in developing ICES EOs – both in the production of transparent, standardized graphs, but also in providing key data for review by the group to inform EO key trends and paragraphs relating to ecosystem change, productivity, and possibly climate change. Potential future linkages to MSFD descriptors such as D7 on Hydrographical Conditions/Changes.

3.2.4 Marine Use Case Study – Mark Payne (WGS2D, DTUAqua, Denmark)

Project aims to use Copernicus standardized, quality-assured data products from the Climate Change Services to inform ICES Ecosystem Overviews. Aiming to develop dynamic, zoomable, clickable maps to select time-series of sea ice cover, SST anomalies, etc. Similar to Olga's work, but different service of Copernicus. Aim to develop a set of climate indicators that can be used in the EOs.

3.2.5 Ongoing studies in support of the MSFD-D4 indicator development in Spain – Marián Torres (CNIEO-CSIC, Cádiz)

A summary of the ongoing studies at the scope of the MSFD-foodwebs indicators in Spain is presented to the group. We focused mainly on the development of three indicators agreed by OSPAR: Mean Trophic Level (MTL, FW4), Trends in the biomass of functional groups (FW7) and Ecological Network Analysis (ENA, FW9).

The MTL (FW4) common indicator aims at monitoring changes in the structure of the ecosystems with a special focus on the impact of fisheries using a spatio-temporal approach. This indicator was estimated using standardized biomass data and regional trophic levels of bentho-demersal species consistently well identified at spatio-temporal scale over the last two decades. The average trophic level in each haul per year was estimated using three different cut-offs: TL>2.0, TL>3.25 and TL>4.0, and the trend of the MTL in each square (5 x 5 km grid resolution) was analysed. Preliminary results showed the relevance of scale: regions where the indicator appeared to have a steady and/or increasing trend, showed negative trends when using local foodwebs. Therefore, the apparent stability of some areas may be masking a shift in the behaviour of fisheries, becoming a resilient but consistently and overexploited ecosystem.

The second candidate indicator Feeding guild indicator (FW7) aimed to understand changes in ecosystem structure and function across OSPAR regions was calculated using long time-series of fish diet compositions and guild biomass data compiled from UK, ES, SE, NO, IS, FR, DE (plus USA). The methodology consisted of two steps: (1) guild classification based on fish diet data using multivariate analysis and (2) spatial and temporal change in the biomass, abundance and richness of the resulting guilds. Preliminary results identified four feeding guilds: planktivores, benthivores, crustacean-feeders and piscivores. Differences between these guilds in predator length, individual prey mass, predator-prey mass ratio, and percentage biomass contribution of different prey functional groups (e.g. nekton, zooplankton, zooplankton-benthos, benthos, fish, other) were found.

The last candidate indicator Ecological Network Analysis (ENA, FW9) was conceived to explore what types of foodweb modelling (i.e. Ecopath with Ecosim software) are suitable to quantify the "Good Environmental Status" of foodwebs. First, a deep review of existing and/or in progress models covering the five Spanish marine subdivisions (e.g. North-Atlantic, South-Atlantic, Canary, Estrecho and Alborán, Levantine-Balearic) was performed. The ENA-indicators outputs from EwE (e.g. fishery-, ecosystem-, recycling- and information-related) regarding all models revised have been compiled into a dataset to run further analyses. A workshop to explore the use of the EwE models outputs to provide advice for the MSFD involving modelling experts and policy-makers will take place early next year to discuss on: 1) how to agree on the most suitable indicators to quantify changes in foodweb structure during the last decades (robustness, less dependent on the construction of the models), 2) issues related to models' comparison: spatial and temporal scale, number of functional groups, coastal vs. deep etc., 3) pressure-state curves:

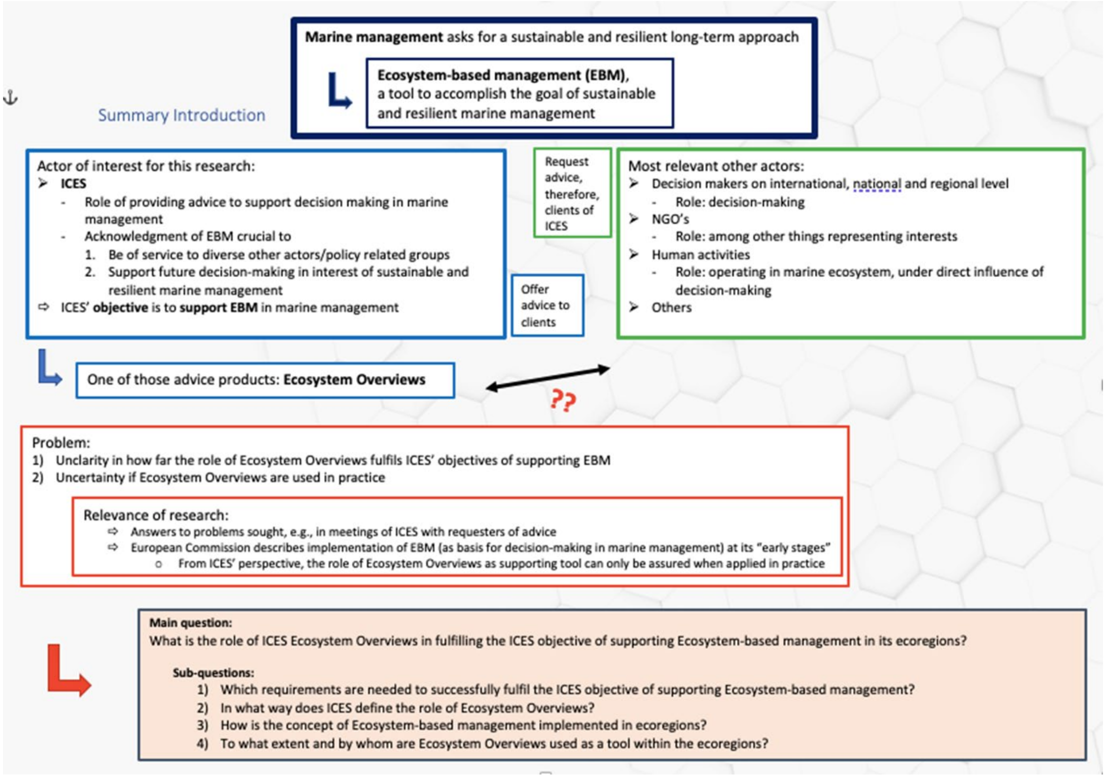
relationships between anthropogenic impacts and foodweb status, 4) potential for supporting EBM (e.g stock assessment, GES of foodwebs).

3.2.6 Role of Ecosystem Overviews in supporting Ecosystem-based management. Summary of bachelor thesis – Lea Schönen

In general, it is unclear to ICES if Ecosystem Overviews as an advice product fulfil the ICES objective of supporting Ecosystem-based management. Due to lacking information on the recognition and uptake of EOs within the ecoregions, one cannot yet determine of their role in Ecosystem-based management.

This new research aims to provide an assessment of the role of EOs in Ecosystem-based management, visualized through an analysis of their usage and users in two ecoregions (Research overview provided in figure 3.13 and 3.14).

The main sub-questions are: Which requirements are needed to successfully fulfil the ICES objective of supporting Ecosystem-based management? In what way does ICES define the role of EO? How is the concept of Ecosystem-based management implemented in ecoregions? To what extent and by whom are EOs used as a tool within the ecoregions? Data are being collected through surveys and expert interviews. Findings will be disseminated back to WGEAWESS to inform future EO iterations.



Summary Introduction

Marine management asks for a sustainable and resilient long-term approach

Ecosystem-based management (EBM), a tool to accomplish the goal of sustainable and resilient marine management

Actor of interest for this research:
- **ICES**
  - Role of providing advice to support decision making in marine management
  - Acknowledgment of EBM crucial to
    1. Be of service to diverse other actors/policy related groups
    2. Support future decision-making in interest of sustainable and resilient marine management

⇨ ICES' **objective** is to **support EBM** in marine management

Request advice, therefore, clients of ICES

Offer advice to clients

Most relevant other actors:
- Decision makers on international, national and regional level
  - Role: decision-making
- NGO's
  - Role: among other things representing interests
- Human activities
  - Role: operating in marine ecosystem, under direct influence of decision-making
- Others

One of those advice products: **Ecosystem Overviews**

??

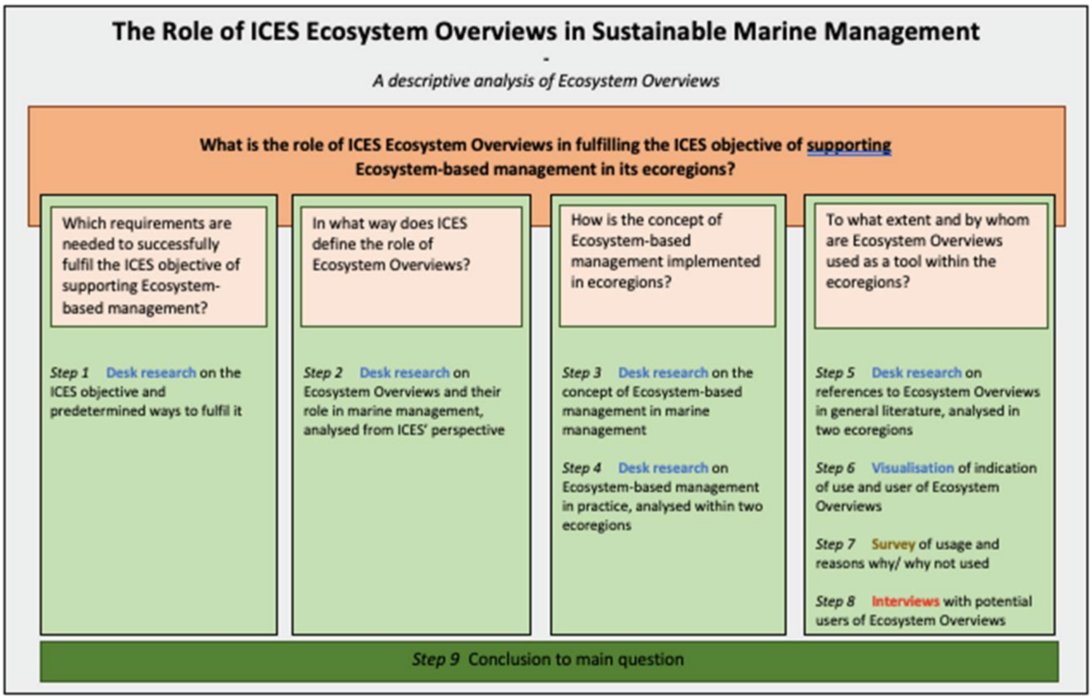
Problem:
1) Unclarity in how far the role of Ecosystem Overviews fulfils ICES' objectives of supporting EBM
2) Uncertainty if Ecosystem Overviews are used in practice

Relevance of research:
- ⇨ Answers to problems sought, e.g., in meetings of ICES with requesters of advice
- ⇨ European Commission describes implementation of EBM (as basis for decision-making in marine management) at its "early stages"
  - From ICES' perspective, the role of Ecosystem Overviews as supporting tool can only be assured when applied in practice

Main question:
What is the role of ICES Ecosystem Overviews in fulfilling the ICES objective of supporting Ecosystem-based management in its ecoregions?

Sub-questions:
1) Which requirements are needed to successfully fulfil the ICES objective of supporting Ecosystem-based management?
2) In what way does ICES define the role of Ecosystem Overviews?
3) How is the concept of Ecosystem-based management implemented in ecoregions?
4) To what extent and by whom are Ecosystem Overviews used as a tool within the ecoregions?

Figure 3.13: Context and justification of the study conducted on the role of ecosystem overviews in supporting ecosystem-based management.



The Role of ICES Ecosystem Overviews in Sustainable Marine Management

-

A descriptive analysis of Ecosystem Overviews

What is the role of ICES Ecosystem Overviews in fulfilling the ICES objective of supporting Ecosystem-based management in its ecoregions?

Which requirements are needed to successfully fulfil the ICES objective of supporting Ecosystem-based management?

Step 1 Desk research on the ICES objective and predetermined ways to fulfil it

In what way does ICES define the role of Ecosystem Overviews?

Step 2 Desk research on Ecosystem Overviews and their role in marine management, analysed from ICES' perspective

How is the concept of Ecosystem-based management implemented in ecoregions?

Step 3 Desk research on the concept of Ecosystem-based management in marine management

Step 4 Desk research on Ecosystem-based management in practice, analysed within two ecoregions

To what extent and by whom are Ecosystem Overviews used as a tool within the ecoregions?

Step 5 Desk research on references to Ecosystem Overviews in general literature, analysed in two ecoregions

Step 6 Visualisation of indication of use and user of Ecosystem Overviews

Step 7 Survey of usage and reasons why/ why not used

Step 8 Interviews with potential users of Ecosystem Overviews

Step 9 Conclusion to main question

Figure 3.14: Main questions and associated steps for the investigation of the perceived and effective role of ecosystem overviews.

3.3 Large-scale Atlantic research projects identified for their potential to contribute to Ecosystem Overviews

In year 3, a mini-workshop was conducted to give an overview of the ongoing projects related to ecosystem-based management. The goal was to evaluate how the work conducted in WGEAWESS could benefit from and to other initiatives, provide an overview on research currently carried out on the topic and overcome the lack of funding in support WGEAWESS ambitions.

Summary SEAwise project – Jochen Depestele

SEAwise is a Horizon 2020-funded project paving the way for the effective implementation of Ecosystem Based Fisheries Management in Europe (grant agreement No 101000318, www.seawiseproject.org, Twitter account: @SEAwiseproject). The SEAwise consortium is an international consortium of researchers, advisors, fishers, and communicators, coordinated by Anna Rindorf and the project team at DTU Aqua in Denmark. SEAwise addresses cross-cutting case studies in four regions: the Mediterranean, Western waters, North Sea and Baltic Sea, spanning small-and large-scale pelagic and demersal fisheries. Working as a collaborative network, SEAwise is designed to deliver a fully operational tool that will allow fishers, managers, and policy-makers to easily apply Ecosystem Based Fisheries Management (EBFM) structures in their own fisheries. With the goal of enhancing the value of fisheries for the benefit of all stakeholders, SEAwise will create tools and advice for collaborative management aimed at achieving long-term goals under environmental change and increasing competition for space.

Beginning in October 2021 and running until September 2025 as part of the EU's Horizon 2020 programme, SEAwise will work by addressing the following four, specific objectives:

1. Build a network of stakeholders, advisory bodies, decision makers and scientists to co-design key priorities and approaches to EBFM.
2. Assemble a new knowledge base, based on stakeholder insight and scientific research, on European fisheries interactions with economic, social and ecological priorities.
3. Collate, develop, and integrate predictive models of fisheries interactions with economic, social and ecological priorities to evaluate management strategies under changes in the environment and in the use of marine space.
4. Provide ready-for-uptake advice for EBFM for the Mediterranean, Western waters, the North Sea and Baltic Sea.

Key priorities in EBFM were articulated by stakeholders during the SEAwise kick-off meeting (scientist) and dedicated scoping workshops co-designed with the Advisory Councils (e.g. NWWAC: https://www.nwwac.org/listing/seawise-workshop.3613.html, SWWAC: https://cc-sud.eu/en/diary/item/atelier-de-travail-du-projet-seawise). At the same time systematic reviews were conducted to assemble scientific knowledge of these social, economic and ecological priorities. Systematic reviews were designed to (1) identify social and economic indicators, and fisheries management properties to which they are linked, (2) to assess the knowledge base on the environmental drivers and processes that impact the productivity of commercial species, (4) to map the available knowledge and evidence of impacts of commercial and recreational fisheries on key species and habitats across European sea basins and (5) to investigate the spatial aspects of fisheries and ecology of commercially fished stocks that will allow for identification of drivers of their spatial distribution. The available knowledge from the systematic reviews was compared to the identified key priorities for EBFM, and set the scene for the development of end-user driven EBFM advice.

3.4 Summary

ToR A was fulfilled successfully. The final EO can be viewed here: https://www.ices.dk/sites/pub/Publication%20Reports/Advice/2019/2019/EcosystemOverview_CelticSeas_2019.pdf

The process was challenging, taking a huge coordination effort and a lot of time and resources. It is hoped that the extensive work to make this EO more transparent and establish connections with relevant other ICES groups will make updates for this IEA group and other IEA groups easier in future.

Despite the improvements in the transparency of the EO advice drafting process, and substantial improvements in communication, some concerns remain in relation to the conceptual diagram grey dashed lines issue (outlined in section 3.1.1). Despite the work in WKTRANSPARENT to address the previous ADG concerns, the issue currently remains unresolved between ADG and ACOM and their visions of the diagram. This needs to be solved urgently before next EO updates, along with the necessary updates to the technical guideline definitions suggested by the ADG in order to ensure consistency across EOs.

Excellent progress was made on ToR D, with the investigation and inclusion of multiple new products and sections into the EO, most notably, in relation to the social fisheries indicators, and ongoing developments on the use of model outputs to provide ecosystem indicators. There remains much to be explored, particularly in relation to aligning with other processes, and this is likely to be reflected in the ongoing work of the group.

3.5 ToR A and ToR D references

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4 ToR B) Compare and contrast among sub-ecoregion level ITAs to identify and report on commonalities and divergences among areas, with a focus on climate variability

4.1 2020–2022 ITA overview

Year 1 (2020): Marcos Llope presented a summary of the work developed over the years on the different subregions based on info from previous reports and presentations. The summary focused on available data: components covered (e.g. zooplankton not in all regions), type of aggregation or origin (functional groups, scientific surveys, stock assessment) and time-series length as well as methods expertise existing within the group and current level of understanding/assessment in each subregion.

- The group nominated Jed Kempf as main **coordinator** of the envisaged paper as well as one responsible person per subregion (see next) to ensure commitment. Jed will also be in charge of extracting modelled data (e.g. from copernicus).
- subregions **responsible persons**: West of Scotland (represented by Clive Fox) will be incorporated to the Irish Sea (Steven Beggs), Celtic Sea (Jed kempf), Bay of Biscay (Morgane Travers, Sigrid Lehuta), Cantabrian Sea (Izaskun Preciado, Eider Andonegi), western Iberian Coast (Fatima Borges, Corina Chaves) and Gulf of Cadiz (Marcos Llope, Marián Torres) subregions. The local differences, diversity of drivers and latitudinal extent of the area make the task of coming up with a clear message challenging.
- **Commonalities**. The group still needs to find a compromise on the variables to include in a global ITA representative of the two ecoregions. For instance, functional groups, despite being considered a solid option, are not at present developed for all subregions. This issue raised a good deal of discussion
- **Divergences**. The group needs to devise a suitable approach to present the more detailed (subregional) analyses in a comparable but not exhaustive way. Also, some subregions have manuscripts in preparation.

Year 2 (2021): WGEAWESS reviewed the datasets gathered so far for the various **subregions**, namely, West of Scotland (WS), Irish Sea (IS), Celtic Sea (ClS), Bay of Biscay (BoB), Cantabrian Sea (CnS), West of Iberia (WI), and Gulf of Cadiz (GoC). These included 6 environmental variables from copernicus, climate indices and CPR plankton data (except Bay of Biscay and Gulf of Cadiz where there is no CPR survey). For the Cantabrian Sea we identified the RADIALES time-series (https://www.seriestemporales-ieo.net/) as a source of plankton information, an official request was submitted to IEO and data received.

- **Environmental** (copernicus): chlorophyll (CHL), euphotic zone depth (EZD), mixed layer depth (MLD), net primary production (NPP), sea bottom (SBT) and surface temperature (SST).
- **Climate**: North Atlantic Oscillation (NAO and NAO winter) and Atlantic Multidecadal Oscillation (AMO).
- In some subregions **additional** environmental information, such as river discharges (Guadalquivir, Douro) was highlighted.

- CPR: small copepods, large copepods, *Calanus finmarchicus*, *Calanus helgolandicus*. Gelatinous zooplankton (Irish sea and Celtic Sea only). Cantabrian Sea: mesozooplankton and copepods.

In an intersessional meeting (held in May 2020) we agreed using **trophic guilds** (inspired by Mike Heath's approach) as a way of summarizing the existing information and facilitate comparability across subregions. Other categories, such as Nephrops and an open 'species of interests' category, in case this was deemed necessary were incorporated to the dataset template. These were:

- Trophic guilds: pelagic piscivores, planktivores, benthivores, bentho-pelagic, demersal piscivores, elasmobranchs, mixed diet fish. Cephalopods and Nephrops were also included since the former are known to respond quickly to environmental changes and the latter do occur in all subregions. When possible, main species were kept separately (for instance hake and cod in demersal piscivores) in case they needed to be analysed independently. Detailed information on the species making up the groups in each subregion was provided in metadata.

The ToR B subgroup evaluated various proxies for **fishing pressure** in an intersessional meeting (in February 2021) and found out that no one dataset was long enough and consistent to match the length of the biological data (STECF spatial resolution changed in 2016 to choropleth) or in the case of fishing mortality from stock assessment, since this is species dependent and the area of the stocks does not always overlap nicely the different subregions.

Year 3 (2022): After a short intro by Marcos Llope, Jed Kempf presented two analyses: RDA (redundancy analysis) & DFA (dynamic factor analysis) carried out for the Celtic Sea and the Gulf of Cadiz to the group.

4.2 Commonalities and divergences of functional group trends across sub-ecoregions – Jed Kempf, Marine Institute

Dynamic factor analysis (DFA) was applied to each sub ecoregion's functional group's time-series (e.g. planktivores, demersal piscivores) to identify commonalities and divergences between CPUE trends of the functional groups. We outline the key findings from the preliminary analysis.

Planktivores in the Bay of Biscay and West of Scotland followed a similar trend (i.e. declined then stabilized around 2008) whereas planktivores in the Celtic Sea followed the inverse of the common trend (i.e. increased then stabilized around 2008) (Figure 4.1).

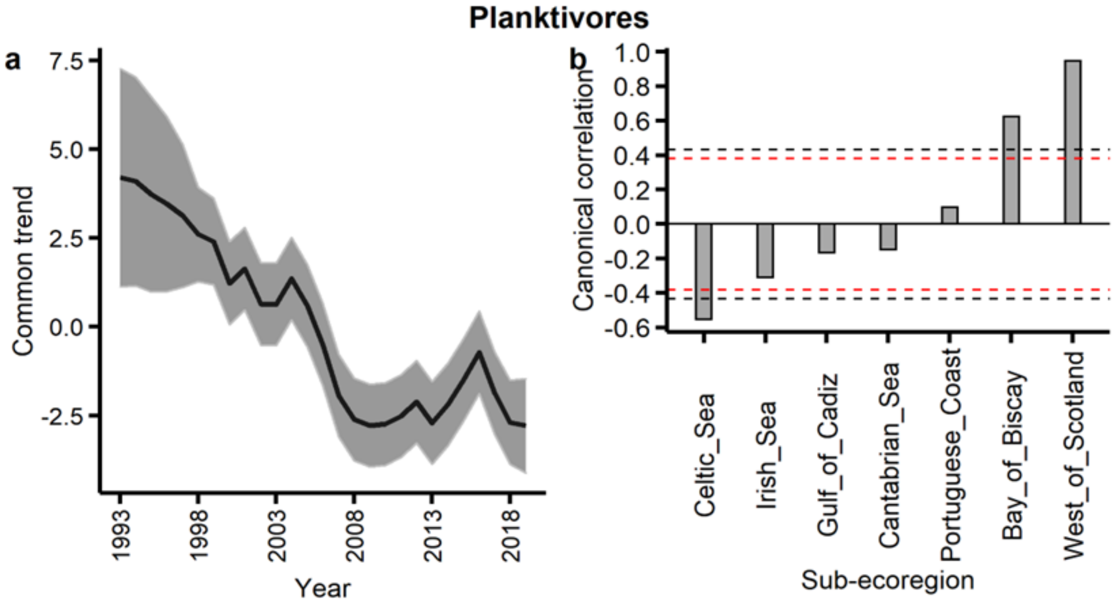

Figure 4.1. (a) Common trend estimated in the planktivore functional group. (b) Canonical correlation between each sub-ecoregion planktivore CPUE series and the common trend. Red line denotes significant correlations for Celtic Sea and West of Scotland sub-ecoregions. Blue line denotes statistical significance for all other sub-ecoregions.

The common trend estimated for the benthivore functional group was characterized by a period of stability between 1993 to 2010 then experienced a rapid change in CPUE from 2011 to 2018 (Figure 4.2a). Benthivores in the Irish Sea, Bay of Biscay, Cantabrian Sea, Gulf of Cadiz and Portuguese Coast shared a similar pattern (Figure 4.2a) and were positively correlated with the trend. In contrast, benthivores in the Celtic Sea were negatively correlated with common trend (Fig 4.2b). The West of Scotland correlation with the common trend was not statistically significant.

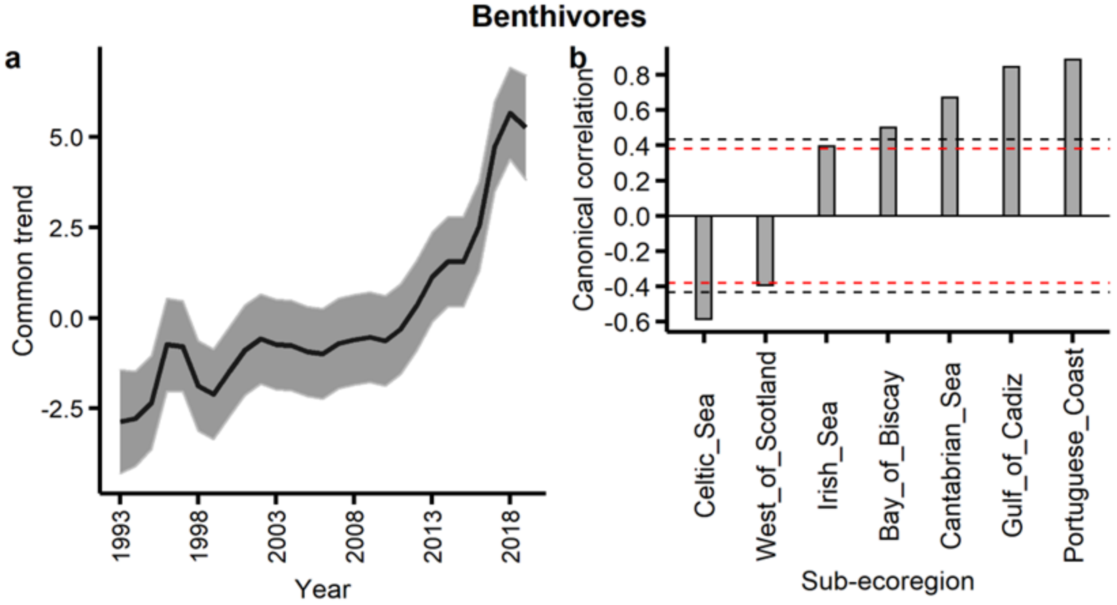

Figure 4.2. (a) Common trend estimated in the benthivore functional group. (b) Canonical correlation between each sub-ecoregion benthivore CPUE series and the common trend. Red line denotes significant correlations for Celtic Sea and West of Scotland sub-ecoregions. Blue line denotes statistical significance for all other sub-ecoregions.

Two common trends were estimated for the demersal piscivores (Figure 4.3a). Trend 1 was characterized by a decrease in CPUE which then stabilized in 2009. Trend 2 was stable until 2007 and then rapidly increased until 2017 (Figure 4.3a). Demersal piscivores in the Celtic Sea and Cantabrian Sea were negatively correlated with trend 1 and positively correlated with trend 2 (i.e. CPUE increased then stabilized). Demersal piscivores in the Bay of Biscay and Portuguese Coast were negatively correlated with trend 1. West of Scotland was positively correlated with trend 2. The main difference between trend 1 and trend 2 is the time at which a rapid change in the CPUE occurred (i.e. 1998 for trend 1 and 2007 for trend 2). The Irish Sea demersal piscivores trend diverged from all other sub ecoregions and was positively correlated with trend 1 (CPUE decreased then stabilized) (Figure 4.3b).

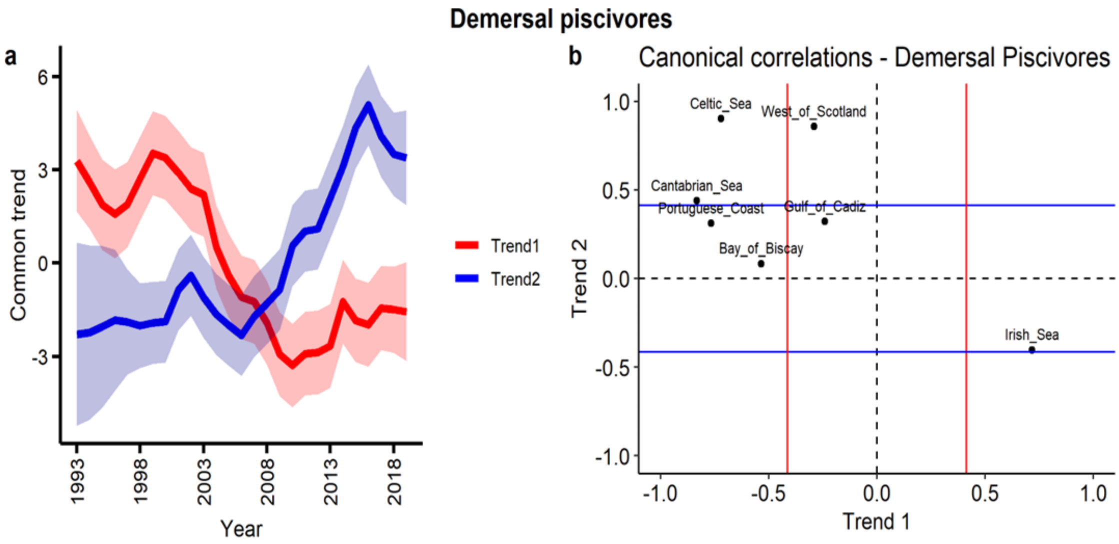

Figure 4.3. (a) Common trend estimated in the demersal piscivore functional group. (b) Canonical correlations between each sub-ecoregion demersal piscivore CPUE series and the common trends. Red line denotes thresholds for significant correlations with trend 1. Red line denotes significant correlations for Celtic Sea and West of Scotland sub-ecoregions. Blue line denotes statistical significance for all other sub-ecoregions.

The common trend estimated each sub-ecoregions hake CPUE series was characterized by a period of stability between 1993 to 2003, rapid change in CPUE from 2003 to 2008 and then a period of relative stability until 2019 (Figure 4.4a). Hake CPUE in the Celtic Sea, West of Scotland, Cantabrian Sea and Portuguese Coast were positively correlated with the common trend (Figure 4.4b). In contrast, hake in the Irish Sea was negatively correlated with the common trend. Gulf of Cadiz hake did not share any common pattern with the other sub ecoregions.

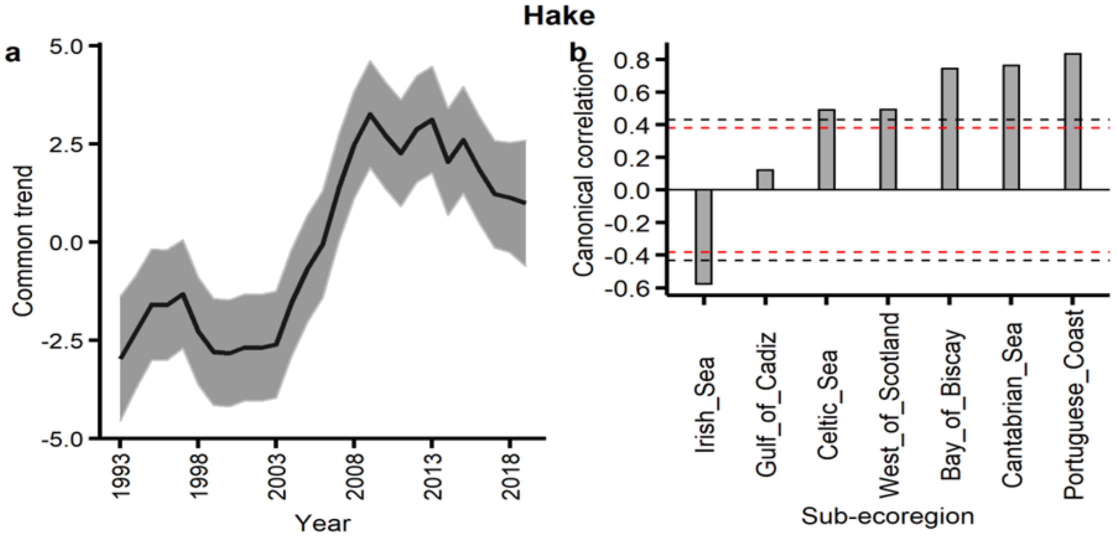

Figure 4.4. (a) Common trend estimated in the hake CPUE series. (b) Canonical correlations between each sub-ecoregions hake CPUE series and the common trend. Red line denotes significant correlations for trend 1 and the blue line denotes statistical significance for trend 2.

4.3 Integrated Trend Analysis of sub-ecoregions

Redundancy analysis was used to explore linear relationships between response (i.e. CPUE series) and explanatory variables (environmental data and fishing pressure) within the Irish Sea, Celtic Sea and Gulf of Cadiz sub ecoregions. Variables characterizing fishing were not yet available for West of Scotland, Bay of Biscay, Cantabrian Sea and the Portuguese Coast. The marginal effects of each explanatory variable was ranked according to the percentage of variance explained. The top four explanatory variables that explained the most variance in the CPUE series were then included as covariates in the dynamic factor analysis. All possible permutations of the covariates were analysed and the AIC of each model was compared to find the optimal model. Below are the key findings from the preliminary analysis.

4.3.1 Celtic Sea (1997–2019)

RDA identified mean exploitation rate, *Calanus finmarchicus*, exploitation rate of cod and net primary productivity as the most influential explanatory variables. All possible permutations of the covariates were included in the DFA. The optimal DFA model, as judged by AIC, had the mean exploitation rate, *Calanus finmarchicus*, and the exploitation rate of cod as covariates and one common trend. Regression coefficients of the DFA regression component showed that the CPUE (kg/km2) of cod, spurdog, hake, megrim, plaice and the skates and rays decreased when the mean fishing exploitation rate (F/Fmsy) increased. The CPUE series of cod, plaice, whiting and Trisopterus spp. increased when cod exploitation rate decreased whereas the CPUE of anglerfish, skates and rays and spurdog increased when cod exploitation rate increased. The CPUE of hake, plaice and whiting increased when the abundance of *Calanus finmarchicus* increased in the plankton. A common trend, characterized by a rapid increase from 1997 to 2008 followed by a period of relative stability, was found in the CPUE series of haddock, hake, megrim, plaice, sole, and lesser spotted dogfish. Using spearman's rank correlation, we found that the common trend had a negative monotonic association with the fishing pressure of anglerfish, northern hake and whiting. This suggests that the CPUE series of haddock, hake, megrim, plaice, sole, and lesser spotted dogfish decrease when the exploitation rate of anglerfish, northern hake and whiting stocks increase. Preliminary analysis suggests that fishing is the primary driver of CPUE in the Celtic Sea and the abundance of *Calanus finmarchicus* in the planktos may be important for hake, plaice and whiting recruitment.

4.3.2 Gulf of Cadiz (1993–2019)

RDA identified demersal trawling effort, Guadalquivir discharge, NAO index and purse-seiner effort as the most influential explanatory variables. All possible permutations of the covariates were included in the DFA. The optimal DFA model, as judged by AIC, contained the NAO index and the discharge of the Guadalquivir river as covariates and one common trend. The NAO index had a negative relationship with the CPUE of flatfish and the discharge of the Guadalquivir river had a positive effect on demersal fish CPUE. The common trend was positively correlated with blue whiting, gadoids and chimaeras, horse mackerels, monkfishes, nephrops, skates and sparids CPUE. Demersal trawling effort and the common trend had a negative monotonic association. This suggests that as demersal trawling effort decreased the CPUE of blue whiting, gadoids and chimaeras, horse mackerels, monkfishes, nephrops, skates and sparids increased. Demersal trawling effort appears to be the dominant driver of CPUE trends in the Gulf of Cadiz (see also Carvalho-Souza *et al.* 2021).

4.3.3 Irish Sea (1994–2019)

RDA identified herring mortality rate, mean mortality rate (sole and haddock), chlorophyll concentration and sea surface temperature as the most influential explanatory variables. Herring CPUE decreased with herring mortality. In contrast the CPUE of cod and plaice increased when herring mortality increased. The mean mortality rate of haddock and sole had a negative relationship with plaice and cod CPUE. Flatfish, cod and rays CPUE increased with chlorophyll concentration whereas the CPUE of ‘other demersal fish’ decreased with chlorophyll concentration. Rays, haddock and sole CPUE were positively correlated with the common trend. Mixed layer depth had a positive monotonic association with the common trend and the fishing mortality of whiting had a negative monotonic association with the common trend. Further work is required to establish whether it is mixed layer depth or whiting fishing mortality driving the CPUE of rays, haddock and sole. Preliminary analysis suggests that recovery of herring may have impaired the recruitment of cod and plaice in the Irish Sea.

The dataset has continued to be populated and is fairly complete. It now includes river discharges from the Douro (WI) and Guadalquivir (GoC) Rivers, and new plankton data (CnS). Some data gaps were, however, identified, like the upwelling index for WI but most importantly a proxy for fishing pressure was missing for some subregions.

In the interim between annual meetings, Harvest Rate (HR), was explored as an option, HR was calculated from landings (DCF, CFP) and biomass (IBTS surveys) for the various trophic guilds in the GoC. However, when carrying out the analyses this approach resulted in a large number of variables that was not appropriate for the analyses (more variables than years). Therefore, this option was discarded and not transferred to the other subregions. During the meeting we agreed to use effort in those subregions were almost only one country operates (e.g. GoC or CnS) and F (weighted by biomass) in those subregions were the stock distribution more or less coincides with the subregion (e.g. ClS or WS).

In terms of assigning writing tasks, it was agreed that each subregion responsible person (see above) will be responsible for interpreting and writing the corresponding results.

4.4 Presentation summaries relevant to ToR B

Throughout the 3-year term, a number of presentations were provided to inspire the ongoing and future work/development within the EOs. Summaries are provided below.

4.4.1 Integrated Trend Assessment using min-max autocorrelation factors analysis in the Bay of Biscay Ecosystem – Pierre Issac, M. Travers-Trolet, M. Doray, P. Laffargue, S. Lehuta (Ifremer; Issac, 2019)

Among several methodologies used to conduct ITA (WKINTRA, 2017), Principal Component Analysis (PCA) presents the advantage of reducing dimensionality of the variables and summarizing major trends. For instance, PCA was chosen to select the survey species abundances, catch time-series carrying the main trends, and rank them for the Irish Sea (WGEAWESS, 2018). PCA However, PCA has been criticized for being sensitive to temporal autocorrelation, which produces spurious correlations between unrelated time-series (Planque and Arneberg 2018).

In this paper, we propose to investigate the use of another method, MAFA (Shapiro and Switzer, 1989). This method explicitly accounts for autocorrelation, in the search for the most continuous time-series in a set of variables and project them on an orthogonal basis of time-series. Contrary to PCA, the most contributing variables are not those carrying major variance but those presenting the smoothest evolution (highest autocorrelation) excluding the most chaotic trends.

We also extend the range of variables considered compared to the previous ITA studies and to focus on the temporal trends in biotic components of pelagic and demersal fish species in relation to other components of the ecosystem considered as drivers. We assume that environmental forcing affects primary production and fish population dynamics through growth or recruitment processes. Human activities such as fishing affect species dynamics directly by selecting some individuals or indirectly by modifying habitat and increasing or reduced prey abundance. Data availability over long periods is often an issue; we investigate the change in perception provided when conducting the analysis over different period durations. To do so, we also rely on a different type of analysis. The objectives of this paper were: i) to characterize the main trends occurring in the different ecosystem components, and ii) identify and select which main indicators were contributing to these trends. We then iii) confronted these selected indicators across the different ecosystem components with forcing components in order to investigate the drivers of the Bay of Biscay ecosystem. We discuss how identifying trends may inform the ecosystem status and dynamics, in the context of the implementation of marine ecosystem management. We also discuss the effect of the size of the period in the analysis of the results.

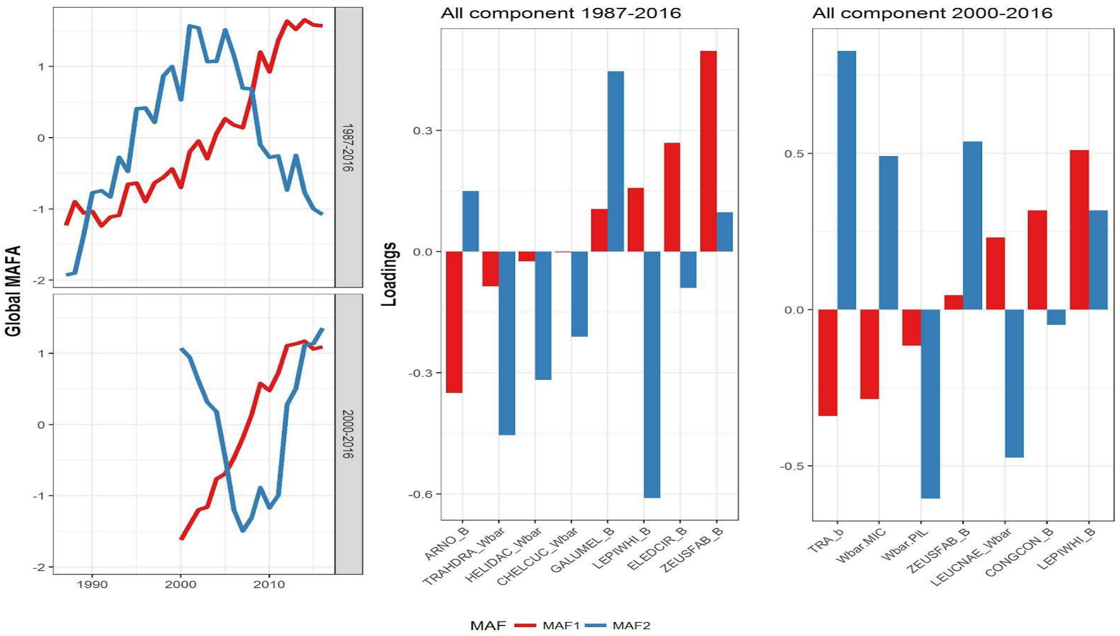

Figure 4.5. Loadings on MAF1 and 2 for the most continuous variables selected with continuity index and values of MAF1 and 2 for global MAFA on the periods 2000–2016 and 1987–2016.

MAFs analysis for both periods revealed several trends in the ecosystem (Figure 4.5).

Increasing trend in the biomass of benthic and demersal component matching a decrease in fishing forcing. Regarding the benthic-demersal component, it seems that different groups of species experienced a strong increase in their biomass. These species belonged to different trophic guilds and family were cephalopods (horned octopus and common cuttlefish), flatfishes (megrim, flounder), small sharks (dogfish, catfish), benthic fish (Greater weaver and red gurnard) and demersal fish (John Dory). These increasing trends were matched in the fishing forcing component for several of these species (common cuttlefish, catfish, and dogfish).

High variability and no clear trend appeared for environmental forcing and physical state variables. Except for a slow increasing trend in mean sea surface temperature no strong signal seems to emerge from environmental forcing and the physical state components for both periods. At this level, variability remained high for these variables throughout the time-series. For some variables, it seemed that this variability slightly increased with time.

Instability and preoccupying trends displayed by MAF analysis in the pelagic components: Global MAFA seems to indicate that predominant trends occurring in the ecosystem in the years 2000–2016 concerned the pelagic component. These trends highlighted the decrease in the mean weight of sardine and horse mackerel together with the collapse and recovery of anchovy. This signal is more apparent than the increasing trend in biomass occurring in the benthic-demersal and suggests that the pelagic component reacted more to perturbation than the benthic and demersal component.

Importance of the length of the time-series to detect change in the ecosystem: Some signals were not detected in the short time-series like the increasing trend of sardine landings are the increase of several benthic and demersal species. This difference in the results emphasized the importance of choosing the longest time-series available to clearly see patterns appeared in the ecosystem.

Lack of information on key ecosystem components: The absence of reliable long time-series of information concerning key ecosystem components such as zooplankton and other human induced forcing gave a partial view of the changes occurring in the ecosystem.

4.4.2 How EwE models can inform ITA, an example of Western Iberian coast – Dorota Szalaj (University of Lisbon, Portugal)

Presented work demonstrated how outputs of Ecopath with Ecosim modelling suite can inform Integrated Trend Analysis. The presented methodology is based on the studies performed by Tomczak *et al.* (2013) and Heymans and Tomczak (2016), which analysed changes and occurrence of regime shifts in the Baltic Sea and Northern Benguela, respectively. The main idea of the presented application was to use outputs of a calibrated EwE model as inputs in the Integrated trend analysis. The application was shown on the example of the Western Iberian coast (Portuguese side). We used outputs (modelled catch, biomass, and ecosystem indices) of Ecopath with Ecosim temporal model parameterized for Portuguese continental shelf ecosystem (PCSE) between 1986 and 2017. We found out that PCSE has changed such that the pelagics were reorganized between the main commercial stock sardine and less commercially viable chub mackerel, bogue, horse mackerel, mackerel, and anchovy (Figure 4.6). Moreover, predatory fish (higher trophic level fish/ demersal piscivores fish) become more abundant in the ecosystem and more important in the national catch share (Figure 4.6).

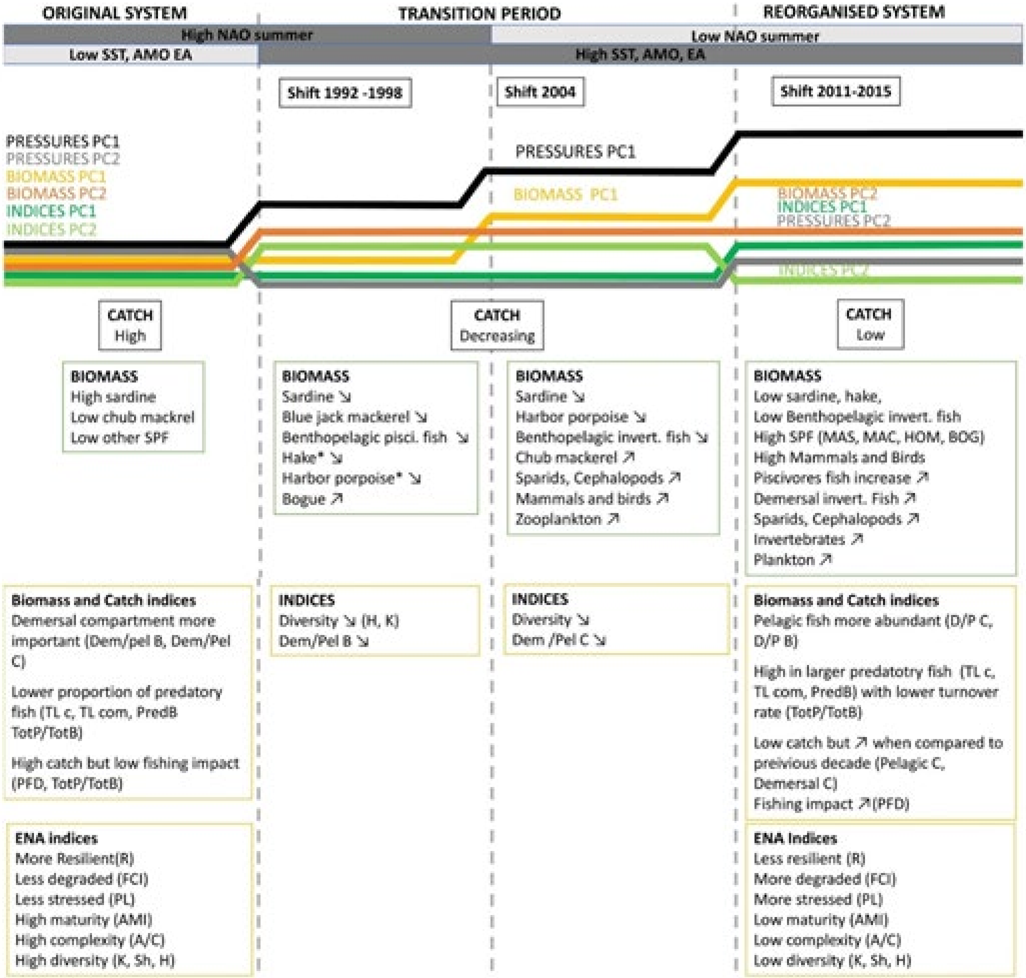

Figure 4.6. Conceptual diagram displaying the changes in the Portuguese Continental shelf ecosystem between 1986 and 2017.

Analysis of ecosystem indices demonstrates that although changes in PCSE were characterized by changes in species abundance as well as community composition there is no evidence of permanent trophic reorganization.

The presented example showed that the use of EwE outputs in the Integrated Trend Analysis can be beneficial in the circumstances when observational data lacks and model estimates can be used as an alternative. Moreover, it can enrich the output of the ITA by extra information that can be obtained by the inclusion of Ecological indicators (calculated from EwE) into an analysis.

4.4.3 Integrated Trend Analysis for the Celtic Sea – Jed Kempf (MI, UCC).

Integrated Trend Analysis (ITA) uses time-series data to summarize changes in ecosystems and highlight possible connections between physical, biological and human ecosystem components. ITA methods serve as a tool to inform Integrated Ecosystem Assessments. Mérillet *et al.* (2020) recently published an ITA that assessed the effect of fishing and environmental pressures on demersal community structure in the Celtic Sea from 2000 to 2016. Chlorophyll *a*, bottom temperature and depth consistently had strong structuring effects on demersal assemblages throughout the entire time-series. Whereas, bottom and pelagic trawl effort had relatively little impact, particularly in the last decade. The authors conclude that biotic communities were controlled more by environmental variables than fisheries in the Celtic Sea. The issue with using short time-series (< 30 years) is that spurious relationships arise between variables that are associated but not causally related due to either coincidence or confounding factors. As an example, 8 random-walk time-series were randomly generated which yielded 17 'significant' correlations from 36 possible pairwise correlations. This correlation or covariance matrix is often the input for popular dimension reducing techniques like PCA. PCA analysis of this data yielded time trajectories similar to what is seen in literature despite having no causal relationship between each time-series. This exercise emphasizes the importance of *a priori* selection of variables which are theoretically defensible, have practical utility and represent the dynamics of the ecosystem. It is also important to consider autocorrelation structures, lagged effects and non-linear relationships in the data and to use statistical methods that can account for these attributes.

4.5 ToR B references

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5 ToR C) Investigate and report on the subregional spatio-temporal entities constituting the Bay of Biscay/Iberian Waters and Celtic Seas ecoregion, and the multiple pressures relevant at these scales in support of ecosystem-based management.

This ToR is aimed at investigating scaling issues related to summarizing information from locally relevant scales/models to ecoregion reporting.

5.1 Presentation summaries relevant to ToR C

5.1.1 Demersal and pelagic fish's trends across contrasted habitats in the Bay of Biscay – Morgane Travers-Trolet, Sigrid Lehuta & Luca Marsaglia

While integrated trend analysis (ITA) are being implemented in several ecoregions or subregions, the objectives of this study are to assess 1) if the overall fish trends identified from ITA at the subregion level remain valid at smaller scales, and 2) if consideration of finer spatial scales provide additional understanding of ecosystem functioning compared to global analysis.

We focus this analysis on the Bay of Biscay subregion (ICES area 8ab), and we define the spatial scale to be considered by gathering and combining spatial zones identified by previous studies. This resulted in the identification of three contrasted habitats: a coastal habitat influenced by rivers, the great mud banks characterized by a muddy substrate and high spring stratification, and the outer shelf located on the continental slope. Species richness and beta diversity shows that the coastal habitats have more specific fish species than the two others, and that the diversity between great mud banks and outer shelf is a mix of species turnover and nestedness. Analysis of fish species trend over the available time-series shows that in the coastal habitat, demersal species biomass has mainly decreased, while in the two other habitats, demersal species biomass has increased (Fig 5.1). The opposite pattern is observed for pelagic species, i.e. increase of biomass in the coastal habitat, but decrease of biomass on the two other habitats. When assessing trends of mean weight, both demersal and pelagic fish species show a decreasing trend in their mean weight, regardless of the habitat. An analysis performed on the subset of species present in the three habitats show that about a third of species displays similar trends across the three habitats, and another third displays opposite trends in the coast compared to the more offshore habitats. Mean weight trends display less variation in space since about 60% of species (present in the three habitats) have common mean weight trends across habitats.

Such results illustrate that regional patterns observed at the Bay of Biscay scale hide the coastal biomass dynamics that are opposite to the dynamics observed offshore, maybe due to different anthropogenic or environmental pressures near the coast. Conversely, decrease of mean weight is homogeneous over the region, which could be linked to large-scale pressure, such as climate change.

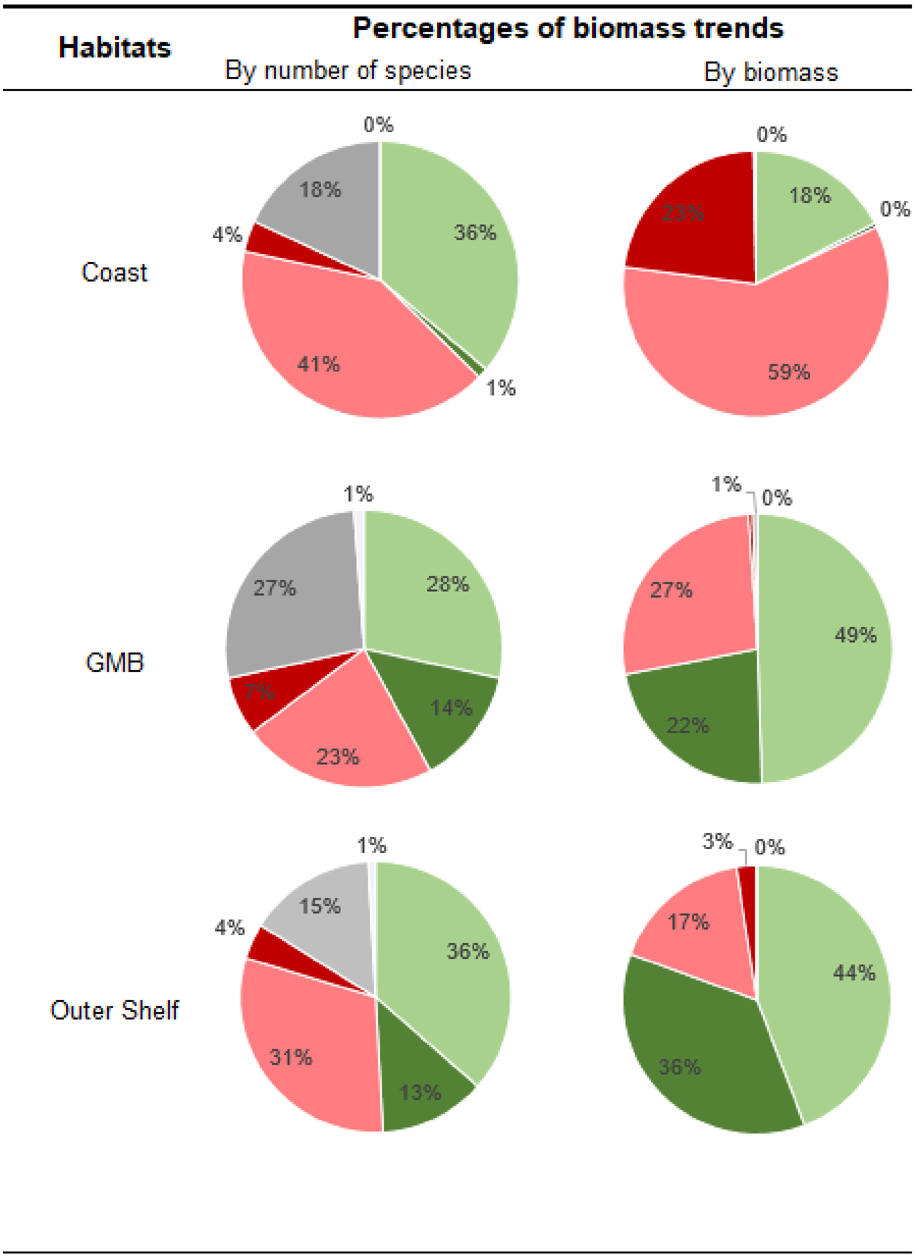

Figure 5.1: Main trends in the evolution of demersal fish in three habitats of the Bay of Biscay: the coast, the great mud bank (GMB) and the outer shelf. The figure depicts the percentage of species (left) and corresponding biomass (right) with trends either decreasing (red; dark red if p-value<0.05) or increasing (green, dark green if p-value<0.05). The percentage in grey is species for which no trend could be computed. In the coastal habitat, the majority of species, also accounting for the most biomass, show decreasing trends while the opposite pattern is seen in the two most offshore habitats.

6 ToR E) High resolution Ecospace models for selected case studies within WGEAWESS ecoregions to identify opportunities to support marine spatial planning

WGEAWESS decided to explore the possibilities of models such as Ecopath with Ecosim (EwE) and Ecospace to inform ecosystem based marine management, particularly in relation to MSP.

6.1 Presentation summaries relevant to ToR E

6.1.1 High resolution Ecospace for selected case studies within WGEAWESS ecoregions to identify opportunities to support marine spatial planning – Natalia Serpetti

As Scotland is aiming to triple salmon farming production by 2050, it is expected that aquaculture farms will be established further offshore in more remote areas exposed to increasingly severe weather conditions. To potentially shelter the farm, here we proposed the co-location of marine renewable energy devices (MREDs) with the aquaculture site creating Multi-Purpose Platforms (MPPs). MPPs can comprise wind turbines as well as wave energy converters that will provide energy for farm operations. Disentangling the impacts, conflicts and synergies of MPP elements on the surrounding marine ecosystem is challenging.

The Ecopath with Ecosim and Ecospace (EwE) modelling suite has been considered one of the most suitable tools for evaluating the direct and indirect effects of anthropogenic pressures on spatial scale ecosystem dynamics. Here we created a high-resolution spatio-temporal Ecospace model of the West of Scotland in order to assess impacts of MPP on the surrounding ecosystem and how these impacts can cascade through the foodweb.

The model evaluated the following specific ecosystem responses: i) top-down control pathways due to distribution changes among top predators (seals, harbour porpoise, gadoids and seabirds) driven by attraction to the farming sites and/or repulsion/killing due to operational wind turbine; ii) bottom-up control pathways due to aquaculture activity providing increasing of benthic eutrophication predicated by a farm footprint model, NewDepomod, and nutrient loading by recycled production.

The model showed evident responses to anthropogenic pressures, highlighting the necessity of using species-specific responses to define attraction and repulsion to/from the farm sites. Results also showed high sensitivity to changes of bottom-up drivers such as sediment and water eutrophication that cascaded through the foodweb from primary producers and detritus to pelagic and benthic consumers respectively. We assessed the sensitivity of the model to each of these impacts and the cumulative effects on the ecosystem, discussing the capabilities and limitations of the Ecospace modelling approach as a potential tool for marine spatial planning.

6.1.2 Impacts of shipping noise on harbour porpoises on the west coast of Scotland – Bethany Harvey, Denise Risch, Natalia Serpetti

Anthropogenic noise in the oceans is increasing with human activities and is a major component of global ocean soundscapes. Sound is vital for marine animals, particularly cetaceans, which are highly vocal and use sound for communication, navigation and prey detection. Noise impacts are notoriously difficult to assess as responses may vary between species and individuals as well as within individuals, depending on factors such as current behavioural state or prior noise exposure.

The west coast of Scotland is an important area for cetaceans, with 11 species seen regularly. Harbour porpoises are the most abundant cetacean, and are listed under Annex II of the Habitats Directive leading to the development of the Inner Hebrides and the Minches candidate SAC for their protection.

One of the main noise sources on the west coast of Scotland is commercial and recreational vessel activity. Higher-frequency cetaceans such as porpoises react negatively to high-frequency components of shipping noise which could be an overlooked problem for small cetaceans, particularly where high levels of shipping traffic and high population densities of cetaceans coincide.

In this study, monthly co-occurrence maps were created overlaying spatial distributions of harbour porpoises with shipping noise allowing to identify hot-spot of spatial co-occurrence. We then used Ecopath with Ecosim and Ecospace and Ecospace (EwE) modelling approach to assess the impact of shipping noise in these hot-spots creating a species-specific response function that reduce their consumption rate. Results showed that, based on the shipping intensity recorded in the West coast of Scotland, it is unlikely that this pressure will have a significant impact on this species distributions.

6.1.3 Ecosystem-based fishing mortality reference point (F_{eco}) – Jacob Bentley, Natural England

Although frequently suggested as a goal for ecosystem-based fisheries management, incorporating ecosystem information into fisheries stock assessments has proven challenging. The uncertainty of input data, coupled with the structural uncertainty of complex multispecies models, currently makes the use of absolute values from such models contentious for short-term single-species fisheries management advice.

Here, we developed a new approach to enhance standard stock assessment methodologies using ecosystem information in the pursuit of an Ecosystem-based Approach to Fisheries Management (EAFM). Using a case study of the Irish Sea, we illustrated how stock-specific ecosystem indicators can be used to set an ecosystem-based fishing mortality reference point (FECO) within the “Pretty Good Yield” ranges for fishing mortality which form the present precautionary approach adopted in Europe by ICES. We showed how this new target, FECO, can be used to scale fishing mortality down when the ecosystem conditions for the stock are poor and vice versa.

This approach provided a streamlined quantitative way of incorporating ecosystem information into catch advice and provided an opportunity to operationalize ecosystem models and empirical indicators, while retaining the integrity of current assessment models and the FMSY-based advice process. This pragmatic approach to EAFM can increase the adaptive capacity of management by encouraging more precautionary stock harvest during poor productivity phases while preventing overly cautious yields during high productivity phases. We are now working with researchers in the Baltic Sea and Bay of Biscay to apply the approach to other ICES areas.

6.1.4 Modelling small scale impacts of Multi-Purpose Platforms in the West of Scotland ecosystem – Natalia Serpetti, Steven Benjamins, Stevie Brain, Maurizio Collu, Bethany J. Harvey, Johanna J. Heymans, Adam D. Hughes, Denise Risch, Sophia Rosinski, James J. Waggitt, Ben Wilson

As we move further offshore to meet the growing demand for marine renewable energy and aquaculture production, there is a growing need for structures that can combine and co-locate the production of these resources - so-called multi-purpose platforms (MPPs). However, understanding their immediate impacts on surrounding marine ecosystems is crucial before big-scale construction of such structures takes off globally.

Sustainable food production will require a constant expansion of the aquaculture industry: competition for space in nearshore coastal-zones can, however, limit expansion. Instead, farms could be established further offshore where higher-energy conditions also offer an opportunity to generate power locally using marine renewable energy (MRE) devices. How to optimize these two aspects? In this paper (Serpetti *et al.*, 2021), we propose the solution of co-locating aquaculture systems and MRE devices, such as offshore wind turbines (OWTs) - providing energy for farm operations as well as potential shelter and we assessed single and cumulative impacts of the elements representing a hypothetical MPP off the west coast of Scotland. Disentangling the impacts, conflicts and synergies of MPP elements on the surrounding marine ecosystem is challenging.

The Ecopath with Ecosim and Ecospace (EwE) modelling approach used in the study evaluated specific ecosystem responses to top-down control pathways, changes in top predator distribution (e.g. harbour porpoise, gadoids, and seabirds) as well as bottom-up control pathways (e.g. increased benthic enrichment, predicated by a farm footprint model, and consequent elevation of water nutrient levels, by recycled production).

The results showed weak responses of the foodweb for top-down changes (e.g. attraction for food by top predators to the MPP site vs. displacement of marine mammals and seabirds due to turbine noise), without significant increases or decreases in top predators' major prey species. Predator top-down controls were weakly cascading through the foodweb as their impacts were distributed across multiple preys, reflecting the complexity of their trophic interactions.

While top-down control pathways were only mildly affected, the results showed high sensitivity to increasing changes of bottom-up drivers that cascaded through the foodweb from detritus and primary producers to benthic and pelagic consumers, respectively. Bottom-up pathways have high energy transfer efficiency, where the energy mainly flows to a few predator groups, and can strongly affect foodweb structure and biodiversity. The primary productivity pathway also showed an amplification of the signal through the foodweb, with a large increase of relative biomass of small zooplankton; however, this amplification did not cascade to higher trophic levels (e.g. large zooplankton and herring).

This ecosystem-based modelling approach allowed the team to investigate the cumulative effects of the different MPP elements. In the cumulative impact scenario, the increasing productivity of the ecosystem, driven by bottom-up pathways, overruled the negative effects caused by the noise pressure and by predator attraction for most of the species impacted. Only harbour porpoises and seabirds did not show cumulative mitigating impacts.

The limited availability of validation material for this study, and uncertainties around the assumptions made regarding noise pressure responses and species habitat preferences were the main limitations of the study. In the future, a sensitivity test should be carried out to assess the model performance.

Assessing the long-term environmental impacts in terms of eutrophication and noise is a priority for both the EU Water Framework Directive and the Marine Strategy Framework Directive. In the study, the cumulative impact scenario showed that the increasing productivity driven by the presence of farming can mitigate or even overrule negative effects caused by noise pressure and predator attraction. Assessing cumulative impacts will be important in the future for the Maritime Spatial Planning under the Integrated Maritime Policy. This work will also help in advancing some of the main goals of WGEAWESS, such as moving towards implementing IEAs as a tool for marine management and updating and improving the Ecosystem Overviews. Aquaculture and marine renewable energy are two expanding sectors of the Blue Economy in Europe: moving toward renewables as a greener and more sustainable option in the face of climate change and due to the necessity of aquaculture production, we propose the use of MPPs to maximize the benefits of these expansions and minimize their impacts.

6.1.5 Ecosystem dynamics in the Bay of Biscay: moving towards a holistic framework to inform Integrated Ecosystem Assessments - Corrales X., Preciado I., Gascuel D., Lopez de Gamiz A., Hernvann, P-Y., Mugerza E., Chust, G., Ramirez, E., Louzao M., Velasco, F., Doray, M., Carrera, P., Cotano, U., Andonegi, E.

During the last decades, the Bay of Biscay (BoB) ecosystem has undergone significant ecological changes caused primarily by intense fishing activity and reinforced by ocean warming. An important challenge for ensuring the sustainable exploitation and conservation of marine ecosystems is to advance our understanding of how multiple human activities, environmental factors and organisms interact and influence each other and to disentangle the effect of different stressors. Within the EPELECO project (Evaluating the pelagic system from an ecosystem base perspective considering trophic interactions) the Ecopath with Ecosim (EwE) approach was used to assess cumulative impacts on the BoB ecosystem and to build a decision support tool for management.

The model included the continental shelf and upper slope of the BoB, comprising previous smaller areas already modelled with EwE (the Cantabrian Sea and the French continental shelf), and considering the connectivity between the areas and fish stocks targeted by fleets corresponding to different countries. The static model Ecopath represents the BoB ecosystem for the 2000–2003, encompassing 120 433 km^2 between 0 and 1000 m depth. The baseline foodweb model was composed of 52 functional groups, ranging from primary producers to top predator species, including specific groups for those species assessed through stock assessment, and considering both Spanish and French fishing fleets.

The foodweb model was then used to explore the historical dynamics of the ecosystem between 2003 and 2019 considering the effects of fishing activities, ocean warming and changes in primary productivity (PP) as the main drivers of the ecosystem and to evaluate their historical cumulative effects. Specifically, time-series of fishing effort, fishing mortalities for those species with available stock assessment, sea surface temperature (SST), sea bottom temperature (SBT) and PP were used to drive the model while time-series of biomass and catches were used to calibrate and validate the model. The temperature response functions of species, which represents temperature preference of the species and, therefore, links species dynamics to temperature time-series, were estimated by using data from the Northeast Atlantic and SC-GAMs (Shape Constrained Generalized Additive Models).

The historical model predictions satisfactorily matched most of the observed data, especially for fisheries target species. Results highlighted the important role that fishing activities are playing in the ecosystem and the noticeable impacts of ocean warming. These results illustrated the importance of including stressors other than fisheries, such as ocean warming, in an ecosystem-based management approach.

During this year it is planned to have a working Ecospace model. The model will consider both static (depth and seabeds (habitats)) and dynamic (PP, SST, SBT and sea surface salinity) environmental variables for specific species/functional groups.

6.1.6 Southern North Sea Ecospace (lessons in Ecospace) – Püts, M., Taylor, M., Núñez-Riboni, I., Steenbeek, J., Stäbler, M., Möllmann, C., Kempf, A.

The increasing demand for spatial usage in all marine ecoregions calls for impact evaluation of spatial management decisions on local ecosystems. Constructing spatially explicit ecosystem models, such as Ecospace, enables the assessment of different scenarios to support management considerations. In the recent decades, Ecospace has been developed further, becoming more flexible by enabling the time-dynamic inclusion of spatial data with the new spatio-temporal data framework (Steenbeek *et al.*, 2013). Furthermore, species habitat preferences can be incorporated in multiple ways. With the new habitat foraging capacity model, species can be impacted by multiple environmental drivers (Christensen *et al.*, 2014). Furthermore, maps derived from species distribution models (SDMs) can be incorporated directly as a prior to inform Ecospace about the foraging capacity. This bridges the gap between single species modelling and ecosystem modelling.

One highly exploited ecoregion with high demands for spatial usage is the Greater North Sea ecoregion. In order to address spatial management questions, the Thünen Institute of Sea Fisheries has developed an Ecospace model for the southern part of the North Sea, representing ICES areas 4b and 4c (Püts *et al.*, 2020). It encompasses 68 functional groups, including 7 multi-stanza groups and 12 fishing fleets and currently simulates the years 1991–2010 (Stäbler *et al.*, 2016).

We applied this model to test the new spatio-temporal framework to dynamically drive the foraging capacity by implementing habitat preferences derived from SDMs (see Püts *et al.*, 2020). There is no common definition on how to define such habitat preferences when they are included in process-oriented trophic models. Therefore, we used generalized additive models to create maps describing habitat preferences: 1) by presence/absence of a species in a certain area and 2) the abundance of a species. Furthermore, we evaluated the impact of different time-scales when updating these habitat preferences during the model execution via the spatio-temporal framework. Model fit was evaluated with a skill assessment routine outside Ecospace, analysing the results for the temporal, spatial and spatio-temporal fit.

Our results revealed that the overall fit of the model increases when accounting for changes in habitat preferences over time instead of assigning static habitat preferences. However, between the different time periods (seasonal, annual or multiyear changes) the differences were not significant. It depends on the targeted research question which frequency is the most appropriate. In regards to habitat preferences, our results showed that the broader definition by presence/absence of a species outperforms the more restricted distribution depicted by abundance data when combining both model types. Even if SDMs depicting abundances show more precisely the hotspots of a species distribution, the narrow definition of habitat preferences leads to match-mismatches between predator and prey distributions when including these in the trophic model. In turn, the model is not able to properly reproduce observed temporal biomass and catch dynamics.

6.1.7 Ecospace in Bay of Seine to investigate spillover from wind farms – Ghassen Halouani

Ghassen Halouani presented an application of the Ecospace model of Bay of Seine to investigate potential spillover effects of a fishery closure in future offshore wind farm of Courseulles-sur-Mer. This work showed that commercial and demersal species could have a significant biomass increase inside and surrounding the offshore wind farm. The Ecospace model predicted an increase of catches (up to 7% near the wind farm) and a slight increase in the proportion of high trophic level. However, the spillover effect remains localized and does not affect the entire Bay of Seine. Furthermore, the Ecospace model was used to test the sensitivity of a set of indicators to the spatial resolution. Several models were created by progressively reducing the spatial resolution of the original model. The preliminary results showed that the Ecospace model of Bay of Seine underestimates catches when the spatial resolution is reduced. The underestimation of catches is accentuated at local scale and low spatial resolutions. At very low resolutions (reduction by a factor of 6), the results of catch indicators seem to be less correlated to the original resolution.

6.1.8 Other presentations – Mikaëla Pottier, Maciej Tomczak, Chiara Piroddi

Celtic Sea Ecopath with Ecosim, Mikaëla Pottier: The Celtic Sea EwE was presented. The model includes temporal and spatial components and has been identified as a potentially important resource for WGEAWESS moving forward. The model is currently being updated better define fishing fleets.

Baltic Sea foodweb model, Maciej Tomczak: There are a number of EwE models being used for the Baltic (whole region and subregions). For EwE models to be used for policy advice it is essential that they are taken to WGSAM for a key run assessment. WGIAB are moving in a similar direction to WGEAWESS: both groups are keen to identify operational routes for ecosystem models to inform indicator assessment and catch options.

Foodweb models to support EU policies, Chiara Piroddi: EwE and other ecosystem models can be tailored to focus on policy issues related to nutrients, contaminant, litter, fisheries, MPAs, and climate change. We can best answer policy questions by seeking to develop coupled modelling systems that benefit from the strengths of multiple tools (e.g. biogeochemical models coupled with foodweb models). The EU network of ecosystem modelling experts (MEME) provide a framework for tackling pan-European policy questions. A similar approach would be beneficial for WGEAWESS.

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Annex 1: List of participants

Table A1.1. List of participants for the three meetings held in 2020, 2021 and 2022, where "1" indicates that the person attended the meeting.

Name	Institute	Country	E-mail	2020	2021	2022
Andrea Farnas	IMBRSea	Spain	andrea.farinas@imbrsea.eu	1	1	
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Ching Villanueva	Ifremer	France	Ching.Villanueva@ifremer.fr	1	1	1
Clive Fox	SAMS	Scotland	Clive Fox <Clive.Fox@sams.ac.uk>	1	1	1
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Annex 2: Resolutions

WGEAWESS - Working Group on Ecosystem Assessment of Western European Shelf Seas

2019/FT/IEASG01 The **Working Group on Ecosystem Assessment of Western European Shelf Seas (WGEAWESS)** chaired by Marcos Llope, Spain, Jacob Bentley*, UK, and Sigrid Lehuta*, France, will work on ToRs and generate deliverables as listed in the Table below.

Year	Meeting dates	Venue	Reporting details	Comments (change in Chair, etc.)
Year 2020	29 June – 3 July	Meeting online	E-evaluation	
Year 2021	11 February 5 – 9 July	Meeting online	E-evaluation	Outgoing chair: Debbi Pedreschi
Year 2022	2–5 May	Meeting online	Final ICES Scientific Report by to IEASG	Incoming Chairs: Jacob Bentley, UK, and Sigrid Lehuta, France

ToR descriptors

ToR	Description	Background	Science Plan codes	Duration	Expected Deliverables
a	Review and update the Bay of Biscay/Iberian Coast (BoB-IC) and Celtic Seas (CS) ecoregion Ecosystem Overviews (EO).	Linked to ICES advice and WKEO3.	6.1, 6.5, 6.6	Ongoing	Ecosystem overviews (EO).
b	Compare and contrast among sub-ecoregion level ITAs to identify and report on commonalities and divergences among areas, with a focus on climate variability.	Responding to requests for standardisation of ecosystem advice products and inclusion of climate change information in Ecosystem Overviews. Linked to WKINTRA, WGS2D, WGOOFE and the commitment to provide advice in the context of EAFM.	1.4, 1.9, 6.5	3 years	Inform IEAs/E O. Results in the final report or/and as a collaborative paper.
c	Investigate and report on the sub-regional spatio-temporal entities constituting the Bay of Biscay/Iberian Waters and Celtic Seas ecoregion, and the multiple pressures relevant at these scales	Linked to WKEWIEA, WKIRISH, ToR B and previous group ToRs. Investigation of scaling issues related to summarising information from locally relevant scales/models.	1.3, 2.4, 6.5	3 years	Inform IEAs/EO. Results in the final report or/and as a collaborative paper.

	in support of ecosystem-based management.				
d	Explore and describe the potential for incorporating additional products (e.g. MSFD indicators, model outputs, social indicators) from ICES EGs and other processes (e.g., OSPAR, EEA, STECF) into the Ecosystem Overviews	Strongly linked to ToR A, WGCERP, WGSOCIAL, WKEO3 and MSFD. Maximising efficiency across relevant groups for EO development, eliminating redundancy.	4.1, 6.5, 6.6	3 years	**Ecosystem overviews. Collaborative network with improved workflow.**
e	High resolution Ecospace models for selected case studies within WGEAWESS ecoregions to identify opportunities to support marine spatial planning.	Working together with ToR C to explicitly incorporate spatial aspects into regional modelling work, investigating opportunities for trade-off analyses and inclusion of socio-economic considerations	6.1., 6.3., 6.6	3 years	**Regional modelling prodcuts**

Summary of the Work Plan

Year 1	The main tasks will be related to drafting the outline for the papers/process for ToRs B&C, and identifying which group members can apply the agreed upon methodology (within their limited resources). Start the process for reviewing the BoB-IC Ecosystem Overviews. The group will continue to identify data and outputs that may be potentially valuable to IEAs, EAFM, and particularly the Ecosystem overviews (Tors A, D & E). The group will work to improve communication with other relevant groups (e.g. WGS2D, WGOOFE, WGSOCIAL, WGCOMEDA, WGIAB, WGMARS, WGBIE, WGIPEM).
Year 2	Continue with Year 1 activities while liaising with relevant ICES WG and external groups (e.g. OSPAR) as relevant. Progress agreed upon methodologies for ToRs B&C, write papers. Advance ToR E, developing regional models (scope of model development/ number of case studies will be dependent funding).
Year 3	Continue with Year 2 activities while liaising with relevant ICES WG membership. Finalise papers.

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. Recently questions have arisen in relation to how to identify relevant scales for various processes, and how to summarise ecoregion level information from disparate, non-continuous data (e.g. surveys using different gears, different modelling approaches, and different socio-economic contexts). Furthermore, standardisation of approaches has become a key topic, particularly as ecosystem assessment moves more towards the realms of advice. This presents particular challenges in the face of such diversity. The EAWESS working group will focus on North Atlantic European continental shelf. Regional area of interest includes the Celtic Seas (Celtic Sea, Irish Sea, West of Scotland), Bay of Biscay (French continental shelf, Cantabrian Sea) and Western Iberia (Iberian Upwelling, Gulf of Cadiz), involving five countries (Ireland, UK, France, Spain and Portugal).
Resource requirements	There is no resource implication for ICES. Working group program is based on synthesis of data and results from existing data sources and in line with existing funding/ scientific programs. Scope of activities is dependent on this funding. Assistance from the ICES Secretariat and IEA Steering group Chair will be useful in identifying and making connections with relevant groups.
Participants	The Group is normally attended by some 8 members plus guests.
Secretariat facilities	None.
Financial	No financial implications.
Linkages to ACOM and groups under ACOM	Direct link to IEA steering group, ICES advice.
Linkages to other committees or groups	There is a very close working relationship with all the groups of IEASG. It is also very relevant to the Working Group on WGECO, WGCERP, WGSAM, WKIrish, along with stock assessment groups such as WGHANSA, WGBIE, WGCSE, WGMIXFISH. Collaborations for the new ToRs have been instigated with WGSOCIAL, WGS2D, WGCOMEDA and WGMARS. The work and membership of this group is also critical to workshops such as WKEWIEA and WKINTRA which are co-chaired by group members, and feedback to the work of WGEAWESS.
Linkages to other organizations	DC- MAP- DG MARE, MSFD DG ENV, OSPAR.