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Interim Report of the Benthos Ecology Working Group (BEWG)

4–8 May 2015

Calvi, Corsica, France



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Executive summary

The Benthos Ecology Working Group (BEWG) was hosted by STARESO and held its 2015 meeting at the Station de Recherches Sous-marines et Océanographiques at Calvi in Corsica, France. The meeting was attended by 30 participants, representing 8 countries and the ICES Secretariat.

The meeting was structured along the four BEWG core business issues: Benthic long-term series and climate change, benthic indicators, species distribution modelling, disentangling the link between biodiversity and ecosystem functioning and a new ToR to review benthic biodiversity and conservation in relation to MPA's.

The group continues to provide insights on the field of benthic ecology, with main emphasis on:

- Long-term series and climate change considering the methodological aspects of time-series;
- Ensuring that the Benthic Long-term series Network (BELT-Net) engages with existing initiatives (e.g. EMODnet);
- Further developments of species distribution modelling and mapping;
- Enhanced understanding on the linkages between ecosystem biodiversity and functioning;
- Developments in effective monitoring programmes (including design, harmonisation and quality assessments);
- Understanding benthic biodiversity and conservation: the role of MPA's;
- Providing expert advice and support to the OSPAR COBAM's request in relation to indicator work on benthic habitats.

1 Administrative details

Working Group name
The Benthos Ecology Working Group
Year of Appointment:
2015
Reporting year within current cycle (1, 2 or 3):
1
Chair(s)
Silvana Birchenough, UK
Meeting venue
Calvi, Corsica, France
Meeting dates
4–8 May 2015

2 Terms of Reference a) – z)

- A. Long-term benthic series and climate change
- B. Species distribution modelling and mapping
- C. Benthos and legislative drivers
- D. Benthic biodiversity and ecosystem functioning
- E. Benthic Biodiversity and conservation: to review the role of benthic ecology in MPA's
- F. **2015/4 Support for the development of common and candidate OSPAR biodiversity indicators for benthic habitats: Benthic habitats**
ICES is requested to support on-going OSPAR indicators work on benthic habitats, in support of the requirements under the MSFD¹.
 - a) Using mobile bottom contacting gear data, produce fishing abrasion pressure maps² (2009-2014) using the BH3 approach as a follow-up of the OSPAR request to ICES (Request 5/2014). Fishing abrasion pressure maps should be ana-

¹ Any analysis relating to main threats and development of abrasion maps should not be applied to the Portuguese continental shelf

² There should be consultation with OSPAR in the drafting of the data call that will be required to deliver of this request. This should build on the experience and lessons learned from the 2014 VMS/Log book data call.

lysed by gear distribution, and type, in the OSPAR maritime area and be based on the methodology propose on the physical damage indicator (BH3). Specifically ICES is requested to:

- i) collate relevant national VMS and logbook data;
 - ii) estimate the proportions of total fisheries represented by the data;
 - iii) using methods developed in Request 5/2014, where possible, collect other non-VMS data to cover other types of fisheries (e.g. fishing boats < 12m length);
 - iv) prepare maps for the OSPAR maritime area (including ABNJ) on the spatial and temporal intensity of fishing using mobile bottom contacting gears (BH3 approach);
- b) Evaluate the applicability of a reduced list of habitats in support the development of Typical Species indicator (BH1)³. This work should consider those habitats that have previously been identified by the COBAM Benthic experts group. Evaluation should consider data availability, and suggest possible prioritisation of habitats already included in the OSPAR list of threatened and declining habitats.
- c) Evaluate monitoring and assessment requirements for multimetric indicator (BH2)² and/or typical species (BH1)², by providing:
- i) overview of existing monitoring programmes with associated benthic sampling stations (e.g. WFD, MPA, Natura2000, impact assessment studies, etc.), taking into account the work done under the JMP project/art 11 reporting.
- G. Produce four short paragraphs for the ICES Ecosystem Overviews on the benthic habitat (geology, dynamics and diversity), one paragraph for each of the following ICES ecoregions: Greater North Sea, Celtic Seas, Bay of Biscay & the Iberian coast and Baltic Sea.
- H. Produce four short paragraphs for the ICES Ecosystem Overviews on the benthic community, one paragraph for each of the following ICES ecoregions: Greater North Sea, Celtic Seas, Bay of Biscay & the Iberian coast and Baltic Sea.

³ In the implementation of this request ICES should ensure that there is a dialogue established between the relevant Working Group chairs and coordinators of the relevant OSPAR subsidiary bodies, including the ICG-COBAM Expert group for Benthic Habitats and ICG-Cumulative Effects. This is to ensure consistent interpretation of the request to meet the needs of OSPAR and avoid duplication in supporting the development and testing of OSPAR common indicators. Where data has been analysed as part of the work to deliver this request, the advice should be delivered in a form that will enable its use in subsequent analyses (including spatial analysis).

3 Summary of Work plan

YEAR 1	ToRS A.1-3, B.1, C.1-2, D.1-2, E.1-3
Year 2	ToRs a.1-3, b.1-2, c.1-3, d.1, E.1-3, F, G, H
Year 3	ToRs a.1-2, b.2, c.2-3, d.1, E.1-3, F

4 List of Outcomes and Achievements of the WG in this delivery period

BEWG discussed and decided on several outputs that will lead to advice, peer review publications, methodological developments and data sets.

- Under the current ToRs, several working themes were identified as potential case studies to explore further. Some examples will take account of current knowledge, exploring methodological aspects and using several data sets to develop case studies.
- Significant progress was made on some of these initiatives, fleshing out the main topics to be further elaborated for peer-review publications.
- Some of the initiatives will need further data gathering exercises, particularly for some of the case studies where data analysis will be needed to detect trends and cause-effects relationships.
- Further discussion in relation to the variability in expert assessments of benthic species tolerances/ sensitivities used for different assessments. General view on how to execute assessments varies between groups and therefore, further consensus is needed to agree on a common set of rules when undertaking such work.
- The BEWG also discussed way of assessing and identifying robust methodologies / approaches that could meet the new requirements outlined in the D1 and D6 criteria for ecosystem functioning. Members of the BEWG chaired and co-chaired the recent D6 workshop undertaken in February, 2015 at ICES HQ. There is a clear need to ensure that the work developed under the BEWG fits into this advisory process to avoid duplication of efforts.
- BEWG also contributed with information on current monitoring and indicator development to support the ongoing work undertaken by OSPAR ICG-COBAM.

There are also eight ongoing initiatives developed and discussed during the meeting:

- Case study: "Potential methodological issues in long-term comparability".
- Case study: "Towards a benthic ecosystem functioning map: interregional comparison of two approaches".
- Case study: "Variability in expert assessment of benthic species tolerances/sensitivities".
- Case study: "Proposal for a joint /co-ordinated monitoring: outcomes of the benthic work under the Joint Monitoring Programme".

- Case study: “Changes in functional composition along sediment gradients”.
- Case study: “To identify the links between benthic functions and ecosystems services”.
- Case study: “Meeting benthic functional indicator needs of the MSFD”.
- Case study: “A benthic ecology perspective for evaluating the effectiveness of MPA’s”.

5 Progress report on ToRs and workplan

The Chair, S. Birchenough, opened the meeting at STARESO in Corsica. S. Birchenough welcomed the participants and introduced the four main themes the BEWG continuously has worked on over the last years: Benthic long-term series and climate change, benthic indicators, species distribution modelling and the link between biodiversity and ecosystem functioning, the role of MPA’s and newly added ToR from ICES/OSPAR. The agenda structure of the meeting follows these main themes. The local host, A. Donnay welcomed the participants on behalf of STARESO and Dr Pierre Lejeune, director of the Station, presented the history of STARESO and the work done at his Institute.

An ICES SharePoint was made available before and during the meeting. This has as before proved to be a valuable tool to speed up the work and make exchange of information more efficient. Further, practicalities for the meeting and reporting were introduced to all participants. H. Hillewaert was appointed as lead editorial rapporteur. Afterwards, the participants introduced themselves and gave a brief review of their scientific activities. 30 participants from 8 countries (Belgium, France, Germany, Italy, Norway, Poland, United Kingdom and the United States) as well as the ICES HQ attended the meeting, three participants contributed remotely (from Belgium, Germany and Spain).

6 Long-term series and climate change

6.1 Progress towards an understanding change in the benthos, e.g. regime shifts, seasonality, fine spatial scale variability.

Coordination: S. Birchenough

Introductory presentations

6.1.1 Will climate change affect our ability to attain GES for marine biodiversity?

Silvana Birchenough up-dated on a recent paper published with a group of colleagues on this topic.

The EU Marine Strategy Framework Directive (MSFD) requires that Good Environmental Status (GENS), is achieved for European seas by 2020. These may deviate from GENS, its

11 Descriptors, targets and baselines, due to endogenic managed pressures (from activities within an area) and externally due to exogenic unmanaged pressures (e.g. climate change). This work is based on conceptual models detailing the likely or perceived changes expected on marine biodiversity and GEnS Descriptors in the light of climate change. We emphasise that marine management has to accommodate ‘shifting baselines’ caused by climate change particularly during GEnS monitoring, assessment and management and ‘unbounded boundaries’ given the migration and dispersal of highly-mobile species. This paper suggests that climate change may prevent GEnS being met, but Member States may rebut legal challenges by claiming that this is outside its control, force majeure or due to ‘natural causes’ (Article 14 of the MSFD). The analysis is relevant to management of other global seas.

Reference: *Force majeure: Will climate change affect our ability to attain Good Environmental Status for marine biodiversity?* (2015) Michael Elliott, Angel Borja, Abigail McQuatters-Gollop, Krysia Mazik, Silvana Birchenough, Jesper H. Andersen, Suzanne Painting, Myron Peck. *Marine Pollution Bulletin*, DOI: 10.1016/j.marpolbul.2015.03.015

6.1.2 Unexpected relative stability of sub-littoral macrobenthos in response to climate change in a biogeographical transition zone after a forty years period

Nicolas Desroy, François Gaudin, Nadia Ameziane, Caroline Broudin, Antoine Carlier, Stanislas Du-bois, Jérôme Fournier, Aurélie Foveau, Franck Gentil, Jacques Grall, Céline Houbin, Lise Latry, Patrick Le Mao & Eric Thiébaud

In the North-East Atlantic, the English Channel constitutes a biogeographical transition zone between the cold-temperate Boreal province in the North and the warm-temperate Lusitanian province in the South. Historical works have shown that the distribution of macrobenthic invertebrates in the Channel was influenced by thermal gradients from West to East so that many species were here in their southern or northern range limits. In parallel, long-term environmental monitoring highlighted an increase in the sea temperature during the last 30 years and a thermal regime shift in the North-West Europe since the 1980s. Accordingly, major changes on the distribution of subtidal macrobenthic fauna are expected as documented for fish, plankton and intertidal organisms. Our results based on a comparison of data collected for mollusks, echinoderms and decapods during a cool period in the 1970s and the present (2012–2014) at 444 and 254 stations distributed along three transects from the Iroise Sea to the central Channel did not confirm this expectation. On the contrary, they suggest a few number of distribution shifts, not clearly associated to warming but a decrease in the occurrence for most species. These results will be discussed in the light of spatial heterogeneity in climate change and fishing pressure.

6.1.3 Understanding Ocean acidification: What will be the future for commercial species?

Silvana Birchenough, John, K. Pinnegar, Matthew B. Sanders and Jeo Lee

Evidence indicates that absorption of atmospheric carbon dioxide (CO₂) in the ocean has already decreased pH levels by 0.1 pH units since 1750, and CO₂ concentrations are projected to rise further by the end of the century as fossil fuel reserves continue to be exploited. To date, the majority of ocean acidification (OA) research undertaken has tended

to concentrate on benthic or planktonic species which are of limited direct importance to fisheries and aquaculture. Furthermore, some of the available evidence is contradictory with some studies demonstrating that species are robust to lower pH whilst others show marked sensitivity. There is still much research needed to understand some of the observed organisms' responses to changes in pH under laboratory and under their natural environment. In the UK, fisheries generate more than £800 million of revenue per year and support 30 000 jobs. Aquaculture generates £350 million and supports a further 4200 jobs. It is important to document the effects of ocean acidification on species of commercial importance. This presentation concentrates mainly on experimental work conducted on lobsters and scallops, providing further understanding on the effects of ocean acidification in connection to co-stressors, such as temperature and/or food availability. This work considers the main changes in the growth, development and shell composition of different species. The outcomes of this research are paramount to understand the future climate change scenarios, which could have important economic and environmental consequences in commercially important shellfish. This information is deemed important for policy makers, scientists and conservation colleagues working on ocean acidification research.

6.2 Facilitate collaboration by further development and promotion of the BEWG Benthic Long-Term Series network (BELTSnet)

Coordination: H. Hillewaert

6.2.1 Current state of BELTSnet and identification of further actions

In general there is support for the BELTSnet concept to be continued in some form, particularly facilitating connections between people who would like to develop projects that would use Long-Term benthic series. However due to the development of EMODnet that covers many of the aspects of BELTSnet it was felt that the BELTSnet web-site may not be the best way forward. Also there was the question of the cost of keeping the web-site running. BEWG can maintain some links to BELTSnet via BEWG ICES web page (contact T. Minkkinen).

There are, however, some issues with EMODnet: Limited geographic scope; it is primarily concerned with metadata compilation and data standardisation not connecting people; the black box issue of data that has already been manipulated and the limited potential for BEWG to influence the direction or content. Several ways were discussed for how to proceed: A representative from BEWG to attend the EMODnet open conference in Ostend in October; BEWG chair to invite an EMODnet representative to BEWG 2016; Send a letter of enquiry to EMODnet steering committee to explore links with BEWG/ BELTSnet.

The ICES data centre would also be a key interested party in this process, key contacts being N. Holsworth (Head) and J. Jensen (benthic ecologist).

Creating a discussion group on LinkedIn was proposed as an alternative to the forum of the former BELTSnet website.

To work towards the identification of methodological issues in long-term series comparability

First issues have to be listed with which are encountered when using long-term benthic macrofauna series:

- Mostly relate either to *internal* (i.e. within each series) or *external* (i.e. across different series), with some potentially affecting both internal and external comparability at the same time.
- Arise from *differences* or *changes* along or between long-term series.

It is emphasized that such differences do not *necessarily* constitute an actual problem for proper analysis of these data and that this ultimately depends on the actual scientific questions being addressed. However, it is also stressed that most issues related to *Taxonomic expertise* and *Taxonomic revisions* will always need to be handled with care, particularly when the taxonomic analysis has been consistently done through time with the same taxonomic expertise (e.g. same person conducting the ID) and this could altered due to the changes in expertise.

For some of the listed issues information will likely not be available for all data series.

Current objectives.

- 1) Populate this *list of potential issues*, both broad categories and specific issues can be added at this time. Everything should be included at this time, with the view to avoid any major aspects in the overview document.
- 2) Gather literature and recent reports on some of the points raised in this list (e.g. sampling gear and other aspects).
- 3) Establish which issues should (can) be *dealt with* and which should be *lived with* in the face of different types of questions.

Contributors of this new initiative: S. Birchenough, L. Buhl-Mortensen, J. Craeymeersch, S. Degraer, O. Gauthier, H. Hillewaert, C. Labrunne, H. Reiss.

Potential methodological issues in long-term series comparability

1. Sampling – Gear (and/or method)

- a. Type
 - i. Selectivity
 - ii. Quantitative/Qualitative
- b. Surface area
- c. Penetration (soft sediment)
- d. Fixation after of before sieving?
- e. Sorting
 - i. On board/In the lab
 - ii. Subsampling of samples
 - iii. Sieve: mesh size
 - iv. Sieve: mesh shape [do we need to go there?]
 - v. Staining etc. [do we need to go there?]

2. Sampling – Effort

- a. Number of (pseudo-) replicated samples
- b. Total surface area
- c. Total volume
- d. Total number of individuals
- 3. Sampling – Temporal issues**
- a. Seasonality
- b. Periodicity of observations (Lambda)
- c. Synchrony of observations (external)
- d. Temporal gaps in the series
- e. Series lengths
 - vi. Absolute length (days, months, year),
 - vii. Number of actual observations (n observation 'dates')
 - viii. Overlap of series
- 4. Sampling – Spatial issues**
- a. Spatial-coverage (dispersion of replicates and stations)
- b. Habitat-coverage
- c. Fixed and/or random stations
- 5. Sampling – environmental data**
- a. Same sampling or surrogate?
- b. Observed or modelled?
- c. Atypical weather events during sampling
- 6. Taxonomy – Biomass or Abundance?**
- a. Individual (head, other piece)?
- b. Abundances
- 7. Taxonomy – Identification (taxonomic expertise)**
- a. Collection availability
- b. Level of identification
 - ix. *Genus sp.* and *Genus spp.*
 - x. > species and genus level
- c. Expertise (change in time, variation in teams...)
- d. Change in available resources
- e. Known identification problems
- 8. Taxonomy – Taxonomic revisions**
- a. Lumping/Splitting
- b. Higher classification changes
- c. Revisions affecting whole distribution range or part thereof
- 9. (...) Other aspects to consider?**

Future perspective: What if (when) a shift is made to meta-barcoding for long-term observation series? How can historical data be expected to be incorporated in this new picture? Is a break in the series inevitable?

7 Species distribution modelling and mapping

7.1 Performance and exploration of the applicability of different qualitative and quantitative species distribution modelling methods, e.g. methods validity, limitations, purposes, knowledge gaps

Coordination: H. Reiss & M. Gogina

Introductory presentations

7.1.1 Modelling climate change effects on benthos: Distributional shifts in the North Sea from 2001 to 2099

Michael Weinert, Moritz Mathis, Ingrid Kröncke, Hermann Neumann, Thomas Pohlmann, Henning Reiss

In the marine realm, climate change can affect a variety of physico-chemical properties with wide-ranging biological effects, but the knowledge how climate change affects benthic distribution is limited and mainly restricted to coastal environments. To project the response of benthic species of a shelf sea (North Sea) to the expected climate change, the distribution of 66 marine species were modelled and the spatial changes in distribution were projected for 2099 based on modelled bottom temperature and salinity changes using IPCC climate scenario A1B. Mean bottom temperature was projected to increase between 0.15–5.4°C, while mean bottom salinity was projected to moderately increase up to 1.7 in some regions. The spatial changes in species distribution were modelled with Maxent and the direction and extent of these changes were assessed. The preliminary results showed a latitudinal northward shift for 71% of the species and a southward shift for 29%. The relatively low rates of distributional shifts compared to fish or plankton species, were probably influenced by the regional topography of the North Sea, hampering further shifts to the north. For 33 species this resulted in a habitat loss of up to 100% until 2099, while only 22 species could benefit from the warming due to habitat gain. Particularly the benthic communities of the southern North Sea, where the strongest temperature increase was projected, will be strongly affected by the distributional changes, since key species showed northward shifts and high rates of habitat loss, with potential ramifications for the functioning of the ecosystem.

7.1.2 Oyster (*Crassostrea virginica*) ecology and population genetics in the Gulf of Mexico: The 2010 BP Oil Spill.

C. Edward Proffitt, Donna J. Devlin, L. Coen, D. Kimbro, S. Geiger, and H. Nance

In response to the BP Deepwater Horizon oil spill in 2010 oyster abundance, survival, and recruitment and associated oyster reef species occurrence at four regions of Florida's Gulf of Mexico (GOM) coast were assessed. Further, oysters were collected from sites around the GOM from south Florida to south Texas, for population genetic work. The genetic study also included comparisons of pre-spill and one year post-spill genetic diversity. No substantial amounts of oil affected our oyster sites in Florida, and thus our ecology results are essentially establishing a broad (500 km of coastline) baseline for future comparisons. Densities of oysters were variable within region but were not signifi-

cantly different among regions. Abundances of juvenile (<10 mm shell length) oysters did differ significantly with lower numbers in the southern region. Microsatellite marker analyses indicated that: 1) Florida GOM populations are different in genetic structure than the rest of the GOM populations and 2) there were no differences in genetic diversity between pre and post spill samples, even in those locations where either oil or oil + freshwater diversions caused very high (>80–90 %) mortalities.

Developments in the Benthic Ecosystem Functioning paper

Former title: **Towards the quantitative benthic species distribution modeling for ecosystem functioning: linking bioturbation potential with nitrate cycling**

Suggested revised title: **Towards a benthic ecosystem functioning map: interregional comparison of two approaches**

M. Gogina coordinated

The group has revisited the initiative launched last year. Its feasibility and an add-on value from the group were addressed in order to avoid redundancy with the parallel case studies investigating bioturbation potential (BP) being carried out recently in each of the originally considered areas: Belgian North Sea, German North Sea, German Baltic Sea. It was agreed that the initiative has an obvious potential to bring an add-on value by doing joint methodological study on the three regional datasets contributed by BEWG participants. Two approaches will be applied separately for each area: i) benthic macrofauna community bioturbation potential (BPc) will be initially calculated per station and treated as response variable for species distribution modelling technique (RandomForest) with relevant available environmental layers used as predictors ii) a number (around 10 or those responsible for up to 70–80 % of total BPc, decision will be made based on a BPi loads histogram per area) key species selected as the most contributing to BPc in each area will be used as response variables and their contributions will later be summed up and scaled up to the BPc. Therefore in contrast to other studies the initiative will not only compare the spatial differences of ecosystem functioning expressed in terms of bioturbation potential at community and species levels in three geographic regions with different environmental settings, but will also address the relative importance of key engineering species within spatial distribution modelling framework aiming for the estimates of functional aspects for the whole community.

The absence of conflict of interests was declared for the case study in relation to publication in preparation by J. M. Holstein, PhD work of A. Wrede (AWI, supervised by J. Dannheim), or Case study 2 covering the distribution of BPc in Belgian North Sea (done by G. Van Hoey and briefly presented by S. Birchenough).

Regional dataset will be taken as they are without limiting them to cover the same spatial extent, at the later stages of analysis filtering by specific ranges of environmental gradients will be applied. Variability in methods of sampling and biomass estimation consistent between areas. The highest possible available resolution of predictor layers is of interest (e.g. 250 × 250 m).

For the Belgian North Sea Biological data was delivered by J. Vanaverbeke & Gert Van Hoey. S. Degraer kindly agreed to deliver predictor layers for Belgian Area (GEOCELL

colleagues will be contacted for the list of all available environmental values: both measured and modelled layers are of interest).

For the German North Sea J. Dannheim will fill the existing dataset with missing new data, J. M. Holstein is asked to deliver environmental data layers, A. Wrede will complete the reworking and mobility table where scores are missing.

Timeline

Until 16 May – Email reminder and data template (M. Gogina to email interested colleagues: S. Birchenough, S. Degraer and colleagues at AWI). Additionally, get in contact with N. Desroy for available Channel dataset and consider including the fourth area. 30 June – Data and predictor layers delivery deadline. End of 2015 – Complete the analysis (M. Gogina) and circulate results to receive feedback (all). Early next year: circulate first draft.

8 Benthos and legislative drivers

8.1 To report on the use of benthic indicators and targets for management: Compatibility and complementarity

Coordination: G. Van Hoey

Introductory presentations

8.1.1 Intercalibration of the benthic indicators for the Water Framework Directive

Presented by G. Van Hoey

For the coastal waters in the North East Atlantic region (NEA), every Member State (MS) has defined its own benthic assessment approach (indicator, reference and boundary conditions). This led to 10 approaches that need to be intercalibrated to show their comparability. After a long history (>10 years), all method information (indicator algorithm, reference and boundary settings) is collected and put in one technical report. The comparability of the methods needs to be tested on a common dataset with benthic data of all MS. This was already accomplished in 2007–2008. Besides it, the methods have to show a similar response to a pressure gradient. This latest was tested based on the Garroch Head sewage sludge disposal ground data set of the UK (Marine Scotland), where all methods show the same trend against a copper pollution. The obstacle for the NEA coastal water intercalibration was the lack of a straightforward approach for benchmarking, due to the lack of pressure data for each station. To do this objectively, a series of tested response variables (diversity parameters) will be used to characterize samples under the same conditions. This approach was not accepted by JRC, therefore, expert judgment was employed to characterize the less disturbed sites within the common dataset. A comparison between those two benchmark approaches shows that the majority of the samples were classified as benchmark samples in both approaches. Nevertheless, based on the expert judgment, some samples with low diversity and EQR values were catalogued as benchmark sites. The condition settings for the comparison, as sub-types, type of benchmark-

ing, standardization method, has its consequences on the criteria outcome and on the level of boundary adaptations eventually needed. This study showed that the intercalibration is a technical issue and that science is far away from it. Although, the good news is that all NEA region benthic indicators were comparable and inter-calibrated.

8.1.2 MSFD Descriptor 6 (seafloor integrity) outcomes of ICES's review process

Presented by S. Valanko (ICES Secretariat)

ICES has been involved in the review of the Commission Decision (2010/477/EU). ICES organised two workshops on the review of MSFD Descriptor 6 (seafloor integrity). This led to the provision of ICES advice on 20 March 2015. Further workshops have been proposed for the short, medium, and long-term to better adapt the revised criteria under D6, "damage to sea floor" and "structural and functional condition of benthic community". In particular ICES has proposed that work present work with RSCs to operationalize a set of regional benthic indicators with methodological standards be a priority by 2016. By 2017 agreement both at a regional and cross-regional level should be achieved on GES boundaries and assessment methods. ICES also recommend that a project is tasked, together with RSCs, to create a common lists of habitats to be assessed (MSFD, WFD, Habitats), as well as how different assessment scales and aggregation methods can be achieved. Furthermore, we have limited understanding on the relationship between different types of pressures acting on the seafloor and what is understood when looking at seafloor resilience. Additionally, there are still gaps in relation to what the temporal and spatial scales will have to be considered when assessing recovery. This work should also be considered a priority and could be carried out in a specific project, which could synthesise best practices and state of the art by 2017.

8.1.3 Progress update on the development of a new Biotic Index in the Benthos-VAL Project

A. Conde Lago presented

A. Conde, C. Labruno, A. Grémare, J. Grall and O. Gauthier

There is an overall goal and agreement among European Union member states to achieve a 'Good Ecological Status' for water bodies in accordance to the Water Framework and the Marine Strategy Framework Directives. As such, ecologists have been using different biotic indices for the assessment of benthic habitat quality during the last two decades. The currently available biological indices for the marine realm are mostly based on lists that provide scores for species reflecting their degree of sensitiveness or tolerance in relation to organic enrichment gradients. A new biotic index, independent from any predetermined lists, and based on the concept of multidimensional deviation from a set of reference sites is proposed. This index is based on a measure of resemblance that captures the divergent distribution of species along anthropogenic stress gradients. Its performance is evaluated with datasets related to various pressures types, such as fish farming, sand extraction, sewage discharge, tailing disposal and hypoxia. The values of the new index properly reflect the pressure gradients. The results obtained with the new index are also compared with those acquired with the more commonly used biotic indices such as AMBI, M-AMBI and BQI.

8.1.4 CSG MSFD brings benthic work into focus within ICES, together with partners

Presented by S. Valanko (ICES Secretariat)

ICES's CSG MSFD (Council Steering Group on the Marine Strategy Framework Directive) aims to focus their work on supporting, at the strategic level, specific actions areas. One of these areas that CSG MSFD is looking to support how to use the ICES platform to galvanize benthic work happening at national, regional and cross-regional level for use in the MSFD. Such a focus theme could span 2015/2016 and look at methodical standards for assessing the effect of human pressures on benthic habitats within and between MSFD regions, as well as their use in ICES Integrated Ecosystem Assessments (IEAs). Together with partners ICES is in a position coordinate ongoing activities to develop cross-regional methodological standards acceptable to all parties (i.e. indicator selection, setting GES boundaries, monitoring requirements, data flow, and assessments standards). To achieve this, the following process is proposed: i) a workshop with partners (autumn 2015), ii) based on the workshop produce a draft advice product/manual (spring 2016), and iii) workshop (autumn 2016) to address feedback and finalise the advice/manual. Some of the following themes could be addressed: 1) support cross-regional indicator development, in particular linking damage and functional characteristics of seafloor 'integrity' to (a) multi-metric index indicator, (b) key species population structure, and (c) cumulative impact indicator. 2) Facilitate cross-regional development of assessment standards using indicators (a-c), both with respect ecosystems in a healthy state (maintaining resilience) and ecosystems that are perturbed (ensuring recovery). 3) Explore links to ICES integrated ecosystem assessments by relating changes in benthic community function using indicators (a-c) to changes in selected fish stocks (demersal/pelagic) by ecoregion. 4) Provide guiding principles to help ensure alignment between setting GES boundaries for seafloor integrity to avoid giving conflicting results between regions, methods, and indicator species. 5) Propose a focused and cost-efficient cross-regional monitoring strategy and data flow that could facilitate regional assessments using identified indicators (a-c) and methodological standards.

8.1.5 Sediment Profile Imagery for Seabed integrity assessments (SPI-smart)

By S. Birchenough

This is an ongoing Defra funded research. The main aims of this work are to assist and optimise the cost and efficiency of benthic monitoring in relation to seabed integrity (D6). This presentation showed the two phases: i) the first phase will look at the existing SPI information in relation to other data sets and pressure layers to delineate the current pressures and areas where there is a high risk associated with co-location of activities and/or persistent activities that could affect the integrity of benthic systems; and ii) development of an SPI metric and data filling exercise for validation and testing.

The overall project is looking at:

- a) To collate existing SPI available information collected from R&D, monitoring and industry across a series of pressures and areas.

- b) To examine the available SPI images alongside available sediment (mainly soft sediments) and different pressure/activities areas (e.g. VMS data, dredging intensity, disposal quantities etc.) to determine benthic state and change.
- c) To develop a SPI metric to support seabed integrity assessments across different areas.
- d) To validate and test the SPI metric across different areas covering different characteristics and pressures.
- e) To optimize the cost and efficiency of seafloor systems surveys and to provide recommendations for MSFD monitoring to achieve GES.

8.1.6 Soft bottom macrofauna monitoring under anthropogenic influences in Calvi bay, Corsica. Methodological simplifications

By A. Donnay

This work is within the framework of STARE-CAPMED long-term research program of STARESO dedicated to STATION of Reference and rEsearch on Change of local and global Anthropogenic Pressures on Mediterranean Ecosystem Drifts. The aims of this program are: (1) improve the understanding of anthropogenic influences on the functioning of the Calvi bay coastal ecosystems and (2) differentiate local from global anthropogenic influences.

Fourteen stations are sampled one to two times per year, along gradients from anthropogenic sources of influence (river mouth, fish farm, anchoring areas and sewage) mere 2 stations out of influences.

The analysis of soft-bottom macrofauna is time consuming and some methodological simplifications are looking for. In the case of *Posidonia oceanica* fibres presence, an adapted staining-distaining method is proposed and allows a time saving in the sorting of soft-bottom macrofauna. In the analysis process, working with habitat types and taxonomic sufficiency are proposed: finding habitat types existing at high precision scale along Corsican coasts is important to adapt reference conditions (bad and high) with the natural characteristics of macrobenthic assemblages. These reference conditions are used to M-AMBI calculation. An adaptation of the M-AMBI for the weak human impacted geographic zone, the Corsica, is envisaged by a weighting with the Piélou index. As a first time, all is done at the species level. In a second time, the steps are done at genus and family levels. By comparison of results obtained between different identification levels, the taxonomic sufficiency (TS) for the Corsican coastal waters is determined. The adapted M-AMBI calculation and TS are applied on the macrofauna populations identified in Calvi bay.

It could be interesting to test the analysis process applied around Corsica on other Mediterranean areas.

Developments during BEWG meeting

The Benthos Ecology Working Group supporting the benthic focus theme of the ICES Council Steering Group on the Marine Strategy Framework Directive (MSFD)

The ICES Council Steering Group (CSG) on the Marine Strategy Framework Directive (MSFD) is seeking to facilitate the development of methodological standards for assessing the effect of human pressures on benthic habitats in the context of MSFD.

An area where further progress is required within the MSFD, is the assessment of impacts on benthic habitats from anthropogenic activities such as fisheries or eutrophication. ICES will be looking to address this issue by coordinating the development of cross regional methodological standards suitable to all parties i.e. indicator selection, setting GES boundaries, monitoring requirements, data flow and assessment standards.

One of the key themes to be addressed relates to the supporting of cross-regional indicator development, in particular linking damage and functional characteristics of seafloor integrity. This theme has close links with the new BEWG proposed initiative on 'Meeting benthic functional indicator needs of the Marine Strategy Framework Directive (MSFD)', which would aim to develop cross-regional guidance on standards for monitoring and assessing the functioning of benthic habitat types under D1 and D6. This could feed into the ICES Integrated Ecosystem Assessments (IEA), which seek to bring together assessments of the different components of the marine ecosystem, e.g. fish, plankton, benthos etc.

Therefore, BEWG should seek to feed into the ICES CSG focus theme and contribute to the discussions on more effectively linking the work of the different ICES working groups (e.g. WGDEC, WGECO etc.) to further increase the coordination between these groups. In order to increase communication and coordination, a review within and between groups of the ToR of benthic related ICES working groups could be undertaken within the coming years to build understanding of the closely connected work areas.

Developments during BEWG meeting

This breakout group discussion followed A. Conde Lago's presentation on the progress made within the BenthovAL project in terms of developing a new biotic index based on benthic Macrofauna community structure and multidimensional deviation from a reference state. The group made several suggestions to the BenthovAL team working on the future work, mainly in connection with the development of the index. These suggestions were discussed. Some detailed consensus was reached and documented below:

1) Assumptions: It was first noted that the theoretical basis for the new index was relevant, mainly because it required the formulation of few *a priori* ecological assumptions. Some of these applications were compared to other indices relying on species sensitivity/tolerance lists. Moreover, relying on the Hellinger distance allows for ease of calculations, compared to the Bray-Curtis dissimilarity, as they can be carried-out in a Euclidean setting while measuring ecologically pertinent changes in community composition and structure.

2) Species and traits: While the proposed approach has the advantage of not relying on *a priori* classifications of species according to their sensitivity/tolerance to specific pressure in order to assess Ecological Status. This approach offers possibilities to identify species responsible for the actual differences along pressure gradients. This will be achieved by indicator species analysis for semi-quantitatively measured pressure gradients, and/or analysing PCA/RDA species loadings for those for which quantitative pressure data are available. Finally, it was suggested to complement the current approach with BTA, which

could allow the research to address questions concerning species replacement and neutrality in the face of pressure gradients.

3) Spatial scale of assessment: Group members stressed that there were growing demands towards regional-scale, rather than local-scale, assessment of ecological status and that it was imperative that this new index take account of these demands to be applicable and acceptable in practice. The methodological basis of the new index does not allow for a brute-force regional-scale assessment: it requires the identification of proper reference stations at the local scale based on expert knowledge because the ecological assumptions only make sense at the sub-regional level. Therefore, for habitats that occur at multiple sites within a region, it is necessary to define proper reference station within each site. More importantly, when a number of different habitats occur within a region, proper reference sites should be defined for each of them within the region. By doing this, it will be possible to devise a methodology to derive regional-scale assessments from the local-based ones.

4) Thresholds: Threshold values used for converting Index values to ecological status will need to be based on the theoretical properties of the index. It is important to consider its range of variation as well as its observed variation in face of different type of pressures. Pressure types and intensities will be taken into account, and this will be based on the analysis of all available datasets.

5) Randomization: Finally, there was a general agreement that it was necessary to better understand the behaviour of the new index as well as evaluate the validity of the reference stations. Randomization procedure (typically, leave-one-out validation, with regards to the reference stations, but more generally jackknifing or bootstrapping), will be used in this context. It remains unclear at the moment whether this will be part of the final index methodology proposition or this will only be used in the development and calibration phase.

8.2 On the myths on indicators: To investigate the importance of species autecology in indicator development and application

Coordination: M. Zettler

Introductory presentation

8.2.1 Variability in expert assessments of benthic species tolerances/ sensitivities

Coordination: S. Degraer

Following on from discussions at the BEWG 2014 meeting, discussions were made on assessing the effectiveness of using static lists on species sensitivities as the basis of biological indicators. Following on from Zettler *et al.*'s (2014, *PLoS ONE* 8(10): e78219. doi:10.1371/journal.pone.0078219) paper, it was deemed necessary to investigate the variability in expert judgment used to populate these lists. It has been proposed that this be achieved by empirically testing the variability in expert assessments of the benthic species tolerances to a series of stressors, identified as threats to Good Environmental Status (GES) within the MSFD.

Developments during BEWG meeting

During the BEWG 2015 meeting progress was made towards the planning and delivery of this work. Sub-group discussions led to the following key developments for inter-session work:

- The agreed working hypothesis is that variability of expert assessment of sensitivity is high for widely distributed species, compared with species with a restricted geographical distribution.
- Independent experts would be sought to assess the sensitivity of widely distributed, moderately distributed and narrowly distributed species across four sea regions: Baltic Sea, Greater North Sea, North East Atlantic (incorporating Lusitanian, Celtic Seas and Norwegian Seas) and Mediterranean Sea.
- Expert judgement would be assessed using a questionnaire format, numerically scoring each species sensitivity and the individual confidence of the expert between 0 and 10. Questionnaires will require the experts to answer all questions, scoring zero where they feel they have no confidence in their answers. Experts will be asked to complete the questionnaire from their own experience (i.e. not consulting their colleagues), but where they use external sources these should be cited.
- A minimum of ten experts will be invited to participate for each region to ensure a robust dataset.
- Sensitivity will be assessed for specific pressures. Specific pressures will be benchmarked and two to three explanatory sentences used to explain each to the experts. Pressures will include physical pressure from towed / mobile fishing gear; organic enrichment (which may incorporate descriptors of hypoxia, siltation, eutrophication and changes in community structure). Two further pressures proposed are ocean warming and chemical pollution (e.g. from oil spills), and a final decision is required regarding these latter proposals.
- Species selection will be undertaken using a robust methodology, which will use an objective framework to exclude expert judgement from the selection process and exclude rare species. This will follow a three stage process as outlined below:
 - 1) Starting from the MARBEF (or any other open source databases), species distributions will be assessed across each sea area. Species will be identified as widely, moderately or narrowly distributed in each region according to their surface areal coverage.
 - 2) Species will be assessed as to their relative rarity, with rare species excluded.
 - 3) Rare taxonomic (e.g. Nemertean, Sipunculid) groups will be excluded, ensuring that species are from easily recognisable groups (e.g. annelids; crustacean; bivalve molluscs).

A total of 15 species will thus be assembled for assessment from each region, these will be selected from: i) five species from a wide distribution, ii) five species from a moderate distribution and iii) five species from a narrow distribution).

At present, there are a number of unresolved tasks from this work, these are in connection to the structure of the questionnaire and the list of experts, which will need to be decided at a later stage. In addition, the methods require refinement and consideration of the relevance of biological traits analysis (BTA) and the importance of substrata type should be considered.

Planning for Future Work

- S. Degraer is the coordinator of this initiative, and is developing the study intersessionally (expert selection, species selection, preliminary data-analysis).
- The following regional coordinators were appointed: North Sea: N. Desroy and O. Gauthier; Mediterranean Sea: C. Labrune; NE-Atlantic: L. Buhl-Mortensen; Baltic Sea: U. Janas.
- Methods for species selection to be refined and a suitable species database identified for each region.
- Questionnaires to be developed and the method checked by colleagues with expertise in social research.
- Interest BEWG members to nominate experts (from each region) to participate in testing.
- Assessments to be carried out intersessionally with the aim to report back at the 2016 BEWG meeting.

8.3 To review the development of effective monitoring programmes, e.g. design, harmonisation and quality assessments

Coordination: S. Degraer

Introductory presentations

8.3.1 Towards a joint MSFD monitoring programme for the North and Celtic Sea, JMP-NSCS: Project outline and state-of-the-art

S. Degraer, Royal Belgian Institute of Natural Sciences, Belgium.

Successful and cost-effective implementation of the MSFD depends on regional cooperation between EU Member States and third countries. This project scoped for joint monitoring within the North Sea and the Celtic Sea. Its results are based on an analysis of all ongoing monitoring in these subregions and the requirements of the MSFD, taking into account options and hurdles to be taken in relation to interdisciplinary and cross-border monitoring. The consortium consisted of all relevant institutes within those countries bordering the North Sea and Celtic Sea. MSFD policy leads support the work and actively contributed to it.

The project came to an end in April 2015 and organised its final event in March 2015. At the final event, scientists, marine managers and marine policy makers discussed the results and identified ways forward in achieving region-wide joint monitoring. Particular attention was given to the added value of joint monitoring along the gradient from the business-as-usual model (i.e. hardly any joint monitoring) to a region-wide centralised coordination of monitoring.

Several products are derived from the project. A searchable web portal holding meta-data on MSFD-related monitoring programmes and their link to MSFD criteria, indicators and targets within the participating EU member states can be visited at <http://jmp.bmdc.be/Login/password:jmpguest/jmpguest>.

Two position papers on the interdisciplinary and cross-border monitoring state-of-the-art and ways forward were produced. Technical tools for (statistically) designing joint monitoring programmes were developed. Three case studies on options for joint monitoring (chlorophyll, benthos and elasmobranchs) were worked out. The project's results are wrapped up in a series of technical reports, which will shortly be available, and integrated and summarized in an executive, non-technical summary (see final summary document <http://www.informatiehuismarien.nl/projecten/joint-monitoring-programme/>). The results of a joint conference, including presentations and concluding statements of this project and the other funded EU sister projects (BALSAM and IRIS-SEAS) are available on the final conference page hosted by HELCOM: <http://helcom.fi/helcom-at-work/projects/balsam/final-conference/>

8.3.2 A summary of the benthic case study selected under the Joint Monitoring Programme: NS/CS

G. Van Hoey

Proposals for joint/coordinated monitoring: outcomes of case study Benthos

The Marine Strategy Framework Directive aims at joint assessments of the good environmental status (GES) of our seas. Since monitoring programs and indicators are performed and developed on a national scale, it is a key challenge to maximize the compatibility between the separate national MSFD assessments, requiring harmonization and inter-calibration. Such a common assessment framework is being drafted for the benthic habitat within the EU-project 'Joint Monitoring Program for the North Sea and Celtic Sea' (see 5.3.1). The existence of a wide variety of benthic indicators, which need to be inter-calibrated for assessment purpose, should not hamper the harmonization of the monitoring. Analysis of a compiled North Sea benthos dataset showed that the highest confidence, i.e. the ability to detect changes, can be reached when collecting habitat stratified species-abundance data by means of harmonized protocols, with the effort per stratum related to the size of the stratum and the variance in benthic characteristics per stratum. Such a data collection design can be cost-effectively implemented when ongoing monitoring at the national scale becomes incorporated into joint/coordinated monitoring at EU level. However, ongoing monitoring often has a long tradition, which may lead to institutional and/or country specific reluctance (skills, expertise, and technology) to deviate from business as usual. Nevertheless, the implementation of a North Sea wide minimum' benthic sampling design, which complement the national driven monitoring schemes, will inevitably lead to better integrated monitoring and allow for a thorough joint GES assessment at the regional scale.

Way forward

After clarification by and discussion with the OSPAR-COBAM, Benthic Habitat WG chair present at the meeting, it was agreed to focus the OSPAR request (ToR F) this year onto:

- 1) the identification of the first insights into monitoring requirements for benthic multi-metric indices (MMIs) as taken from the JMP benthos case study (see 5.3.2), as prepared by BEWG at its 2014 meeting.
- 2) MMI monitoring, as such putting less emphasis on issues related to indicator species and issues related to the assessment of GES.

An overview of MSFD-related monitoring programmes that are or may be useful for MMI assessment can be found at jmp.bmdc.be (username: jmpguest – password: jmpguest). This database contains all information on monitoring programmes as EU member states have reported to the EC. The database hence integrates all Eionet data into a searchable database. While the database contains most – if not all – information on relevant monitoring programmes for benthos within the North Sea and Celtic Sea, it does not cover any other region within the OSPAR area, neither does it hold information on the geographic extent of monitoring programmes. In order to complete our view on the cards we have in hand to play with, the database should be checked for completeness within the North and Celtic Sea, and should be completed beyond the North and Celtic Sea and to include information on geographic distribution and extent of the monitoring programmes. MMIs being targeted, the focus of this exercise should be on those monitoring programmes collecting macro-benthic species-abundance (biomass) data. BEWG recommends ICES to take appropriate action to request its national delegates to launch this database scrutinisation process. Once completed the database will be used to create a “heat map” of monitoring activities relevant for MMI assessment.

Regarding the monitoring design for regional MMI assessment, the group refers to last year’s BEWG report (ICES, 2014), where it was decided that (1) the monitoring programme design should be based on the constituent variables (e.g. species and abundances), irrespective of the MMI under consideration, and (2) while seasonality does influence the constituent variables, BEWG’s exercise focuses on the spatial dimension of the monitoring design. All this lead to the EU-project’s ‘Joint Monitoring Program for the North Sea and Celtic Sea’ (JMP) case study on benthos monitoring design for the North Sea, based on the North Sea Benthos Project 1986 and 2000 data (see 5.3.2). This analysis lead to the identification of optimal sample allocation throughout the North Sea (see Figure 1). Details on the spatial allocation are to be found in the JMP final report (<http://www.informatiehuismarien.nl/projecten/joint-monitoring-programme/>). The BEWG recommends this sampling scheme to be adopted throughout the North Sea and to be complemented with local monitoring stations, where needed.

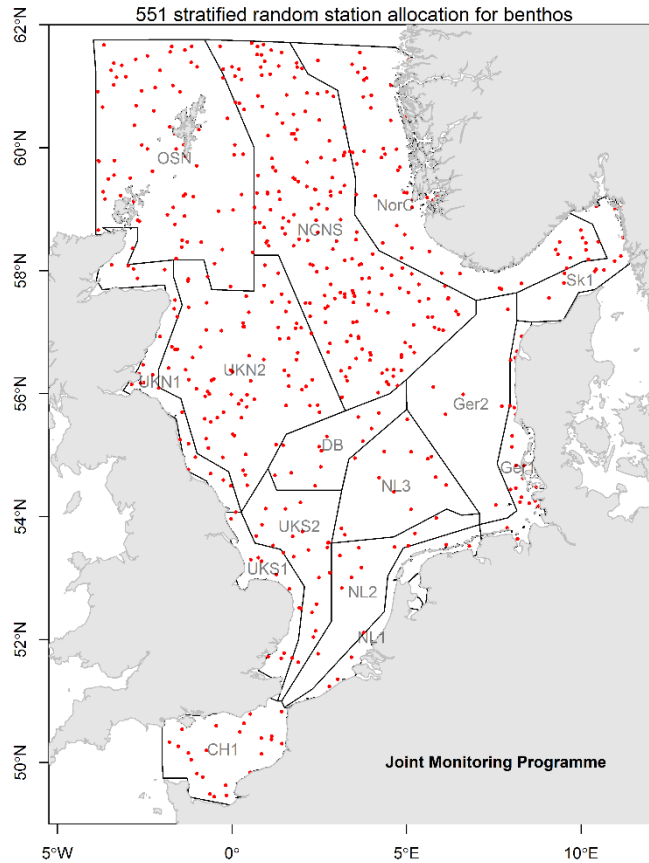


Figure 1: An example of a spatial benthos monitoring program within the different North Sea ecosystem strata. The figure shows the amount of samples per strata, which is allocated depending on the size of the strata and the variability of the benthic parameter. This analysis was conducted for species richness.

9 Benthic biodiversity and ecosystem functioning

9.1 To identify the links between benthic biodiversity and ecosystem functioning, e.g. literature review, ecological processes, biological traits

9.1.1 Literature review on the links between benthic biodiversity and ecosystem functioning

Report by J. Vanaverbeke

During the BEWG meeting in Iceland, this initiative was launched in order to investigate the relationship between macrobenthic biodiversity and ecosystem functioning. The initiative started from the—at that time—increasing evidence that macrofaunal functional diversity had a positive effect on benthic ecosystem functioning. In the literature, benthic ecosystem functioning was mainly investigated as fluxes of carbon, oxygen or nutrients across the sediment-water interface. The bulk of the information was derived from lab experiments, where ecosystem functioning was mainly assessed in single species incuba-

tions. This showed that some macrofaunal activities (bioturbation, bio-irrigation) indeed affected fluxes of solutes and oxygen across the sediment water interface. BEWG raised the question whether there was information about a similar positive link between macrofaunal diversity (i.e. species numbers), density or biomass and ecosystem functioning, rather than information derived from single species incubations.

Therefore, a literature review was organised based on the five most important papers linking biodiversity with ecosystem functioning. Since then, the list of papers to be reviewed was filtered to keep the focus on “marine macrobenthos” and “ecosystem functioning” (the latter being broader than fluxes of O₂ or DIN). Each paper was then reviewed and the table available on the SharePoint was created.

The table shows—for each reference—(1) the investigated aspect (a single species, or the community attribute (diversity, biomass, density)), (2) the response variable, (3) the direction of response (increase – decrease – no response) and comments were needed. The table on the SharePoint is the result of the work done in Dinard, and since then.

The table shows that relevant information was found in 39 papers (out of the clean starting list of about 150 references, all the papers were omitted that had no relevant info, according to the reviewers). From these 39 papers, only two (!) paper directly investigated the relation between diversity and EF (lines in table have a yellow marking). Two papers investigated biomass, one paper investigated densities. Most of the other papers reflected research on single species. For each of these species, the M and R value (for the BPC calculation) were mentioned.

Apart from the papers mentioned in the list, and the Braeckman *et al.* paper (2014 – using BPC and density as a proxy for macrofaunal communities), there is no information available linking macrofaunal diversity with EF. This looks a dead-end street.

Possible ways forward

- A way forward would be to end the exercise here, with a report on what was done, and with the conclusion that there is an urgent need to investigate whole communities, rather than single species.
- Another way forward would be to expand the exercise, and to try to produce a review on the single species results. However, this list is then not the correct list to start from, as we started our literature search with the objective to link DIVERSITY to EF, and not individual behavioural traits. This can be very interesting, however it will never be done intersessionally (too much work, and maybe not with the correct people). It could be done through a workshop with dedicated people that probably need to be recruited outside the current BEWG community.
- The aim of this initiative was to (1) detect generalities in the observed patterns and (2) detect gaps in the research performed so far, based on five key review papers on this topic and the references therein (cited in BEWG 2014). Jan Vanaverbeke was leading this initiative.
- Out of the 531 cited papers 162 were related to macrobenthos in marine environments, and only two of them were found to address diversity effects on ecosystem functioning. The majority of papers addressed single species effects on ecosystem functioning.

- Thus, our initiative was successful in detecting gaps in the research performed so far (objective 2), but further quantitative analyses or a meta-analysis were not possible with the data at hand.
- Therefore, it was suggested to draft a viewpoint paper on the lack of knowledge about diversity effects on ecosystem functioning in marine benthic environments and to provide an outlook for further research priorities in this field. Additional literature research would be needed to underpin our conclusion, which should be mainly based on the few papers that were published in the last two years (as far as known by group members). The potential focus of the viewpoint paper could also include (i) what aspects of macrofauna have generally been investigated (densities, diversity, functional diversity) and (ii) what are the ecosystem functions that have been investigated (extracted from the original plan; BEWG 2014).
- Jan Vanaverbeke was suggested to take the lead in drafting an outline for further distribution among co-workers within the next months.

Introductory presentations

9.1.2 Separate and Combined Effects of Estuarine Stress Gradients and Disturbance on Oyster Population Development on Restored Reefs in Florida: A Structural Equation Modelling Approach

By E. Proffitt & E. Salewski

Ecological theory embraces both stress gradients and disturbance, although seldom are predictions tested in combination. The net effects of multiple interacting stress gradients can be complex, and if disturbance also occurs the ecological responses to stressors may be further modified. The ability to tolerate stress has been reported to be inversely related to competitive response indicating that the interactions among species are affected by stressors. Further, the indirect effects of multiple stressors acting in concert in some cases increase the net effects of a particular stressor or can offset those effects in the case of other stressors. Freshwater flows can establish gradients in river-dominated estuaries for such variables as salinity, turbidity, and nutrients. Because it is technically difficult or prohibitively expensive to conduct long-term experiments on the interactions of a suite of factors over the scale of entire estuaries, it is necessary to employ other methods. We analysed oyster (*Crassostrea virginica*) colonization of novel substrate in the St. Lucie River estuary, SE Florida via structural equation modelling (SEM) to test cause-and-effect multivariate models posed a priori as hypotheses. In essence, SEM is a set of equations in which each response variable is related to its predictors by linear regression. In this manner, causal hypotheses can be tested using observational data. In SEM, a true multivariate model containing a suite of interconnected pathways is posed a priori as a hypothesis and the covariance structure of the model tested for fit to that of the dataset. Here, we use SEM to analyse the complex web of direct and indirect effects of environmental water quality variable stressors and pulsed disturbances (water discharges) on the colonization and survival of oysters (*Crassostrea virginica*) in a large-scale restoration project in the St. Lucie River (SLE) estuary, southeastern Florida. Because oysters are foundation species and ecological engineers, their responses to combinations of stress levels and disturbance can cascade through the reef community. A preliminary analysis of long-term (2000–

2011) water quality (WQ), canal flow, and rainfall revealed these variables were linked in cause-and-effect paths. The best oyster SEM for adult ($R^2=0.74$) and small < 20 mm ($R^2=0.48$) oyster abundances combined WQ stress gradients that occurred during normal canal flow with disturbance resulting from extremely high canal flow. There were no direct effects of salinities occurring during normal canal flows on either oyster size class. Negative indirect effects coupled with direct effects yielded a total effect of the salinity gradient on adult oysters of -0.27 (standardized path coefficient). Disturbance-level very low salinity during extreme canal flows produced large negative direct (-0.53) and total (-0.41) effects on small oysters, but for adult oysters the direct and indirect effects of similar magnitude but opposite sign that yielded no significant total effect. Turbidity during normal canal flow had no effects on small or adult oysters. However, during disturbance flows, the maximum turbidity had strong negative effects.

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9.1.3 Macrofaunal impact on biogeochemical turn over in German Bight sediments

By A. Wrede and Jennifer Dannheim

Macrofaunal bioturbation activity has farreaching ecological and biochemical effects on ecosystem performance and ecosystem services such as nutrient recycling. A PhD Project is set up to quantify the effect of major bioturbators in German Bight benthic biogeochemical processes at large spatial and temporal scales.

9.1.4 Functioning of benthic fauna in the Gulf of Gdańsk

By U. Janas

U. Janas, A. Dąbrowska, H. Kendzierska and A. Rozenbajger, Institute of Oceanography, Gdańsk University, Al. Marsz. J. Piłsudskiego 46, 81-378 Gdynia, Poland

Benthic communities are very significant for functioning of the coastal and deeper areas of the Gulf of Gdańsk. Species biodiversity is well studied in this region, though the functional diversity is not that well known. Among other functions benthic fauna influences the fluxes of biogenic substances between water and sediment or oxygenates the sediment through its activity. Those functions are often impaired in the hypoxia stressed deeper area.

Functional benthic macrofauna biodiversity from areas created by different oxygen conditions in the Gulf of Gdańsk will be shown. Also the aims and new studies on the role of benthic fauna in the coastal filter of the Baltic Sea within COCOA- BONUS project will be presented.

9.1.5 Biological trait analysis

Coordination: M. Zettler

Introductory presentations

9.1.5.1 Changes in functional composition along sediment gradients

Presented by M. Zettler

A. Darr, M. L. Zettler

Understanding the influence of environmental parameter on macrozoobenthic communities is a core area in marine benthic research. Besides biodiversity, functional aspects became focal points supported by the application of biological traits analysis (BTA) during the last decade. Own observation showed that e.g. the influence of salinity on the functional composition of macrozoobenthic communities in the western Baltic Sea is determinable, but less distinct than on species composition (Darr *et al.* 2014). Limited knowledge is also available on the influence of other major environmental drivers (e.g. substrate) on the functional composition of marine macrozoobenthic communities.

Consequently, BEWG defined a new initiative at 2014s meeting in Dinard. The aim of this initiative is to analyse whether there are any differences in traits composition between different substrates (mud, fine sand, coarse sand) and whether those are consistent between different regions/seas (Mediterranean, North Sea, Baltic, others). The initiative has to be tackled in a stepwise approach. In a first step, a common BTA-table will be set up to allow for common analysis whereas the analysis will be done in a second step.

An updated call for data will be circulated after the meeting. It is planned to finalize substantial parts of the initiative until next year's BEWG meeting, i.e. the set-up of the common traits table and the arrangement for species scores should be finished until the end of the 2015, while analysis are foreseen to start in 2016.

Reference

Darr, A., Gogina, M., Zettler, M.L. (2014): Functional changes in benthic communities along a salinity gradient– a western Baltic case study. *Journal of Sea Research* 85: 315-324

Planning for future work

Alexander Darr proposed a tentative programme to continue with this work:

There is a dedicated call for data (e.g. basic information, species data and metadata).

Intersessionally, there is a need to continue with this work by:

- Scoring and coding traits;
- Agree on common traits-table (provided by Alex and discussed by all group by end of September);
- Fill in species' scores (provided by Alex and discussed by all group by end of 2015);
- Analyse by Alex and report at the next meeting in 2016 of the overall results;
- Additional data sets are needed from cold and hot areas.

9.2 To identify the links between benthic functions and ecosystem services.

Paul Montagna was unable to attend the BEWG meeting this year, therefore this initiative continues intersessionally. More up-dates on the manuscript will be done at next year's meeting.

9.3 New initiatives

9.3.1 Meeting benthic functional indicator needs of the Marine Strategy Framework Directive (MSFD)

Coordination: W. Hunter

H. Hinchin reported

The ICES BEWG proposes a new initiative focussing on offering guidance on meeting the benthic functional indicator needs of the MSFD. MSFD specifically defines biodiversity in its Descriptor 1 in terms of functional diversity, species diversity and genetic diversity. The MSFD also defines seafloor integrity in its Descriptor 6 (D6) in terms of ecosystem functioning criteria and indicators; for example nutrient cycling, habitat provision and functional biological traits.

At present biological indicators provide the main approach for monitoring and assessing benthic ecosystem status and most benthic biodiversity indicators focus on community structure aspects only. We currently lack a common approach to monitoring and assessing ecosystem functioning (and associated ecosystem services) within different benthic habitats. As the BEWG, we would seek to offer some useful guidance on how to address this important gap in indicator availability and highlight key approaches / methodologies that could be used to monitor and assess different seabed types. This guidance should seek to result in appropriate agreed methodological standards and feed into the

regional and cross regional assessments under the Regional Seas Conventions (RSC) implementing the MSFD.

Proposal for future work tasks

- Review the new amendments to the MSFD criteria for D1 and D6
- Review the long list of (400 +) indicators provided within the recent D6 workshop report and identify which indicators relate to community structure and which to ecosystem function
- Define and quantify the gap that exists for ecosystem function indicators that are able to meet the new D1 & D6 criteria requirements
- Define three broad substrata types e.g. soft bottom, hard substrate & mixed sediments in order to broadly explore issues of ecosystem functioning
- Attempt to identify the key ecosystem function(s) provided by each broad substrata type (existing work by Alexander Darr can feed directly into this)
- Attempt to identify approaches that could effectively monitor these functions using existing work and case studies e.g. Biological Traits Analysis (BTA) and direct monitoring of biogeochemical fluxes
- Consider the need to include different levels of implementation / accuracy for varying levels of resources available for monitoring and assessment of functional indicators across Member States
- Identify key example methodologies / approaches that could meet the new requirements outlined in the D1 and D6 criteria for ecosystem functioning
- Consideration – It is important to use BTA in a transparent manner so that the methodology applied can be understood fully by others and analyses can be standardised where possible (e.g. for the same substrata types)

10 Benthic biodiversity and conservation: to review the role of benthic ecology in MPA's

Coordination: Clare Greathead and Paolo Magni

10.1 Literature review of the attributes of existing MPAs with benthic objectives and comparison with MPAs in development

It was decided that a global view was required to find examples of how existing MPAs have been selected and managed as the MPA process in the ICES region is still in development. This will be similar to the process in Edgar *et al.* (2014), but focusing on the benthos.

A possible outline was proposed for how the BEWG could conduct a literature search and analysis of the effectiveness of existing MPAs with regard to the benthos.

- 1) Screen internet (standard method) for literature (grey and peer reviewed) on **MPAs with benthic conservation objectives** and compile a list of reports and papers to review.
- 2) Possibly compare with the number of fish/fisheries related MPAs

- 3) Extract the management measures in each of these (or a defined subset?) and define whether they would reduce a pressure that impacts the benthic habitat or species of conservation interest in the MPA.
- 4) Determine if the MPA was effective in protecting/conserving/restoring the habitat or species of conservation interest in the MPA.
- 5) Compare the results with MPAs under development in ICES region (case studies).
- 6) Use case studies to compare the OSPAR/IUCN criteria or guidelines (link to 5B?).

Key Reference

Edgar *et al.* 2014. Global conservation outcomes depend on marine protected areas with five key features. *Nature* 506: 216–220

10.2 To discuss the development of effective (e.g. design, scale, coverage, etc.) MPA's

Introductory presentations

10.2.1 Species Distribution and Functional Ecology in the Small Isles MPA: Conserve, Restore, Monitor?

Clare Greathead

A key part in understanding the ecological issues surrounding the proposal and development of MPAs is to understand the links between protected features and their ecological function. The effectiveness of current MPAs for the conservation of priority benthic species will depend on the application of management measures within MPAs to protect the features that require protection, thereby conserving the ecosystem functions and traits provided by these features. In this talk I will present a case study that demonstrates some issues encountered when trying to establish a BACI study in one MPA. This constantly evolving process could impact the effectiveness of the MPA as the key objectives have been lost in translation and there will potentially be no reduction in a key pressure (benthic/demersal trawling), which may put at risk ecosystem functions and traits in specific habitats. The Small Isles MPA is very physically diverse and contains several habitats and species of conservation concern. The Small Isles will also be used as a case study to introduce the idea of ecological function within MPAs by showing the functional diversity of the habitats in this MPA.

Key References

- Hewitt, J.E., Thrush, S.F. and Dayton, P.D. (2008). Habitat variation, species diversity and ecological functioning in a marine system. *Journal of Experimental Marine Biology and Ecology* 366: 116-122.
- Tillin, H.M., Hiddink, J.G., Jennings, S. and Kaiser, M.J. (2006). Chronic bottom trawling alters the functional composition of benthic invertebrate communities on a sea-basin scale. *Marine Ecology Progress Series* 318: 31-45.

10.2.2 Is the establishment of MPAs enough to preserve endangered benthic species? The case of the Sinis MPA (W Sardinia, Italy)

Paolo Magni

Marine Protected Areas (MPAs) have been established to protect vulnerable species and habitats, to conserve biodiversity, to restore ecosystem integrity, to avoid user conflicts and to enhance the productivity of fish and invertebrate populations in the neighbouring zones. Often the lack of information on the species ecology can limit or make void existing management measures. One of such case is the Penisola del Sinis - Isola di Mal di Ventre MPA (Sinis MPA), Sardinia (Italy), instituted in 1997 to protect the local marine resources. In this overview, I will report recent endeavours carried at the CNR-IAMC of Oristano on the distribution and human impact of endangered benthic species in the Sinis MPA. These activities aim to provide useful advices to the local administration for the management and conservation of vulnerable species and their habitat. A special focus will be on (i) *Patella ferruginea* Gmelin, 1791, an endemic limpet of the Mediterranean Sea, listed in the EC Directive 92/43/EEC as the most endangered marine invertebrate on western Mediterranean rocky shores and (ii) the fan mussel *Pinna nobilis* (Linnaeus, 1758), a Mediterranean endemic bivalve that can exceed 1 m in length. Results show that the population of *P. ferruginea* in the Sinis MPA is near to extinction due human pressure even in the no take-no entry zone. In the case of *P. nobilis*, the outcomes of our work were used by the local MPA for management implementation of the northern section of the Gulf, an area recently included within the reserve perimeter (M.D. 20/07/2011) for the protection of both *P. nobilis* and the seagrass meadows (*Posidonia oceanica* and *Cymodocea nodosa*) which constitute a refuge area for a large number of species. The need for a new strategy where major efforts are invested in public information and participation promotion on the decision making process is also highlighted.

Key references

- Coppa, S. G.A. De Lucia, G. Massaro, P. Magni (2012). Density and distribution of *Patella ferruginea* Gmelin, 1791 in a Marine Protected Area (western Sardinia, Italy): constraint analysis for population conservation. *Mediterranean Marine Science*, 13: 108-117.
- Coppa S., G.A. de Lucia, P. Magni, P. Domenici, F. Antognarelli, A. Satta, A. Cucco (2013). Effect of hydrodynamics on shell orientation and population density of *Pinna nobilis* in the Gulf of Oristano (Sardinia, Italy). *Journal of Sea Research*, 76: 201-210.
- Coppa S., G.A. De Lucia, G. Massaro, A. Camedda, S. Marra, P. Magni, A. Perilli, M. Di Bitetto, J.C. García-Gómez, F. Espinosa (2015). Is the establishment of MPAs enough to preserve endangered intertidal species? The case of *Patella ferruginea* in the Mal di Ventre Island (W Sardinia, Italy). *Aquatic Conservation: Marine and Freshwater Ecosystems*, in press.

Work done at the BEWG meeting

It was initially considered that the development of an effective MPA's is closely linked to the major issue of "Marine Spatial Planning", considered under the EU FP-7 project "Monitoring and Evaluation of spatially Managed Areas" (MESMA) (to be looked at in greater detail).

This initiative will be focussed on a benthic perspective (e.g. how much is missing regarding the "benthos") when defining an MPA. It was agreed that for an MPA to be ef-

fective the main habitats and species should be considered ('habitat-based', 'species-based' approach). As an example, BEWG-related issues may include: species (e.g. *Macoma*) life cycle/distribution or size frequency distribution.

It was suggested to start from existing case studies, taking into account both successful and less successful stories. The Dogger Bank was given as an example of the successful development of an offshore MPA in a degraded condition towards one of restoration. Another case study that could be analysed is the Small Isles MPA (Scotland). Other case studies submitted by BEWG members (or through their links) will be considered (e.g. an MPA development in the Arctic, France, etc.). It was also highlighted that the existence of MPA networks already in place at both the national and international level should be considered.

It was also proposed that a check-list of how to set-up an MPA could be considered. This may go through sequential steps including: 1) design and designation of an MPA; 2) management enforcement; and 3) monitoring how an MPA is managed and effective.

Specific issues relating to monitoring the effectiveness of an MPA may include the evaluation of studies where sampling inside and outside the MPA (or along a gradient of disturbance) has been done to assess differences (e.g. in species distribution) and define whether the MPA is effective or it is just a "Paper park"

Other issues: 1) terminology should also be taken into account, as different terms are in place in different countries according to different legislations; 2) not only scientific literature should be looked at, but also the grey literature (e.g. reports) which is indeed abundant in the case of MPAs.

Plenary Discussion

The group came to the conclusion that aspects of both sub-group discussions should be taken forward as one issue. The main aim of this will be to assess the MPA process for its relevance to the benthos. Working title: **"A benthic ecology perspective for evaluating the effectiveness of MPAs"**.

By:

- 1) Construct a conceptual schematic of how the various ecosystem services of the benthos are covered in MPAs (to link into the choice of case studies).
- 2) Reviewing the current guidelines and criteria of OSPAR, IUCN and MSFD (with regard to the programme of measures), for their relevance to MPA selection and monitoring, focusing on marine benthos (e.g. siting, design, objectives, measures, enforcement and monitoring).
- 3) Specifically to look at the benthic perspective of the concept of an ecologically coherent network of MPAs (i.e. inclusion of a variety of habitats, connectivity (pelagic and benthic dispersal), link to 2 above).
- 4) Case studies:
 - a. Review the original purpose and objectives of the MPA with regard to benthic issues

- b. Evaluation of habitat and species representation ('habitat-based', 'species-based' approach, differences in the energetics and seasonal variability in habitats, connectivity).
- c. Evaluation of the methodologies, including the evaluation of studies where inside and outside sampling (or along a gradient of disturbance) has been done to assess differences (e.g. in species distribution).
- d. Evaluate if pressures have been removed/reduced (link to HELCOM request, see supporting info below).
- e. Summarise the pros and cons of each MPA.

5) Recommendations

Supporting Information

ICES work relating to Marine protected areas (MPA) and Maritime spatial planning (MSP)

Implementation of the MSFD will ultimately require programmes of measures that balance human activity with a functioning marine ecosystem. In this respect, MSP can be viewed as an integrating and – according to current practice and legal competence - “use oriented” process that can help ensure many of the MSFD goals are achieved. In 2010 and 2011 ICES organized joint workshops together with HELCOM/VASAB and OSPAR on multidisciplinary case studies of MSP.

EU Member States are required to provide a coherent and representative network of Marine Protected Areas (MPAs) that adequately cover the diversity of the constituent ecosystems. In response to this several regional seas conventions have identified criteria for ecological coherence. ICES is in a position to provide science-based advice on the MPA, which can be viewed as one of the many management tools available to reach GES.

ICES collects and maintain data for shared use. Furthermore, ICES also provides social and natural scientific input that underpins the marine spatial planning process (*i.e.*, information on fisheries, renewable energies, marine and coastal uses and conflicts, cultural dimensions of ecosystem goods and services, risk assessment procedures). ICES through their working groups and specific workshops (WGMPCZM, WKQAMSP, WKCES, WKRASM) are central in developing and providing the scientific foundation for advice on the implementation process of MSP, how to include cultural perspectives in decision making, or how to address cumulative effects, as well as in policy analysis (in the MSFD context).

Links

WGMPCZM <http://www.ices.dk/community/groups/Pages/WGMPCZM.aspx>

WKQAMSP <http://www.ices.dk/community/groups/Pages/WKRASM.aspx>

WKRASM <http://www.ices.dk/community/groups/Pages/WKRASM.aspx>

WKCES <http://www.ices.dk/community/groups/Pages/WKCES.aspx>

WKMCMSMSP Report (2011)

<http://www.ices.dk/sites/pub/Publication%20Reports/Expert%20Group%20Report/SSGH/IE/2012/WKMCMSMSP11.pdf>

<http://helcom.fi/news/Pages/Fishing-for-space-in-the-Baltic.aspx>

Case study: HELCOM and the Baltic

Ensure that HELCOM MPAs *inter alia* provide specific protection to those species, habitats, biotopes and biotope complexes included in the HELCOM Red Lists, as agreed in the HELCOM 2013 Copenhagen Ministerial Declaration, by considering these in the site selection procedure as well as in site management (for example by specific conservation and restoration measures including restoration of degraded ecosystems);

Ensure, that when selecting new areas, the network of HELCOM MPAs is ecologically coherent and takes into account connectivity between sites including for example migration routes, species mobility and areas of special ecological significance such as spawning areas;

Target for Baltic is at least 10% of the marine area in all sub-basins of the Baltic Sea including the EEZ areas beyond territorial waters is covered by MPAs where scientifically justified. In addition, where ecologically meaningful, coastal terrestrial areas can be included;

HELCOM is applying the newest IUCN categorisation system when describing the HELCOM MPAs in order to allow for global comparisons of regional networks. Similarly, HELCOM will harmonize activities and to work jointly with respective OSPAR and EU groups, as applicable, in order to achieve a Joint Network of marine protected areas.

e.g. HELCOM MPAs (HELCOM MPA database, GIS based map and data service);

HELCOM Request: In 2015 ICES has been requested by HELCOM to give advice on the pressures from fishing activity (based on VMS/logbook data) in the HELCOM area relating to the management of HELCOM MPAs. Where available and possible, provide information on fishing intensity for seine, bottom and mid-water trawl and longline in the 174 official HELCOM MPAs in whole 2013 and first quarter 2013.

11 Other business

11.1 Genetic Tools for Monitoring – From Microbial to Benthic species

H. Hillewaert presented

Work done by L. Devriese *et al.*

ILVO started recently with the development of genetic tools for environmental monitoring. The aim is to optimize, evaluate, implement and integrate these tools for the assessment of ecosystem health. As bacteria are well known sensitive indicators of environmental perturbation, two approaches are presented for the evaluation of bacterial communities on sediment. The polymerase chain reaction denaturing gradient gel electrophoresis (PCR-DGGE) assay is a rapid and easy tool for studying complex environmental microbial communities. This method is based on the evaluation of a genetic fingerprint representing the microbial biodiversity in each sediment sample. Some samples could share 'bands' of the fingerprint (= shared bacterial group) and some 'bands' are specific for one or more samples (= environment specific group). First PCR-DGGE results on the sediments of the Buiten Ratel revealed a clear difference between the bacte-

rial communities of impact and reference sites. The Buiten Ratel is located on Zone 2, the most extracted area on the Belgian Part of the North Sea (BPNS). A metagenomics approach provides information on the bacteria present in a specific environment. In cooperation with the ILVO genomics platform, Next Generation Sequencing, a high throughput sequencing technique is used to unravel the microbial communities on sediment. Metagenomics results on sediments of the BPNS revealed a very high microbial biodiversity, differences between coastal sediments samples and a large group of ‘uncultured’ or unknown bacteria. Genetic tools could also be implemented for the assessment of benthic biodiversity. A DNA metabarcoding approach is based on high-throughput sequencing of DNA-barcodes (genetic markers) and could provide a faster and more accurate alternative for species identification. The aim is to create a genomic based indicator for benthic biodiversity based on taxonomic profiles of the sampled areas. For this purpose, an intensive collaboration between benthic ecologists and genetic engineers is needed.

11.2 Update BEWG’s research plan: Multi-annual ToRs, other ICES/COBAM requests

Coordination: L. Guérin

Introductory presentation

11.2.1 Overview of OSPAR works in progress, linked to benthic habitats & Overview of Regional Seas actual common approaches, and use of community based indicators, for benthic habitat assessment

L. Guérin, Muséum National d’Histoire Naturelle, FR (contact : lguerin@mnhn.fr), C. Herbon, Joint Nature Conservation Committee, UK, N. Schröder, Bundesamt für Naturschutz, DE, A. Serrano, Instituto Español de Oceanografía, ES

L. Guérin presented an updated overview of the work led, and in progress, by the Benthic Habitat Expert Group of ICG-COBAM

(OSPAR Committee), co-led by L. Guérin, C. Herbon, N. Schröder and A. Serrano. The approach developed is to assess benthic habitat. This approach includes “indicators” and monitoring guidelines, and it is based on several years of background works as well as several expert workshops. Illustrations of the progressive methodological steps highlight specificities and complementarity of the indicators (BH1 to BH5). It also facilitated participants to identify issues addressed during the meeting, or that still will have to be done (New OSPAR request, see detailed in Term of Reference F). The set of indicators (BH1 to BH5) has been elaborated to answers to assessment requirements (which habitat, where, how much and how long impacted?). These indicators are still under development but some have been tested on datasets shared in 2014, to conclude on them soundness and sensitivity to reflect anthropic pressures. In March 2015, BH2 (Benthic habitat community condition) and BH3 (physical pressure on predominant and special habitats), have been endorsed by the Biodiversity Directory Committee, to be recommended for adoption by Contracting Parties. This imply than at least these 2 indicators will be assessed, according to data available and available resources, to contribute to OSPAR 2017 Intermediate Assessment. Recent strengthen links with other working groups (e.g. ICES, JRC) and Regional Sea Conventions (Barcelona, HELCOM) have been highlighted, notably by joint

meeting or participation of representatives. Further complementary development of these indicators should integrate a risk based approach, involving both pressure data and environmental data. These, according to MSFD issues, are also the main drivers to optimize both monitoring and assessment methodologies.

Request

ICES has been requested by OSPAR to support on-going OSPAR indicators work on benthic habitats. One of the new detailed request (2015/4 in ToR Fc) aims to evaluate the applicability of a reduced list of habitats in support the development of Typical Species indicator (BH1)⁴. This work should consider those habitats that have previously been identified by the COBAM Benthic experts group. Evaluation should consider data availability, and suggest possible prioritisation of habitats already included in the OSPAR list of threatened and declining habitats.

Two introductory presentations were made during the meeting:

L. Guérin. Overview of OSPAR works in progress, linked to benthic habitats (General presentation, done 04/05 for Issue 1A).

L. Guérin. Overview of Regional Seas actual common approaches and use of community based indicators, for benthic habitat assessment (Focused detailed presentation, done 07/05 for Issue 6A).

These presentations made previously to the work in sub-group, helped participants to understand and better address this new request. Furthermore, for BH1, relevant document where also presented and shared: technical specification, the OSPAR list of threatened and declining habitats and a preliminary list already shared through COBAM, elaborated by Spain and UK.

Progress made

The first step of the work conducted in sub-group was to compare these 2 lists, to identify potential gaps and commonalties. According to this request, criteria to select a prioritized list of habitats was then discussed and established:

- Inclusion in OSPAR list of threatened and declining habitats , with a clear definition;
- Specific expertise represented in BEWG;
- Several relevant datasets existing at Regional scale (both spatial and stationnal);
- Various communities types (more or less dominated by 1 or more species; predominant habitat) to be represented in the set for further testing;

⁴ In the implementation of this request ICES should ensure that there is a dialogue established between the relevant Working Group chairs and coordinators of the relevant OSPAR subsidiary bodies, including the ICG-COBAM Expert group for Benthic Habitats and ICG-Cumulative Effects. This is to ensure consistent interpretation of the request to meet the needs of OSPAR and avoid duplication in supporting the development and testing of OSPAR common indicators. Where data has been analysed as part of the work to deliver this request, the advice should be delivered in a form that will enable its use in subsequent analyses.

- For further analyses, as much as possible, data or proxy of pressure, should be associated to biological/environmental datasets.

As expertise for several habitats in both lists was not represented during the meeting (mainly on rocky habitats), another sheet have been added to the file of the preliminary list ('BEWG ToR exercise'), presenting the results of the prioritization made, according to the criteria. Some habitats of the COBAM preliminary list are also represented. These habitats are:

- Marine mud shores (to be further declined in specific communities: EUNIS level 5, according to available data);
- Intertidal and infralittoral seagrass (*Zostera* beds, e.g. *Z. marina*, *Z. noltii*);
- Intertidal and infralittoral seagrass (*Cymodocea* meadows);
- Seapens and burrowing megafauna in circalittoral fine mud;
- Maerl beds (e.g. *Phymatolithon calcareum*, *Lithothamnion corallioides*...);
- Deep Sea bioherms (e.g. corals, sponge aggregation; to be further declined in specific communities: EUNIS level 5, according to available data).

Planning for future work

It was proposed to send this table to all BEWG members groups, and OSPAR relevant contacts (secretariat and Benthic Habitat Expert Group leads) to keep them informed as mentioned in this request. This table should be associated with a brief note to help understand the issue (e.g. See Annex 3), for participants, which were not able to attend this meeting. This table could thus be filled intersessionally: each participant could add a line, for each relevant habitat to include available information.

- A review of existing literature addressing BH1 issue (typical species variability, due to natural and/or anthropic pressures): bibliographic references or internet links;
- If relevant existing datasets, add a reference in the "BEWG ToR exercise" to the line of the specific additional sheet, where its metadata can be detailed ('BEWG Metadata');

Depending of the level of participation and of available datasets identified, a "data sharing call" could be sent, according to a chart and in link with OSPAR, to test the concept, methodologies and sensitivity of BH1 against anthropic pressure and natural variability. According to the discussion during the subgroup, functional aspects could also be considered while testing the variability (e.g. biological traits of the typical species, trophic resources for seabirds, spatial fragmentation of habitats, etc.). This could lead to a scientific publication between participants addressing this issue.

Potential links have then been highlighted with works conducted in ICES-Habitat Mapping, ICES-Birds and ICES-BEWG (for other issues, as links between benthic 'biodiversity and ecosystem functioning' or 'evaluate monitoring and assessment requirements for OSPAR indicators').

Further intersessional progress made on this issue will be reported at next BEWG meeting (May 2016).

11.3 BEWG Outreach initiatives

11.3.1 BEWG's webpage on www.ices.dk

Coordination: S. Birchenough

S. Birchenough share with the group the current text and photo in the ICES BEWG webpage. The group photo was also up-loaded onto a Facebook group for BEWG (<https://www.facebook.com/ICES.Marine/photos/a.216906871687405.55618.172806912764068/927993607245391/?type=1&theater>)

Some suggestions from the group was to add our current list of publications to disseminate further the work under the BEWG. S. Birchenough to get in touch with Celine Byrne at ICES to up-date as discussed.

11.3.2 Conference contributions, workshop organization, etc.

Coordination: S. Birchenough

A brief discussion on which other ICES Expert groups will be interested and could be beneficial to interact with and to keep close contacts, these were:

- Working Group on Marine Benthic and Renewable Energy Developments (WGMBRED)
- Working Group on Ecosystem Effects of Fishing Activities (WGECO)
- Working Group on Marine Habitat Mapping WGMHM
- Working Group on Spatial Fisheries Data (WGSFD) Working Group on Oceanic Hydrography (WGOH)

11.3.3 Summary presentations

11.3.3.1 ICES Working Group on Marine Benthic and Offshore Renewable Energy Development (21–24/04/2015)

J. Dannheim reported on the ICES working group on “Marine Benthic and Renewable Energy Developments” (WGMBRED) established in 2012. The group met the third time in Oban, United Kingdom (21-24 April 2015) and was co-chaired by J. Dannheim (AWI, Germany) and Andrew B. Gill (Cranfield University, UK). The meeting was attended by 15 experts, representing six countries. WGMBRED has six terms of references which can all be summarised under three main topics: the ‘knowledge group’ evaluating and reviewing existing knowledge on the effects of offshore renewable constructions and related topics (e.g. artificial reefs), the ‘monitoring group’ reviewing and evaluating sampling techniques and the scientific efficiency of ongoing monitoring programmes and the ‘metadatabase topic’ focusing on summarising available knowledge in a metadatabase (see <http://tethys.pnnl.gov>) in order to cross-foster research and target monitoring, as well as future modelling approaches. WGMBRED will finalise all tasks concerning the ToRs until the end of the three years multi-annual cycle, i.e. the end of 2015, including two publications on the monitoring topic and knowledge gap issue, respectively. The group decided that a continuation of the WG beyond its current term is required and suggested four new terms of references for another multi-annual cycle (2016-2018). More

details on its achievements may be found at:
www.ices.dk/community/groups/Pages/WGMBRED.aspx.

Future opportunities

ASLO 2015 (22–27/02/2015): Call for sessions (deadline: 10/05)

ICES ASC 2015 (Copenhagen 21–25 September, 2015)

Sessions of interest, with co-venuers from BEWG, these sessions are: Seafloor habitat mapping: from observations to management (N) and Ocean acidification: Understanding chemical, biological and biochemical responses in marine ecosystems (H).

S. Birchenough will circulate further information when ICES call is out to submit further session for the next ASC 2016 (from 19–23 September 2016 in Riga, Latvia).

Benthic Ecology Meeting 2015 (<https://www.facebook.com/benthics2015>)

11.3.4 BEWG's publications: guidelines for authorship

Several initiatives under BEWG have decided to work towards peer-reviewed publications, as some journals do require to stipulate all of the roles of the contributors. It is important to adopt a clear set of authorship guidelines to ensure the process is transparent and the effort is shared across co-authors. A sub-group discussion decided to adopt the existing Vancouver Guidelines for authorship and citations (www.icmje.org) and there are other articles that can also provide further guidance on ethics and how to deal with authorship, for more details see the COPE report 2003 (<http://publicationethics.org/files/2003pdf12.pdf>)

The overall concept comprises the stages of:

- 1) Idea
- 2) Planning
- 3) Designing

During the discussion, there were several steps identified for contributions (e.g. data collection, analysis, writing and interpretations). There was also pointed out the cases, when colleagues are unable to travel but actively participate in the discussions, scoping and writing these manuscripts, these should be also considered as co-authors. There will be a further discussion on the exceptions and a clear document to ensure all aspects are covered during the entire process of paper writing.

Overall, for every paper initiative, there will be a leader driving the initiative and there will be at the discretions of the main leader to accept later contributions or close the initiative, particularly during the final stages of the paper (e.g. editorial suggestions and formatting of the manuscript). This process will ensure transparency, as some journals will require to detail every co-author's contributions during the whole process of paper production. This clear guidance will ensure that the overall process is smooth and conducted over the stipulated time.

11.4 Any other business

Coordination: S. Birchenough

Every year ICES issues a call under the ICES Science Fund. It is important to discuss and decide if there are initiative under BEWG that could apply for this money to run workshops or further discussions on the current and new initiatives. The call is often issue in February and submissions were this year in early March. S. Birchenough encouraged all of the BEWG participants to consider this opportunity.

12 Revisions to the work plan and justification

There is no revision of the work plan necessary.

13 Next meetings

The group opted to hold next year's meeting on 9–13 May 2016 in Lisboa, Portugal. Miriam Guerra of the Instituto Português do Mar e da Atmosfera (IPMA) will host the meeting.

Annex 1: List of participants

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Annex 2: Recommendations

Detailed recommendation for consideration under the ICES Council are:

- A dedicated ToR to support the development of common and candidate OSPAR biodiversity indicator for benthic habitats was added to this year's ToR. There is a need to evaluate the monitoring and assessment requirements for multimetric indicator (BH2) and or typical species (BH1), which will required to provide an overview of existing monitoring programmes and associated benthic sampling stations. During this exercise, there was a data based developed under a dedicated EU programme (JMP) and **BEWG recommends** ICES to take appropriate action to request its national delegates to launch this database and scrutinised this process. Once completed the database will be used to create a "heat map" of monitoring activities relevant for marine monitoring inventorying (MMI)/ assessment.
- An area where dedicated efforts are required within MSFD is the assessment of impacts on benthic habitats form anthropogenic activities. **BEWG recommends** that ICES will discuss these gaps and engage BEWG with all of the relevant expert groups to ensure wider co-ordination to avoid duplication of work. This activity will ensure maximum benefits (e.g. development of cross regional methodological standard to ensure that these are fit for purpose for indicator selection, setting GEWs boundaries, monitoring requirements and data sharing)
- An area identified by the BEWG is with regards to structural and functional indicators, particularly linking damage and functional attributes to support seabed integrity assessments. BEWG has been working on several aspects of indicators, monitoring and assessment. **BEWG recommends** engaging with other ICES EG's and ICES CSG on MSFD on the development and discussions of these aspects, particularly given our current initiative on 'Meeting benthic functional indicator needs of the Marine Strategy Framework Directive (MSFD)'.

Annex 4: Ecoregions (ToRs G/H)

Ecoregion: Baltic Sea

Ecosystem overview

Baltic Sea is a brackish system with two main environmental variables (salinity and oxygen supply) affecting the diversity. It is a young ecosystem formed after the latest glaciation, continuously undergoing postglacial successional changes. It is an enclosed, non-tidal ecosystem and has steep latitudinal and vertical salinity gradients. Substrate distribution is formed by the water movement. Muddy sediments and occasionally sands are most common in the basins, whereas rocky and mixed sediments can occur in near-shore exposed regions. The southern parts including the Belt Sea are closely connected to the Kattegat and Skagerrak and show salinities between 25 and 30 psu. Within a few 100 km toward the east or the north the values drop down to 5 psu and, finally, in the most northern part to more or less freshwater conditions. Oxygen availability also drives the diversity. In the shallow parts of the Baltic hypoxia may occur during the summer months due to high water temperatures.

Benthic communities

As a consequence of the salinity gradient, the number of marine species is significantly decreased or has been displaced by limnic species in the North and inner coastal waters. Due to anoxic conditions, benthic life is often absent in the deeper basins below the halocline particularly after longer periods without any saline water inflow. Even though the Baltic is a young ecosystem, species-poor and vulnerable to the threat of invasive marine and exotic species, both the strong gradient and the rapid change in salinity conditions especially in the southern Baltic inhibit an unhindered colonization. As a result, the Baltic benthic fauna is still largely characterized by species with obvious opportunistic life history traits. The whole northern area is occupied by community which is characterized by the amphipod *Monoporeia affinis*, the polychaete *Marenzelleria* spp., and the bivalve *Macoma balthica* mainly occurring on muddy sediments. The gastropods of Hydrobiidae, the polychaete *Pygospio elegans*, the bivalve *Cerastoderma glaucum* are dominating the community mainly found in sandy habitats in the southern Baltic Sea. At areas that are often anoxic and the motile polychaete *Bylgides sarsi* is the one to arrive first when conditions are better. Due to higher salinity up to 8 major communities in the southern-western part are much more diverse.

Reference

Zettler, M.L., Schiedek, D., Glockzin, M., 2008. Zoobenthos. In: Feistel, R., Nausch, G., Wasmund, N. (Eds.), State and Evolution of the Baltic Sea. John Wiley & Sons, Inc, pp. 517–541. 1952–2005.

Ecoregion: Celtic Seas

Ecosystem overview

Western Region is primarily soft mud seabed, with areas of sandy mud, whereas the areas to the east of the region tend to be more mixed and coarser sediments with areas of rock in the northern parts and photic zones. The primary influx of water from the southwest has a warming effect on this region, which allows southern species to extend further north than in more eastern regions.

Benthic communities

The soft sediments are primarily characterised by burrowing megafauna including sea pens (indicator species?) and commercially important species such as *Nephrops norvegicus* and macro-benthos such as deposit feeding polychaetes. The more coarse sediment includes sensitive species such as maerl, brittle star beds, *Modiolus modiolus* beds and *Atrina fragilis*. Also present in this habitat are important commercial shellfishery species such as *Pecten maximus* and *Aequipecten opercularis*. The rocky habitat in this region is predominantly in the littoral and photic zones and characterised by algae and epifauna. However there are some areas of rocky habitat in deep water in the north of the region characterised by hydroids, bryozoans and cnidarians such as *Eunicella verrucosa* and *Swiftia pallida*.

Ecoregion: Greater North Sea

Ecosystem overview

The benthic habitats of the Greater North Sea are predominantly characterised by soft-sediments. These vary from muds to gravel beds. Mobile muds to coarse sands are present throughout the whole area. Gravel beds are mainly distributed along the Channel area and Southern North Sea. The sediment distribution is linked to the geomorphology and consequent hydrodynamics that creates locally highly diverse benthic habitats, e.g. sand banks. The North Sea contains limited biogenic and geogenic reefs, except for patches of *Sabellaria spinulosa*-reefs and scattered boulder fields. The shores consist mainly of mobile sediment types, i.e. mud, sand and boulder beaches, while rocky shores can only be found predominantly in the Northern North Sea and the English Channel. The North Sea benthic habitats are highly impacted by bottom trawling, sand and gravel extraction and recently the growing introduction of offshore renewable energy structures such as wind farms.

Benthic communities

The structure and distribution of the Greater North Sea benthic communities can be explained largely by the natural environmental variables such as temperature, salinity, tidal/wave-induced bed stress, stratification, depth, and sediment type. There is a clear separation of communities in mainly shallow inshore waters in the south from the French up to the German coastal-zones, in the Channel, as well as adjacent to the English east and southeast coasts, from those in deeper waters north of the Dogger Bank (below 50m). In between, the offshore communities of the sandy and muddy areas are also well distinguished, including the Oyster Ground and the sandy Dogger Bank and its more muddy slopes, which are inhabited by the same community as is found in the Pleistocene Elbe valley extending from the inner German Bight to east of the sandbank. Coarser substrata especially in the south-western North Sea and eastern English Channel generally supported species-rich communities, which contrast with a latitudinal (south-to-north) trend towards higher diversity in finer sediments.

Ecoregion: Bay of Biscay and the Iberian Coast

Ecosystem overview

The main human pressures in offshore waters of the Bay of Biscay & the Iberian coast are fishing (pelagic in the whole area and demersal/benthic in the continental shelf below 100 m) and shipping. The coastal fringe supports some 'green tides' (e.g. Brittany) and waste water discharges (currently most of them treated) associated to main rivers and cities. In addition, marine debris (including microplastics) are also matter of concern. The subregion has detailed benthic habitat mapping, at least for the continental shelf, with maps (e.g. from MESH Atlantic project) covering levels 3-4 of EUNIS, with some regions with habitat mapping until level 5-6. However, most of the area has very deep waters (>4000 m) with no habitat mapping, being most of the area unknown. It is true that these abyssal areas are not exploited and, as such, they are supposed to be in good status.

Benthic communities

The main human pressures in offshore waters of the Bay of Biscay & the Iberian coast are fishing (pelagic in the whole area and demersal/benthic in the continental shelf below 100 m) and shipping. Although in general the environmental status of benthic communities in the whole subregion can be considered as in good status (with some minor areas associated to high pressures, i.e. discharges, fish trawling), the climate change is producing a rapid shifting in intertidal and infralittoral macroalgae and macrofauna composition, with a change from cold-temperate canopy forming species to temperate-warm species, with an important change in composition in the last 10 years. This is an important point relating potential reference conditions setting for the MSFD. This must be taken into account and adequately monitored.

Annex 5: Technical minutes from the RGBENTH

Review Group Technical Minutes

Review Group: Method development, operationalization and testing – indicators for benthic habitats (RGBENTH)

Reviewers: Koen Vanstaen (Chair)
Carolyn Lundquist
Gerjan Piet

Secretariat: Sebastian Valanko, Michala Ovens

Review period: 9th July – 3rd August 2015

This review group worked by correspondence during the period indicated. Two teleconference meetings were held during the review – one on the 9th July 2015 to agree the approach to the review, request any additional documentation or clarification from the ICES Secretariat and assign tasks to the reviewers. A second meeting was held on the 20th July to discuss progress and preliminary conclusions, and ensure consistency in approach to the reviews and agree deadlines for completion.

Review introduction

The review group reviewed the reports provided by the working groups. WGSFD provided an extensive report (*WGSFD 2015 draft report.docx*) which addressed both OSPAR request a) and the HELCOM request. BEWG provided their entire meeting report (*BEWG 2015 draft report.odt*), with sections relevant to the OSPAR request found on pages 18-20 (request c), pages 31-33 and Annex 3 (request b). WGMHM produced a separate output relevant to OSPAR request b) (*WGMHM ToR E.doc*). Background documentation provided by ICES included: the OSPAR list of threatened and/or declining species and habitats (*Ospar list species and habitats.doc*) and OSPAR BDC Collation of technical specifications for biodiversity indicators (*OSPAR_COBAM_indicators_03in01_technicalspecs.pdf*).

OSPAR REQUEST A: USING MOBILE BOTTOM CONTACTING GEAR DATA, PRODUCE FISHING ABRASION PRESSURE MAPS2 (2009-2013) USING THE BH3 APPROACH AS A FOLLOW-UP OF THE OSPAR REQUEST TO ICES (REQUEST 5/2014).

Introduction

The Marine Strategy Framework Directive (MSFD) aims to achieve Good Environmental Status (GES) across the EU's marine waters by 2020. A set of criteria and indicators were produced by the Commission to help Member States implement the Directive. Descriptor 6 of the MSFD is concerned with seafloor integrity, such that the functioning of marine ecosystems is maintained. One of the criteria for this descriptor is physical damage (6.1). OSPAR facilitates the coordinated implementation of the MSFD and as part of this work ensures compatibility and consistency in approaches between Member States.

As part of the coordination activity, OSPAR is overseeing the development of Benthic Habitat Indicator 3 (BH3): Physical damage of predominant and special habitats.

Request

OSPAR requested support from ICES in the development of common and candidate biodiversity indicators for benthic habitats. Specifically, the request was to: *Using mobile bottom contacting gear data, produce fishing abrasion pressure maps (2009-2013) using the BH3 approach as a follow-up of the OSPAR request to ICES (Request 5/2014). Fishing abrasion pressure maps should be analysed by gear distribution, and type, in the OSPAR maritime area and be based on the methodology propose on the physical damage indicator (BH3). Specifically ICES is requested to:*

- i) collate relevant national VMS and logbook data;*
- ii) estimate the proportions of total fisheries represented by the data;*
- iii) using methods developed in Request 5/2014, where possible, collect other non-VMS data to cover other types of fisheries (e.g. fishing boats < 12m length);*
- iv) prepare maps for the OSPAR maritime area (including ABNJ) on the spatial and temporal intensity of fishing using mobile bottom contacting gears (BH3 approach).*

The ICES Working Group on Spatial Fisheries Data (WGSFD) included this request in their Terms of Reference for their 2015 meeting. The meeting was held in June 2015 at the ICES Headquarters in Copenhagen, Denmark.

RGBENTH assessment of WG response

i) Collate relevant national VMS and logbook data

The ICES data call appears suitable to collate the relevant VMS and logbook data even though not all member states answered the call. Because of this only OSPAR areas II and III are adequately covered for the calculation of indicators/metrics. Further efforts should be made to resolve issues with or lacking data submissions by certain Member States. Where data were submitted in an incorrect format or were incomplete, assistance should be provided to resolve future issues. Where data were not provided, ICES and OSPAR or HELCOM should seek to ensure Member States provide the necessary data, as incomplete data only allow for incomplete assessments. Tables 4.2.1.1 and 4.2.1.2 swept area are useful for trends over time but the absolute values are dependent on the member states that delivered data.

The data checks appear adequate and caveats identified in 4.1.6 appear comprehensive. The revised data exchange format should allow an improved calculation of future metrics and maps. We recommend that an extra bullet point is added to section 4.1.6 that highlights the limitation of logbook data in this section, as the vessel under 10m overall length are not adequately captured by such data.

ii) Estimate the proportions of total fisheries represented by the data

As indicated in the report: Ideally this would be an estimate based on effort, but in the available data, the effort in the aggregated VMS data is reported as fishing hours and the effort in the aggregated logbook data is reported as fishing days, these two variables can't be compared directly. Landed weight is assumed to be a reasonable alternative of the datasets available to estimate the proportions. This assumption is however not validated or substantiated in the report, and should therefore be clearly listed as a limitation.

Building on the comment in section i) regarding the use of logbook data, it is recommended that the limitations on the percentages presented should be made clearer. The percentages mainly apply to vessels >15m and vessels between 10 and 15m. It may be beneficial for the report to mention somewhere the absolute values and relative proportions of registered fishing vessels by vessel length to put this into context.

Based on these limitations, the high percentages (>90%) of all bottom contact gears suggest that the data of those gears are sufficiently representative. Dredge gear was noted as an exception to this rule, with significantly lower percentages (~40-60%). The report would have benefitted from some discussion to validate this result.

iii) Cover other types of fisheries

The approach in 4.5.2 to superimpose logbook-based distributions of the fishing boats <12 m on top of the VMS-based distributions is probably the only possibility to address this issue using the data available to the WG. However, because you lose the small spatial scale (logbook data presented at ICES rectangle scale) this will result in a marked overestimation of impact when combining pressure and habitat sensitivity data in the BH3 methodology. In addition and as indicated, the method is very sensitive to the assumption of 24 hours fishing, which was shown for at least the Dutch fleet to be considerably less, i.e. closer to 17 hours (Piet *et al.*, 2007). We recommend that further work is therefore undertaken to inform a more appropriate duration before the results are used.

AIS also does not cover all the smaller vessels, so unless these smaller vessels are required to use VMS (preferably) or AIS, we just need to acknowledge that these small vessels cannot be included in the analysis. For each reporting area some estimate should be provided of the importance of these other fisheries based on e.g. effort or landed weight.

In the UK work has been undertaken in recent years to address the inshore fishing vessel gap. Breen *et al.* (2015) reported on an approach to address this issue. We recognize that this work was only recently published and that the WG may not have come across this work. The review group is also not aware whether the data used in this approach are available across the OSPAR area.

Using the data available we feel the WG has done the best possible. There is however an issue in relation to the data availability for smaller vessels which hampers these assessments.

iv) Prepare maps

The method shown in Figure 4.3.1.2.1 “Workflow for production of fishing effort and swept area maps from aggregated (c-square) VMS data” is appropriate and probably the best approach within the limitations discussed.

OSPAR REQUEST B: EVALUATE THE APPLICABILITY OF A REDUCED LIST OF HABITATS IN SUPPORT THE DEVELOPMENT OF TYPICAL SPECIES INDICATOR (BH1).***Introduction***

The Marine Strategy Framework Directive (MSFD) aims to achieve Good Environmental Status (GES) across the EU’s marine waters by 2020. A set of criteria and indicators were produced by the Commission to help Member States implement the Directive. Descriptor 1 of the MSFD is concerned with maintaining biological diversity, such that the quality and occurrence of habitats and the distribution and abundance of species are in line with prevailing physiographic, geographic and climatic conditions. One of the indicators for this descriptor (1.6.1) assesses the typical species composition based on presence of species in samples in all habitats across the region. The target would be to maintain the proportion of typical species within each habitat type, compared to reference conditions. OSPAR facilitates the coordinated implementation of the MSFD and as part of this work ensures compatibility and consistency in approaches between Member States. As part of the coordination activity, indicator 1.6.1 is also referred to as Benthic Habitat Indicator 1 (BH1).

Request

OSPAR requested support from ICES in the development of common and candidate biodiversity indicators for benthic habitats. Specifically, the request was to: *Evaluate the applicability of a reduced list of habitats in support the development of Typical Species indicator (BH1). This work should consider those habitats that have previously been identified by the CO-BAM Benthic experts group. Evaluation should consider data availability, and suggest possible prioritisation of habitats already included in the OSPAR list of threatened and declining habitats.*

Two ICES working group included this request in their Terms of Reference for their 2015 meeting: Benthos Ecology Working Group (BEWG) and the Working Group on Marine Habitat Mapping (WGMHM). Both working groups held their meetings in May 2015 in Calvi, France, and Reykjavik, Iceland, respectively.

Summary of WG reports

WGMHM reviewed the OSPAR list and provided brief comments in their report. WGMHM was unclear on reasons why “special habitats” had been proposed. WGMHM also commented on the inclusion of generic habitats which are made up of several EUNIS habitats. The WGMHM suggests that a generic habitat will be “problematic” for indicator use, as their typical species composition will show large variation. Generic habitats include: coral gardens, seapen and burrowing megafauna and deep sea sponge aggregations. There was no prioritization beyond this recommendation, but prioritization criteria were suggested.

BEWG benefitted from representation by members who have been heavily involved in the OSPAR indicator development work for benthic habitats (incl. BH1). The group reviewed available lists (OSPAR & COBAM). The group prioritized the habitats based on 5 criteria, but the prioritization was incomplete due to a lack of experts for certain habitats. The report suggested that this would be completed intersessionally, but no clarity on timelines was provided.

RGBENTH assessment of WG response

Both working groups provided incomplete responses to the advice request. This is likely due to a lack of clarity in the advice request and/or background documentation, as well as lack of expertise within the working group (BEWG).

- *Lack of clarity*

The WGMHM commented on the lack of clarity why “special” habitats had been proposed for consideration under BH1 instead of “predominant” habitats.

The Review Group agrees that background information was very limited in relation to BH1 and mainly included decision statements, without reasoning.

- *Lack of expertise*

The BEWG reported that their prioritization was incomplete due to a lack of expertise in relation to rocky habitats. This meant that the prioritized list presented was incomplete and can therefore not be considered in drafting advice as it stands.

BEWG developed a list of 5 criteria to prioritise habitats. Criteria 2 (*Specific expertise represented in BEWG*) was not deemed appropriate by the Review Group, as expertise should be brought to the WG, instead of habitats being excluded from prioritization. The criteria used should be unambiguous and it was felt that some of the criteria in the report failed this test and should be improved.

WGMHM developed a list of 11 criteria to allow prioritization of habitats. The list was considered complementary to the BEWG criteria. The list is comprehensive and the Review Group generally agrees with the criteria proposed. It is probable that some of the criteria were already taken into account during the development of the BH1 Indicator and the resulting recommendation to focus on special habitats. Therefore, some criteria may be excluded to reduce the task associated with prioritization. Other criteria could be combined as they are closely related (e.g. 3 and 11).

WGMHM did not undertake any prioritization of habitats based on the criteria proposed. Three habitats were considered “problematic”, namely: coral gardens, seapen and burrowing megafauna, and deep sea sponge aggregations. Full prioritization would have been useful based on the expertise within the WG.

Using their five criteria, BEWG shortlisted 6 habitats. Two of these habitats (seapen and burrowing megafauna; deep sea sponge aggregations) were included in the BEWG list, but were considered low priority by the WGMHM due to their geographic variations in typical species composition.

RGBENTH recommendations

- To make best use of the working groups' time, it is recommended that any requests are accompanied by fully documented background information. Different terminology was used in the different documentation ("OSPAR T&D habitats; special habitats; reduced list of habitats) which caused confusion.
- ICES and its WGs should ensure the necessary expertise is available to respond to the advice requests. Consideration should be given to working group working together on advice requests as opposed to splitting requests by area of expertise or duplicating effort.
- Of the two prioritization approaches proposed, the criteria proposed by the WGMHM are recommended with minor modifications. The prioritization will need to be undertaken at the ADG meeting, as no appropriate prioritization was presented in the WG reports.
- Prioritisation may benefit from being undertaken at EUNIS Level 5 instead of the higher OSPAR definition levels. Although this will result in a higher number of habitats requiring review, it is likely a large number will receive low prioritization due to not meeting the wide geographic distribution criteria.
- Prioritisation of EUNIS habitats with already defined characteristic species lists could be considered initially, as this would negate the initial task of developing species lists for each habitat.
- Further consideration should be given to the predominant habitats to ensure none of these habitats would be more suitable than the special habitats considered.
- Based on the recommendations above, a prioritized list may look like the list below and should be finalized by ADGBENTH.

DESCRIPTION	OSPAR Regions where the habitat occurs	Prioritised (Y/N)
HABITATS		
Carbonate mounds	I, V	Y
Coral Gardens	I, II, III, IV, V	N ¹
<i>Cymodocea</i> meadows	IV	N ²
Deep-sea sponge aggregations	I, III, IV, V	N ¹
Intertidal <i>Mytilus edulis</i> beds on mixed and sandy sediments	II, III	Y
Intertidal mudflats	I, II, III, IV	Y
Littoral chalk communities	II	N ²
<i>Lophelia pertusa</i> reefs	All	Y
Maerl beds	All	Y
<i>Modiolus modiolus</i> beds	All	Y
Oceanic ridges with hydrothermal vents/fields	I, V	N ³
<i>Ostrea edulis</i> beds	II, III, IV	Y
<i>Sabellaria spinulosa</i> reefs	All	Y
Seamounts	I, IV, V	Y
Sea-pen and burrowing megafauna communities	I, II, III, IV	N ¹
<i>Zostera</i> beds	I, II, III, IV	Y

1: Definition too broad, significant geographic variation expected.

2: Limited geographic distribution across OSPAR area.

3: Unlikely to be subject to human induced pressure.

OSPAR REQUEST C: EVALUATE MONITORING AND ASSESSMENT REQUIREMENTS FOR MULTIMETRIC INDICATOR (BH2) AND/OR TYPICAL SPECIES (BH1).

Introduction

The Marine Strategy Framework Directive (MSFD) aims to achieve Good Environmental Status (GES) across the EU's marine waters by 2020. A set of criteria and indicators were produced by the Commission to help Member States implement the Directive. Descriptor 1 of the MSFD is concerned with maintaining biological diversity, such that the quality and occurrence of habitats and the distribution and abundance of species are in line with prevailing physiographic, geographic and climatic conditions. Descriptor 6 of

the MSFD is concerned with seafloor integrity, such that the functioning of marine ecosystems is maintained. OSPAR facilitates the coordinated implementation of the MSFD and as part of this work ensures compatibility and consistency in approaches between Member States. As part of the coordination activity, OSPAR is overseeing the development of Benthic Habitat Indicator 2 (BH2): Multi-metric indices.

A multi-metric index (MMI) (BH2) indicator of quality of benthic habitat communities was endorsed by COBAM, BDC (February 2013) and OSPAR (June 2013) as one of the common indicators for OSPAR subregions II, III and IV [ICG-COBAM(1) 14/4/3 Add. 2]. This MMI indicator is explicit in the indicator 6.2.2 of the Commission Decision on GES (2010/477/UE) and partly implicit in the indicators 1.6.1, 1.6.2 and 6.2.1. Further development and validation across regional benthic communities and habitat types is required for the MMI indicator to be generally suitable for MSFD/OSPAR. This indicator should be sensitive to both a variety of pressure types, and to a pressure gradient, and should be applicable to intertidal, shallow and shelf benthic habitats, including both special and dominant habitat types at EUNIS level 4 or 5 biological community classification levels.

The BH1 indicator (ICG-COBAM(3) 13/4/1 Add. 14-E) refers to typical species composition, which requires complete species inventories of all habitats including current and historical (pre-disturbance) species composition. Typical species are a selected subset that have one of the following qualities: structure or functional species; indicator of habitat quality; sensitive to habitat condition; or are long-lived or have low fecundity. Typical species are analysed using frequency or density, or IndVAL or SIMPER statistics, with typical analyses being of changes in pressure, density or biomass with changing pressure.

Multiple indicators have been used previously in the OSPAR region, and two MMI formulations were proposed. The first consisted of three ecological parameters of species richness, species diversity (Shannon) and a third, the proportion of sensitive, tolerant and opportunistic species using the Infaunal Trophic Index (ITI) or the AMBI index, as a proxy for disturbance. A second proposed approach would incorporate both ecological and pressure data with sampling occurring along a pressure gradient concurrent with sampling of paired nearby reference un-impacted locations. Data from monitoring programmes would initially be used to determine and refine indicators and to standardize data requirement to calculate these indicators across different benthic habitats and pressure types.

Request

OSPAR requested support from ICES in the development of common and candidate biodiversity indicators for benthic habitats. Specifically, the request was to: *Evaluate monitoring and assessment requirements for multimetric indicator (BH2)2 and/or typical species (BH1)2, by providing:*

- i) overview of existing monitoring programmes with associated benthic sampling stations (e.g. WFD, MPA, Natura2000, impact assessment studies, etc.), taking into account the work done under the JMP project/art 11 reporting by countries.*
- ii) overview of existing network of sampling stations and monitoring frequency across all OSPAR regions.*
- iii) evaluation of on-going monitoring with regard to, geographical coverage, parameters consistently measured across the whole network, monitoring design and sampling strategy for*

assessment requirements (BH2/BH1). Evaluation should identify any gaps and indicate how they could be completed (monitoring sampling strategy and/or methods).

The ICES Benthos Ecology Working Group (BEWG) included this request in their Terms of Reference for their 2015 meeting. BEWG held their meeting in May 2015 in Calvi, France.

RGBENTH assessment of WG response

Monitoring a network of EUNIS habitats using BH2 indicators was previously proposed within the main OSPAR regions, complementing BHI monitoring with focus on habitat x pressure paired sampling locations across different pressure types. Monitoring was proposed (p96, BDC 15/3/Info.1-E) as networks of monitoring stations at three nested scales: sub-regional; national; and finer scale adopted to local pressure and habitat types. Sampling methodologies should be determined based on standardized methods (e.g., ISO 2011 for soft sediment benthic macrofauna). For deeper waters, monitoring by bioregion using EUNIS 3 habitat classifications was suggested, whereas higher resolution EUNIS 4 was suggested for the coastal zone, with standardized box cores sieved on a 1 mm mesh (BDC 15/3/Info.1-E).

The BEWG provides limited information in reference to OSPAR Request C (primarily p 17-20). We note that within the ToR listed in the 2015 BEWG report, only part of Request C is listed (overview of existing monitoring programmes; their ToR F) and reference is made to discussions at the meeting with the Benthic Habitat WG chair to focus in this year on insights for MMI monitoring (p19). The JMP is summarized in the BEWG report for the North Sea and Celtic Sea. The JMP project has produced a metadata catalogue and also provided a weblink to other technical reports. Links with conference presentations from a joint conference with BALSAM and IRIS_SEAS are also provided, though no summary of information within these links is provided. Many of the weblinks provided were not accessible and would therefore have benefited from being summarized in the report. A second abstract in the BEWG report summarized recommendations from a North Sea benthos long-term dataset and suggested stratified sampling across habitats and a North Sea wide minimum benthic sampling design. One map (North Sea) was provided, detailing apparent 'optimal sampling allocation'. Details of spatial allocations (e.g. depth, substrate, habitat type) were not provided and the weblink to access additional information on the spatial allocation process did not lead to the final report. It is suggested that spatial allocation (Figure 1, p20) is based on the size of strata and benthic community variability, though without more detailed information, visual interpretation of this map suggests monitoring gaps in some regions (Ger2, NL2, NL3) with some large strata having few monitoring points, and unclear justification as to whether this low sampling effort is due to low variability in benthic community composition.

The JMP catalogue appears to include all EU member states, and at least North Sea and Celtic Sea benthic monitoring. Information from the JMP catalogue is not summarized in the BEWG report, which would have been a useful response to OSPAR request c), including information on the number of stations in each region and strata, the geographic extent of monitoring stations, the EUNIS habitats covered by monitoring, and the frequency of monitoring. It appears that at least part of this information exists in the JMP catalogue, and ICES should suggest further detail in the database to provide additional missing in-

formation to allow evaluation of the OSPAR benthic monitoring network. The brief information recommended sampling to evaluate MMI indicators could be achieved using constituent variables, though these were not defined.

No information was provided with respect to monitoring frequency (c/ii) or beyond the North Sea. No information was provided with respect to geographical coverage, parameters consistently measured across the whole network, monitoring design and sampling strategy, or identified gaps (c/iii).

RGBENTH Recommendations

In summary, the request for information from BEWG on benthic monitoring was incomplete and primarily refers to reports, metadata catalogues and technical documents. Inadequate summary information from these documents was presented in the BEWG report or advice derived for it in response to the request. Only limited descriptions of information related to the ToR were provided, making it challenging to assess whether the OSPAR specific request 2015/4 has been responded to.

To adequately assess this request, summary statistics of JMP benthic monitoring should be provided, including: recommended number and location (by spatial allocation method suggested) and actual monitoring stations to determine gaps in monitoring, and for monitoring effort to be allocated and evaluated by strata, size of strata, and EUNIS habitat type. Frequency of monitoring should be summarised, as well as which constituent variables are collected in order to determine the subset of proposed MMI indicators that can be evaluated across the OSPAR region.

On p19 of the BEWG report a recommendation to ICES to compile information and prepare a heat map of MMI related monitoring activities for the North and Celtic Seas (and ideally beyond) is proposed. The review group felt that this recommendation overlaps with the current request and that it would have been useful if BEWG could have undertaken this work in response to the current request.

Reasons for the incomplete response to the existing request are unclear. The structure from the BEWG report suggests that the ToR was dealt with by inviting related presentations, which may have taken the focus away from the request. Dealing with the request only may provide a more focused response. Without compilation of existing information on monitoring, gaps cannot be identified, and if sampling parameters are inconsistent, MMI indicators are unlikely to be compared across the region. It is possible that this request will be actioned further in subsequent years, as item ii) and iii) of OSPAR request c) were not included in this year's BEWG Terms of Reference.

HELCOM REQUEST: PRESSURES FROM FISHING ACTIVITY (BASED ON VMS/LOGBOOK DATA) IN THE HELCOM AREA RELATING TO BOTH SEAFLOOR INTEGRITY AND MANAGEMENT OF HELCOM***Request***

HELCOM requested support from ICES to assess pressure from fishing activity in the HELCOM area relating to seafloor integrity and management of HELCOM MPAs. Specifically, the request was to:

a) Produce maps and shape-files of fishing intensity for the HELCOM area based on a 0.05 x 0.05 c-square degree grid. The maps should consist of a set of the polygonal feature classes and be submitted in the ESRI shape file format. Polygons should indicate the areas with equal fishing intensity measured in hours per year or per season being classified in the way harmonised with similar maps produced for the OSPAR region when applicable.

b) The maps and shape files of fishing intensity should be calculated for bottom contact gear and mid-water trawl and longline for every year in the period from 2009 to 2013 and for each quarter of 2013. In particular the following maps should be produced:

- i) intensity of fishing by each fishing activity for each year in the period from 2009 to 2013;*
- ii) total intensity for each year in the period from 2009 to 2013;*
- iii) total intensity and by each fishing activity by quarter in 2013.*

c) Where available and possible, provide information on fishing intensity for bottom contact gear and mid-water trawl and longline in the 174 official HELCOM MPAs in whole 2013 and first quarter 2013. The information should be provided in the forms listed in paragraph a) of the current request. Information on overall fishing effort should also be provided.

d) Estimate the proportion of total fisheries represented by the data.

The ICES Working Group on Spatial Fisheries Data (WGSFD) included this request in their Terms of Reference for their 2015 meeting. The meeting was held in June 2015 at the ICES Headquarters in Copenhagen, Denmark.

RGBENTH assessment of WG response**a) Produce maps and shape-files of fishing intensity**

The review group felt that the WG addressed this adequately.

b) Produce maps and shape-files for different gears

As discussed as part of the OSPAR request, the method used is deemed appropriate. We are however unclear why mid-water trawl and longline could not be covered.

c) Information on fishing activity within HELCOM MPA's

The information expressed in fishing hours suggests that some fishing occurs in these MPA's. Some discussion and/or additional analysis on the chance that these are spurious

registrations (e.g. speed falling within the “fishing” interval even if not fishing) should come with these results.

d) Estimating the proportion of total fisheries represented by the data

See above as per OSPAR request.

Generic RGBENTH recommendations

1. The Review Group experienced difficulties getting a complete background picture to the request. We recommend that future requests by OSPAR/HELCOM are supplied with a briefing note providing such information in a single place. The Review Group expects that ICES Working Groups will have experienced similar difficulties and that this will have affected the completeness of the responses. This was confirmed during informal discussions with WG members who confirmed they were not very clear what was expected of them (especially in relation to OSPAR request b) and c)).
2. The responses to the OSPAR request by the three working groups were presented in three different formats. The BEWG response to the request was buried in the main meeting report. We recommend that ICES provides guidelines and a template to working groups when responding to requests. Providing justification, and where possible references to do so, would be essential, as it was felt that this was missing from some of the responses provided.

Additional references to those for review

Breen, P., Vanstaen, K., and Clark, R.W. E. (2015) Mapping inshore fishing activity using aerial, land, and vessel-based sighting information. *ICES Journal of Marine Science*, 72: 467–479.

Piet, G. J., Quirijns, F. J., Robinson, L., and Greenstreet, S. P. R. 2007. Potential pressure indicators for fishing, and their data requirements. *ICES J. Mar. Sci.*, 64: 110-121.