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8–12 May 2017

Gdynia, Poland



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Executive summary

The third annual meeting of the Benthos Ecology Working Group (BEWG) was attended by 22 experts, representing 11 countries and was held at the National Fisheries Research Institute in Gdynia, Poland on 8–12 May 2017. The meeting was chaired by Silvana Birchenough, UK. The agenda structure of the meeting followed 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, the link between biodiversity and ecosystem functioning and the role of benthos within MPAs.

The meeting was structured along the agreed BEWG issues. The group continues to provide insights on the field of applied benthic ecology, with main emphasis on:

- Long-term series and climate change, considering the methodological aspects of time-series;
- Participating on existing initiatives related to benthic ecology (e.g. long-term series, biological traits) being developed under ongoing programmes (e.g. EMODnet biology);
- Developing applied exercises with regards to species distribution modelling and mapping;
- Reviewing relevant literature to report on the linkages between ecosystem biodiversity and functioning;
- Developments in effective monitoring programmes (including design, harmonisation and quality assessments);
- Understanding benthic biodiversity and conservation under the role of MPA's;
- Providing input and reviewing the state and/or trends of the benthic communities/habitats in support of the ICES Ecosystem Overviews.

Seven ongoing initiatives are under development:

- Case study: "The value of long-term time-series: bringing science to support management decisions";
- 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: "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".

The BEWG provided some recommendations:

- An area identified by the BEWG is directly connected to structural and functional indicators (relevant to many aspects of the MSFD, mainly D1-biodiversity and D6

seabed integrity), particularly linking damage and functional attributes to support seabed integrity assessments. BEWG has been working on several aspects of indicators, monitoring and assessments. The BEWG **recommends** that for better integration across EGs (e.g. workshop or a targeted session for the next ICES in 2018) should be considered. This activity will help to disseminate ongoing developments, highlight the current gaps and foster integration for future work.

- The BEWG has been working on several case studies with dedicated efforts on cost-effective monitoring practices, data-sharing approaches. There is a need for targeted efforts to support legislation requirements (e.g. under MSFD) in support of understanding impacts on benthic habitats from anthropogenic activities. **BEWG recommends** that ICES EGs will consider dedicated discussions with relevant EG chairs to avoid duplication of efforts and promote complementary knowledge to be applied to these initiatives.

1 Administrative details

<p>Working Group name Benthos Ecology Working Group (BEWG)</p> <p>Year of Appointment within current cycle 2015</p> <p>Reporting year within current cycle (1, 2 or 3) 3</p> <p>Chair(s) Silvana Birchenough, UK</p> <p>Meeting dates and venues Calvi, Corsica, France; 4–8 May 2015 Lisbon, Portugal; 8–13 May 2016 Gdynia, Poland; 8–12 May 2017</p>
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2 Terms of Reference a) – z)

a) Long-term benthic series and climate change

1. Facilitate collaboration by development and promotion of the BEWG Benthic Long-Term Series (BeLTS-net) with other networks;
2. To identify methodological issues in long-term series comparability;
3. To progress towards an understanding change in the benthos, e.g. regime shifts, seasonality, fine spatial scale variability.

b) Species distribution modelling and mapping

1. To report on ongoing case study: “Towards a benthic ecosystem functioning map: interregional comparison of two approaches”;
2. To compare and report on the performance and explore the applicability of different qualitative and quantitative species distribution modelling methods, e.g. methods validity, limitations, purposes, knowledge gaps.

c) Benthos and legislative drivers

1. To report on the use of benthic indicators and targets for management: Compatibility and complementarity;
2. On the myths on indicators: To investigate the importance of species autecology in indicator development and application;
3. To review the development of effective monitoring programmes, e.g. design, harmonisation and quality assessments.

d) Benthic biodiversity and ecosystem functioning

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

e) Benthic Biodiversity and conservation: to review the role of benthic ecology in MPA's

1. To identify the links between protected features and their ecological function
2. To relate the functions of protected marine features to the main pressures that would affect these features (cause-effect analysis)
3. To consider the effect of not excluding key pressures that affect the designating feature from MPAs (i.e. no take zones).

f) Support for the development of common and candidate OSPAR biodiversity indicators for benthic habitats (work completed during 2015).

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 (work completed during 2015).

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 (work completed during 2015).

i) Recommend a scoring process for benthic habitat sensitivity to fishing pressure and provide input to WGMHM (work completed during 2016).

j) Review the content drafted for the state/trends of the benthic community/habitat for the Ecosystem Overviews of i) the Iceland Sea and ii) Norwegian Sea ecoregions.

k) Provide draft text on the state and trends of the benthic community/habitat that could be used for an Ecosystem Overview for iii) the Oceanic north-east Atlantic and for iv) the Azorean ecoregion.

3 Summary of Work plan

2015	ToR	A.1-3	B.1	C.1-2	D.1-2	E.1-3	F			
2016	ToR	A.1-3	B.1-2	C.1-3	D.1	E.1-3	F	G	H	I
2017	ToR	A.1-2	B.2	C.2-3	D.1	E.1-3	J	K		

4 Summary of Achievements of the WG during 3-year term

Over the last three years, the BEWG has been drafting publications, contributing to key advisory products, compilation of sensitivity scoring matrices, collating data sets, modelling outputs in support of case studies and methodological developments. A strong contribution has been made across all ToRs. The work conducted by the BEWG has been structured over the main core ToRs A-E. However, annually, a series of dedicated ToRs have been added, depending on advisory initiatives and requests (see examples provided below). Furthermore, members of the BEWG have chaired workshops (e.g. WGACIDUSE), provided input over advisory drafting meetings and chaired dedicated sessions at ICES ASC in 2015 (i.e. ocean acidification and habitat mapping), and will continue to chair and present at both sessions planned for this year ICES ASC in Fort Lauderdale, Florida (e.g. Session K: introduction of man-made structures and at the Open session entitled: “Pressure and state indicators”).

Science developments (ToRs A, B, C, D, E)

Activities 2015–2017

- Continuing to explore and report on ongoing work on long-term series and climate change considering the methodological aspects of time-series;
- Ensuring that 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;
- Understanding benthic biodiversity and conservation: the role of MPA’s.

Deliverables

- **Publication entitled:** Birchenough, S.N.R., Reiss, H, Degraer, S., *et al.* (2015) Climate change and marine benthos: A review of existing research and future directions. *WIREs Clim Change*, 6: 203–223. doi: 10.1002/wcc.330;
- The production of a rationale document to assess the “Potential methodological issues in long-term comparability” was drafted and reported in 2015 BEWG annual report;
- A literature review paper to assess the “The value of long-term time-series: bringing science to support management decisions” was produced and will be further elaborated intersessionally by a sub-group during 2017;
- A dedicated exercise to assess “benthic ecosystem functioning map: interregional comparison of two approaches” has worked intersessionally to compile biological data and physical variables, undertake a preliminary data analysis and now is being fine-tuned for a peer review publication (work being conducted intersessionally by December 2017);
- A case study: “Variability in expert assessment of benthic species tolerances /sensitivities” was discussed and is under development. Intersessional work is

planned to discuss list of species/areas, statistical design and a questionnaire to assess experts' responses;

- The compilation of data to test a case study: "Changes in functional composition along sediment gradients", data has been partially compiled and further work is planned intersessionally, this work is due to report next year;
- A dedicated literature review of the papers dealing with the links between ecosystem biodiversity and functioning was conducted. A summary overview and reference list were generated. The plan is to write up the outcomes into a short-communication paper (to be submitted to *Ecological Indicators* this year);
- A report and exercise was populated to assess the "links between benthic functions and ecosystems services", further inversional work is planned to develop this report into a publication entitled: 'Ecosystem functions and ecosystem services: misconceptions and benthos matters';
- A table and draft manuscript is being populated to reflect the process of selecting MPAs and the role of benthic habitats and species therein. A summary table and a draft document is currently under development. Additional data sets will be gathered by the end of July 2017.

Advisory requests: monitoring, indicator developments, fishing impacts and legislative drivers (ToRs C, F, I)

Activities 2015–2017

- Provision of a plan for effective monitoring programmes (including design, harmonisation and quality assessments) taking account of benthic ecosystems and the previous work conducted during the 1986 and 2000 (North Sea Benthos Survey and North Sea Benthos Project, respectively);
- To evaluate the applicability of habitats and metrics in support of OSPAR indicators for benthic habitat quality (e.g. BH1, BH2 and BH3);
- To assess and report on a dedicated scoring process for sensitivity of benthic habitats in relation to fishing pressure.

Deliverables

- Developed a proposal for a joint /co-ordinated monitoring: outcomes of the benthic work under the EU project "Towards a Joint Monitoring Programme for the North Sea and Celtic Sea" with input from BEWG members;
- Production of a publication, to showcase a 'proof-of-concept' for sampling benthic systems (paper entitled: "Back to the future: Designing a regional monitoring programme to support marine benthic ecosystem assessments", Van Hoey *et al. under review*);
- Working on developing a case study to assess the current state of benthic functional indicators within the Marine Strategy Framework Directive (MSFD);
- Produced and scored a sensitivity matrix to document benthic habitats responses to fishing effects;

- Provided written expert advice to the OSPAR COBAM's request in relation to indicator work on benthic habitats (ADGBENTH) for SCICOM, ACOM and OSPAR.
- Members of the BEWG contributed with technical benthic advice to the following workshops and key advisory documents:
 - ICES Workshop on guidance for the review of MSFD decision descriptor 6 – seafloor integrity II (WKGMSFDD6-I). Copenhagen, Denmark, 16–19 February 2015 (Steven Degraer - chair, Silvana Birchenough - vice-chair);
 - ICES Benthic Habitats Advice Drafting Group (ADGBENTH) meeting. Copenhagen, Denmark, 10–13 August 2015 (Silvana Birchenough);
 - ICES Workshop on guidance on how pressure maps of fishing intensity contribute to an assessment of the state of seabed habitats (WKFBI). Copenhagen, Denmark, 31 May – 1 June 2016 (Gert Van Hoey, Silvana Birchenough, Johan Craeymeersch, Paolo Magni and Alexander Darr);
 - ICES Workshop to evaluate regional benthic pressure and impact indicator(s) from bottom fishing (WKBENTH). Copenhagen, Denmark 28 February – 3 March 2017 (Gert Van Hoey).

Contribution to ICES Ecosystem Overviews (ToR G–H, J–K)

Activities 2015–2017

- Compilation of summary text to report on the state and trends for benthic habitats, communities and Ecoregions.

Deliverables

- Text drafted and included in the Annex of the annual BEWG reports for the following ICES ecoregions:
 - Greater North Sea;
 - Celtic Seas;
 - Bay of Biscay;
 - The Iberian Coast;
 - The Baltic Sea;
 - Oceanic North-East Atlantic.

5 Final report on ToRs, workplan and Science Implementation Plan

Overview of group activities, highlights and achievements:

The benthic system is an important reservoir of biodiversity. Coastal and shelf seas ecosystems are highly productive areas, and often subject to several degrees of pressure over a series of spatial and temporal scales resulting from many types of human activities. These types of activities can directly affect species loss and create alterations, with direct effects on ecosystem processes, many functions and overall services with clear repercus-

sions for biodiversity. The benthic fauna, through their feeding, bioturbation, burrow construction and burrow irrigation activities provides a key role for marine ecosystems.

The work conducted by the BEWG is represented widely across several members (Figure 1) across topics. The number of ToRs have varied over the last 3-years (ongoing main ToRs= 5 and recently added via advisory requests additional 5 new ToRs). The backbone of the BEWG work is focussed on **scientific developments** with dedicated exploration on how the benthos contributes to many cause-effect relationships, processes, functions, services and overall biodiversity (ToRs A-E). Depending on the knowledge required, members of the group have focussed their work on ongoing tools and data aspects (e.g. long-term time-series assessments in support of climate change work); (ToR A), developing new approaches to understand key processes (e.g. bioturbation) based on modelling, distribution and mapping to test and validate several response hypotheses (ToR B). More recently, the need to support current legislative drivers (MSFD); (ToR C and D) has provided the opportunity to focus on the development of indicators (e.g. considering structural and functional attributes), understanding such interactions has created the need to fine tune response-driven processes, functions and services, within which the benthos has a great deal of contribution. A recent work raised by members of the BEWG has been to document how the benthos has been considered over biodiversity and conservation practices (particularly over MPA assessments) and how effective (e.g. over design, scale and coverage) the consideration of benthic species and habitats has been taken into the overall designation process (ToR E). The BEWG also contributes to **advisory requests** (ToR F-I), mostly: i) chairing and participating in key workshops, and responding to technical advisory requests (e.g. understanding fishing effects and the sensitivity of benthic habitats), ii) proposing indices (at the recent WKBENTH) to demonstrate trade-offs between benthic impacts and fisheries and iii) contributing with monitoring designs, indicator developments under MSFD in support of ongoing work (e.g. developed by OSPAR colleagues). Finally, the BEWG remains an active contributor of the ICES Ecosystem Overviews to show case the current state and trends of benthic species and habitats over several ecoregions, as requested (ToR G-H and J-K).

Members of the group have strong networks and linkages with different EGs (e.g. WGMHM, WGECO, WGDEC, WGMBRED, WGBIODIV) are actively encouraged to ensure that the science developed under the BEWG can integrate where possible (mainly over advisory requests and collaboration across theme sessions at the ASC). The BEWG has a set core of active members from Europe, the U.S.A. and this year new members from Ireland and Norway have joined the group.



Figure 1. Countries that have experts in the BEWG.

Science highlights:

- **Publication entitled:** Birchenough, S.N.R., Degraer, S, Reiss, H, *et al.*, (2015) Climate change and marine benthos: A review of existing research and future directions. *WIREs Clim Change*, 6: 203–223. doi: 10.1002/wcc.330.
- Members of the BEWG contributed to the following workshops and key advisory documents:
 - ICES Workshop on guidance for the review of MSFD decision descriptor 6 – seafloor integrity II (WKGMSFDD6-I). Copenhagen, Denmark, 16–19 February 2015 (Steven Degraer - chair, Silvana Birchenough - vice-chair);
 - ICES Benthic Habitats Advice Drafting Group (ADGBENTH) meeting. Copenhagen, Denmark, 10–13 August 2015 (Silvana Birchenough);
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 - ICES Workshop to evaluate regional benthic pressure and impact indicator(s) from bottom fishing (WKBENTH). Copenhagen, Denmark 28 February – 3 March 2017 (Gert Van Hoey).
- Ecosystems overviews for several Ecoregions (as described above).

Beside the scientific work conducted by the BEWG members there is also a wide range of activities, ranging from R&D programmes, workshops and relevant conferences. Some examples are outlined below:

- EU “Towards a Joint Monitoring Programme for the North Sea and Celtic Sea” (**Silvana Birchenough** led WP4: across states, **Steven Degraer** led: WP1/2:

monitoring metadata compilation and **Gert Van Hoey**: led the case study to improve current benthic monitoring methodologies).

- EU funded (H2020) research programme Columbus (Knowledge transfer for Blue growth). **Silvana Birchenough** contributes with technical knowledge on marine activities and provides linkages with ICES EGs. ICES is also represented by **Wojciech Wawrzynski** as the ICES Science coordinator.
- EU funded project EMODNET Biology phase III. **Silvana Birchenough** and **Gert Van Hoey** are direct partners. The ICES Data Centre is also represented, **Neil Holdsworth** provides examples of ICES requirements for science-evidence products. Contributions over WP 2, 4 and 5 for data provision, interpretation, brokerage events and provision of scientific outputs are the main contributions.
- EU funded project BENTHIS. **Gert Van Hoey** contributed to this research programme with benthic expertise, data sets, biological traits analysis and interpretation.
- UK funded INSITE (Oil and Gas) project entitled: "Understanding the influence of man-made structures on the ecosystem functions of the North Sea-UNDINE" (contributors: **Jennifer Dannheim**, **Steven Degraer** and **Silvana Birchenough**).
- UK funded INSITE (Oil and Gas) Blue growth data Workshop initiative (contributors: **Jennifer Dannheim** and **Silvana Birchenough**), organised by Heriot Watt University, 7th February, Edinburgh 2017. A data paper is in preparation from this activity (journal Marine Policy).
- COST Action Proposal OC-2016-2-21498 "Adaptive assessment of the environmental status of marine ecosystems: meeting end-user needs" (contributors **Paolo Magni** and **Silvana Birchenough**).
- COST Action CA15121 "MarCons, Advancing marine conservation in the European and contiguous seas" (contributor: **Steven Degraer**).
- The North Sea Open Science Conference (NSOSC), 7–10 November 2016, Ostend, Belgium. **Henning Reiss**, **Silvana Birchenough** and **Steven Degraer** were Members of the Scientific Steering Committee). Henning Reiss chaired "Session I: scientific backbone of the North Sea Ecosystem", Silvana Birchenough chaired "Session II: a new era of environmental monitoring and assessment" and Steven Degraer led the organising Committee of the Conference. **Mark Dickey-Collas** (ICES) provided the key highlights and final remarks of the NSOSC.

6 Cooperation

BEWG remains one of the oldest expert groups within the ICES community with 36 years since its origins in 1981. The group has close links with several EGs, some examples include WGMHM, WGECO, WGDEC, WGMBRED, WGBIOD, WKMSD and WGEXT. These direct links have been fostered via the advisory work requested under WKFB, ADGBENTH, WKBENTH. The work developed by the BEWG has provided dedicated technical advice to the EU Commission based on the workshop entitled: Workshop on

guidance for the review of MSFD Commission Decision descriptor 6 – seafloor integrity II, working alongside OSPAR, JRC and HELCOM colleagues. Further work based on Workshop on guidance on how pressure maps of fishing intensity contribute to an assessment of the state of seabed habitats (WKFBI) and the recent advisory workshop WKBENTH, proposing benthic indices to demonstrate trade-offs between benthic impacts and fisheries landings. These advisory workshops have provided direct interaction with VMS, WGRECORD, ICES data centre and OSPAR and HELCOM colleagues.

The BEWG has been successful in proposing and chairing joint-theme sessions during the ICES ASC meetings with colleagues from the WGMHM, PICES and OSPAR (e.g. mainly under the topic of ocean acidification with a session in 2015 and WKACIDUSE in December 2016). This year at the ICES ASC, both Steering Group on Ecosystem Processes and Dynamics (EPD) / Steering Group on Ecosystem Pressures and Impacts (EPI) proposed an open Session entitled: Functional links between pressure and state indicators. This session will be supported by presentations of several of the EGs (i.e. BEWG, WGMBRED and WGDEC).

7 Summary of Working Group self-evaluation and conclusions

The full Working Group self-evaluation is in Annex 4 of this report. This section is summarising the main conclusions.

The work conducted by the BEWG has contributed with scientific developments to the following priorities (1-4) and sub-priorities (1.1., 2.1, 3.1 and 4.1) of the ICES Science Plan.

- The main outcomes and achievements of the science conducted are summarised in publications, technical outputs advisory reports, and Ecosystem Overviews (as outlined in earlier sections of this report);
- Members of the BEWG actively have contributed to ICES drafting advisory workshops, chairing technical meetings and proposing several themes sessions for the ICES ASC;
- Members of the BEWG are actively participating across several EU and national projects, providing technical, data and scientific expertise;
- Many of the ongoing ToRs are dealt intersessionally, many of the core-members of the BEWG have shown their commitment and dedication to the group by responding to advisory requests, leading case studies and attending the annual meetings.

Future plans:

- The remit of the BEWG is to develop science and provide ‘state of art’ level of technical support to advisory requests. Members agree on the continuation of the group, there is a series of ongoing case studies and scientific publications in preparation. Further areas of interest have been discussed at our recent annual meeting. A short-list of a new set of topics will be further explored at next year meeting (see new proposed set of aims under existing ToRs in Annex III);
- Recent recommendations provided by the BEWG have aimed a better integration of common topics of interest (e.g. indicator development, legislative requirements, monitoring tools) across EGs, which can help to foster a better and

much more effective manner to produce high level outputs to showcase ICES cutting-edge science;

- Further activities under the BEWG and within ICES EGs will continue to foster links where appropriate. An example to support better integration under the BEWG and with initiatives such as EMODnet biology, could help to support the compilation of data sets are fit for advice and analytical purposes. The BEWG could play a role at workshop discussions, helping to cascade methodologies (e.g. biological traits analysis and time-series work). These activities could support and endorse EMODnet products, which could be targeted to support scientific developments and advice where appropriate.
- Members of the BEWG recognize the advantages of exploring with other EGs the potential for integration and further collaboration on common topics of interest and joint publications (e.g. via CPR assessments and drafting exercises).
- Testing scientific hypothesis via a series of targeted experiments was discussed by the BEWG members. This work will be further explored over intersessional activities.

Annex 1: List of participants

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Annex 2: Recommendations

The BEWG has provided the following recommendations for consideration, please see a summary below:

Recommendation	Addressed to
1. Following a number of advisory requests (e.g. ToR I). It is clear that active integration between and within EGs will help and foster active integration across relevant topics, promoting science across ICES EGs and avoiding duplication of efforts.	The BEWG recommended last year to explore the wider collaborative opportunities. There is a need to support wider and active collaboration with other EGs (WGMHM, WGDEC, WGVMS-Records, Data centre, etc.). An open session has been organised between EPI and EPD. More of these types of activities will help to advance, produce high outputs via dissemination of 'state of art science' (for SCICOM's consideration)
2. The BEWG has been working on development of indicators with dedicated efforts on setting baselines, cost-effective monitoring practices, data-sharing exercises and targeted need to support legislation requirements (e.g. under MSFD) to support the assessment of impacts on benthic habitats from anthropogenic activities. BEWG recommends that ICES will discuss these gaps and engage with relevant experts group to avoid duplication of efforts and complementary knowledge to be applied to these initiatives.	ICES will be aware of the relevant groups, some suggestions will be under data centre, WGECO, WGDEC, WGMBRED, WGMSFD, WKPIMP and via active engagement from the Secretariat to assist this process.
3. An area identified by the BEWG is with regards to structural and functional indicators (relevant to many aspects of the MSFD, mainly D1-biodiversity and D6-seabed integrity), particularly linking damage and functional attributes to support seabed integrity assessments. BEWG has been working on several aspects of indicators, monitoring and assessment. The BEWG suggests that better integration is fostered across EGs (e.g. workshop or a targeted session for the next ICES ASC in 2018). This activity will help to cascade ongoing developments and highlight the gaps for future work.	ICES EGs with an interest in developing science to support the Marine Strategy Framework Directive (MSFD), mainly WGBIODIV, WGECO, and others to be identified by ICES Secretariat and cascade options.

Annex 3: BEWG draft terms of reference for the next meeting

The Benthos Ecology Working Group (BEWG), chaired by Silvana Birchenough, UK will meet in Laboratoire d'Ecogéochimie des Environnements Benthiques, Banyuls-sur-Mer, France, 14–18 May 2018 to continue to work along the main ToRs of the group, these are:

- Understanding long-term benthic series and climate change;
- Providing dedicated work on species distribution modelling and mapping;
- Actively update on the ongoing developments of benthic indices and legislative drivers;
- Continue to understand and provide targeted work in relation to benthic biodiversity and ecosystem functioning;
- To contribute to ongoing work on benthic Biodiversity and conservation, particularly with emphasis on the role of benthic ecology in MPA's.
- **NEW proposed ToR: To explore the feasibility to undertake studies (e.g. laboratory or field experiments) to test ecologically relevant hypothesis in relation to benthic responses.**

Supporting Information

Priority	The current activities of BEWG will continue along the key ecological aims for the development of the EG, these are: long-term series and climate change, benthic indicators and EU directives, species distribution modelling, and benthic biodiversity and ecosystem functioning (including issues directly in connection to MPAs). All issues mentioned fit the ICES Science Programme and are considered to be of high priority with opportunity for the provision of dedicated scientific outputs. The BEWG are active contributors and aim to report their outcomes directly to ICES in their annual report and where opportune in the peer reviewed literature, for example: ICES JMS, PLOS One and ecological indicators, etc.)
Scientific justification	<p>Term of Reference a) Long-term benthic series and climate change To identify methodological issues in long-term series comparability.</p> <p>Term of Reference b) Species distribution modelling and mapping To report on ongoing case study: "Towards a benthic ecosystem functioning map: interregional comparison of two approaches"</p> <p>Term of Reference c) Benthos and legislative drivers To report on the use of benthic indicators and ongoing initiatives Variability and expert judgement of benthic species tolerances/ sensitivities To review the development of effective monitoring programmes, e.g. design, harmonisation and quality assessments (e.g. MPAs). Case study developed under the –Joint Monitoring Programme -JMP</p> <p>Term of Reference d) Benthic biodiversity and ecosystem functioning To report on the ongoing case studies to assess ecological responses across sediment gradients. To consider new functional indicator needs to support MSFD requirements. To identify links between benthic functions and ecosystem services.</p> <p>Term of Reference e) Benthic biodiversity and conservation: to review the role of benthic ecology in MPAs To review the role of benthic ecology in relation to Marine Protected Areas (MPAs)</p>

	<p>NEW proposed TOR: To explore the feasibility to undertake studies (e.g. laboratory or field experiments) to test ecologically relevant hypothesis in relation to benthic responses.</p> <p>To explore funding opportunities and collaborative proposals for setting up and conduct experimental studies;</p> <p>To compile a list of scientific ideas to develop research Master's thesis projects and promote co-supervision activities within BEWG members;</p> <p>To explore ICES support for inviting early career scientists to the BEWG annual meetings.</p>
Resource requirements	The current needs are the use of the share point during and after meetings, the use of Skype facilities to continue with ongoing intersessionally work and the support of the ICES secretariat and colleagues during planning of the annual meeting, compilation of the report and dealing with dedicated requests (e.g. additional ToRs).
Participants	The Group is normally attended by some 20–25 members and guests.
Secretariat facilities	None.
Financial	No financial implications.
Linkages to advisory committees	There are no obvious direct linkages with the advisory committees.
Linkages to other committees or groups	There is a possibility for interaction of several ICES expert groups, among which WGDEC, WGVMS, WGEKO, WGMHM and WGEXT.
Linkages to other organizations	The group has direct interaction with members of OSPAR IGC-COBAM.

Annex 4: Copy of Working Group self-evaluation

- 1) Working Group name: The Benthos Ecology Working Group (BEWG)
- 2) Year of appointment: 2015
- 3) Current Chairs: Silvana Birchenough (UK)
- 4) Venues, dates and number of participants per meeting:
 - Calvi, Corsica, France (4–8 May 2015); 30 experts
 - Lisbon, Portugal (8–13 May 2016); 28 experts
 - Gdynia, Poland (8–12 May 2017); 22 experts

WG Evaluation

- 5) **If applicable, please indicate the research priorities (and sub priorities) of the Science Plan to which the WG make a significant contribution.**

In relation to the ICES Plan research priorities, the work conducted by the BEWG has contributed to the following aspects:

1. Describe and quantify the state of North Atlantic Ocean regional systems
 - 1.1 Assess the physical, chemical and biological state of regional seas and investigate the predominant climatic, hydrological and biological features and processes that characterise regional ecosystems;
2. Understand and forecast the impact of climate variability and change on marine ecosystems
 - 2.1 Quantify the different effects of climate change on regional ecosystems and develop species and habitat vulnerability assessments for key species
3. Resolve and quantify ecological processes in marine ecosystems, including modelling the dynamics of food webs and their responses to environmental change
 - 3.1. Quantify the role of structural and functional diversity in marine ecosystems in providing stability and resilience;
4. Quantify the relationship between habitat condition, ecological processes and the provision of ecosystem goods and services
 - 4.1. Identify indicators of ecosystem state and function for use in the assessment and management of ecosystem goods and services.

- 6) **In bullet form, list the main outcomes and achievements of the WG since their last evaluation. Outcomes including publications, advisory products, modelling outputs, methodological developments, etc. ***

This is the first time that the BEWG has conducted this evaluation process. The most relevant outcomes and achievements are outlined below:

- Birchenough, S.N.R., Degraer, S, Reiss, H, *et al.*, (2015) Climate change and marine benthos: A review of existing research and future directions. *WIREs Clim Change*, 6: 203–223. doi: 10.1002/wcc.330.

- Van Hoey *et al.* (*under review*) “Back to the future: Designing a regional monitoring programme to support marine benthic ecosystem assessments” ICES JMS.
- Contribution to ICES Ecosystem Overviews on the benthic habitat (geology, dynamics and diversity), for several ICES ecoregions: Greater North Sea, Celtic Seas, Bay of Biscay & the Iberian coast and Baltic Sea, the Iceland Sea and Norwegian Sea ecoregions.
- ICES Workshop on guidance for the review of MSFD decision descriptor 6 – sea-floor integrity II (WKGMSFDD6-II). Copenhagen, Denmark, 16-19 February 2015.
- ICES Workshop on guidance on how pressure maps of fishing intensity contribute to an assessment of the state of seabed habitats (WKFBI),
- ICES Benthic Habitats Advice Drafting Group (ADGBENTH) meeting. Copenhagen, Denmark, 10-13 August 2015
- ICES Workshop to evaluate regional benthic pressure and impact indicator(s) from bottom fishing (WKBENTH). Copenhagen, Denmark 28 February – 3 March 2017

7) Has the WG contributed to Advisory needs? If so, please list when, to whom, and what was the essence of the advice.

The BEWG has contributed to the following advisory products:

- ICES Workshop on guidance for the review of MSFD decision descriptor 6 – sea-floor integrity II (WKGMSFDD6-II). Copenhagen, Denmark, 16-19 February 2015.
- ICES Workshop on guidance on how pressure maps of fishing intensity contribute to an assessment of the state of seabed habitats (WKFBI),
- ICES Benthic Habitats Advice Drafting Group (ADGBENTH) meeting. Copenhagen, Denmark, 10-13 August 2015
- ICES Workshop to evaluate regional benthic pressure and impact indicator(s) from bottom fishing (WKBENTH). Copenhagen, Denmark 28 February – 3 March 2017

8) Please list any specific outreach activities of the WG outside the ICES network (unless listed in question 6). For example, EC projects directly emanating from the WG discussions, representation of the WG in meetings of outside organizations, contributions to other agencies’ activities.

Additional opportunities for wider interaction across BEWG members is supported by R&D programmes, workshops and relevant conferences. Some examples are outlined below:

- EU “Towards a Joint Monitoring Programme for the North Sea and Celtic Sea” (Silvana Birchenough led WP4: across states, Steven Degraer led:

WP1/2: monitoring metadata compilation and Gert Van Hoey: led the case study to improve current benthic monitoring methodologies).

- EU funded project EMODNET Biology phase III. Silvana Birchenough and Gert Van Hoey are direct partners along with the ICES Data Centre (Neil Holdsworth). Contributions over data provision, interpretation, brokerage events and provision of scientific outputs for several partners.
- EU funded project BENTHIS. Gert Van Hoey contributed to this research programme with benthic technical expertise in relation to benthic data and biological traits analysis.
- UK funded INSITE (Oil and Gas) project entitled: “Understanding the influence of man-made structures on the ecosystem functions of the North Sea-UNDINE” (contributors: Jennifer Dannheim, Steven Degraer and Silvana Birchenough).
- UK funded INSITE (Oil and Gas) Blue growth data Workshop initiative (contributors: Jennifer Dannheim and Silvana Birchenough), organised by Heriot Watt University, 7 February, Edinburgh 2017.
- COST Action Proposal OC-2016-2-21498 "Adaptive assessment of the environmental status of marine ecosystems: meeting end-user needs" (contributors: Paolo Magni, Silvana Birchenough).
- COST Action CA15121 “MarCons, Advancing marine conservation in the European and contiguous seas” (contributor: Steven Degraer)
- The North Sea Open Science Conference, 7–10 November, Ostend, Belgium 2016. Henning Reiss, Silvana Birchenough and Steven Degraer were Members of the Scientific Steering Committee). Henning Reiss chaired “Session I: scientific backbone of the North Sea Ecosystem”, Silvana Birchenough chaired “Session II: a new era of environmental monitoring and assessment” and Steven Degraer led the organising Committee of the Conference.

9) Please indicate what difficulties, if any, have been encountered in achieving the workplan.

The BEWG has worked well as per the agreed ToRs and additional SCICOM/ACOM requests. Some of the new initiatives have taken longer to make progress as most of the work has been conducted intersessionally. The BEWG discussed the opportunity for ICES to explore dedicated funding opportunities (e.g. ICES Science Fund or equivalent mechanisms) to support the EGs with resources enabling further collaborations and the possibility to answer applied scientific questions. Similarly, inviting early career scientists to our annual meetings will help to expand our current network, providing training opportunities to develop future scientists. Equally, active integration across the work conducted by BEWG with other EGs will help the development of high impact products and helping to avoid duplication of efforts.

Future plans

10) Does the group think that a continuation of the WG beyond its current term is required? (If yes, please list the reasons)

YES. The group actively continues to develop new ideas, with several case studies. A number of outputs are in preparation under several ToRs. Equally, the work published by the BEWG has attracted new members this year from Norway and Ireland.

11) If you are not requesting an extension, does the group consider that a new WG is required to further develop the science previously addressed by the existing WG.

N/A

12) (If you answered YES to question 10 or 11, it is expected that a new Category 2 draft resolution will be submitted through the relevant SSG Chair or Secretariat.)

A list of recommendations were added in our summary table. These suggestions are in connection with the integration of ToR across EGs, to avoid duplication, creating a stronger overview of ICES science. The chair of the BEWG is keen to improve the scientific products by elevating the profile of the group.

13) What additional expertise would improve the ability of the new (or in case of renewal, existing) WG to fulfil its ToR?

Discussions on ongoing and new work were discussed by the group. Some emerging topics such as barcoding, genetics, food web-modelling, diseases affecting benthic organisms under changing climate conditions and the emerging effects of deep-water mining on benthic habitats, were topics of interest. A prioritisation exercise will have to be done, to ensure the necessary skills are available within this group or another ICES EG.

14) Which conclusions/or knowledge acquired of the WG do you think should be used in the Advisory process, if not already used? (please be specific)

The BEWG has often provided technical advice on several advisory requests. Whilst these requests have been targeted with an specific end-point (e.g. OSPAR or European Commission request), there are additional opportunities, where the BEWG could provide assistance and make wider contributions. Some bullet points are provided below with dedicated suggestions:

- Importance of benthic systems (structure and functioning) for ecosystems assessments, particularly in connection with indicator development i.r.t. MSFD and OSPAR/HELCOM assessments;
- Better integration of benthic shelf seas and deep-water habitats;

- Understanding and assessing benthic impacts resulting from deep-water mining activities;
- Innovative tools to support cost-effective benthic monitoring and assessments;
- Assessing the role of climate change and ocean acidification on commercial species (e.g. benthic calcifiers such as mollusc, crustaceans);
- Promote better application and interaction of benthic-pelagic understanding in marine systems. This work could help to support an enhance ICES Ecosystem Overviews across several ecosystems and ecoregions.

Annex 5: Ecoregions (ToR K, ICES/BEWG May 2017)

Review the content drafted for the state/trends of the benthic community/habitat for the Ecosystem Overviews of i) the Iceland Sea and ii) Norwegian Sea ecoregions

Provide draft text on the state and trends of the benthic community/habitat that could be used for an Ecosystem Overview for iii) the Oceanic north–east Atlantic and for iv) the Azorean ecoregion

Ecoregion: Oceanic North East Atlantic (203 words)

(source: <https://www.ospar.org/convention/the-north-east-atlantic/v>)

Ecosystem overview

Oceanic North East Atlantic, also known as the Wider Atlantic or OSPAR Region V, represents the deep waters of the North-East Atlantic extending across the abyssal plain and the Mid-Atlantic Ridge, and including many seamounts. Human population in the region is restricted to the Azores Archipelago. The main human activities, outside Azores archipelago, are fishing and maritime transport. Its topography ranges from continental slopes, through the sharply fluctuating seabed associated with seamounts, banks of fragmented continental rocks and the Mid-Atlantic Ridge, to extensive areas of almost featureless abyssal plain.

Benthic communities

Bottom sediments vary according to the topography and the local currents. Where the topography is rugged, crustal rocks may be exposed, especially along the Mid-Atlantic Ridge and in the Charlie Gibbs Fracture Zone where the seafloor was formed relatively recently. However, on the abyssal plains the seabed is generally covered with thick accumulations of sediment.

The benthic communities, even if few data available, seems much richer in species than the pelagic communities, and show a similar latitudinal step in species richness. There have been recent discoveries of a number of different fragile deep-sea habitats (such as hydrothermal vents, carbonate mounds, cold-water coral reefs, coral gardens and sponge communities).

Annex 6: BEWG 2017 meeting

The third annual meeting of the Benthos Ecology Working Group was attended by 22 experts, representing 11 countries (Belgium, France, Germany, Ireland, Italy, Netherlands, Norway, Poland, Sweden, the United Kingdom and the United States) and was held at the Morski Instytut Rybacki (National Fisheries Research Institute) in Gdynia, Poland on 8–12 May 2017.

Director Dr Emil Kuzebski welcomed the group at his Institute followed by some introductory information by our local host Jan Warzocha and Silvana Birchenough chair of the BEWG. After brief round table introductions (current and new members) rapporteurs were appointed, which are this year: chief rapporteur Hans Hillewaert assisted by Steven Degraer. The report deadline was set at 30 June 2017 and involves the final report and the self-evaluation.

The agenda was accepted without major changes.

Long-Term benthic series and climate change (ToR a)

A background and history to the ToR was presented. Despite lots of ideas and enthusiasm lack of follow-up due to time constraints and the size of the initiatives proposed was noted. Belts-Net encountered difficulties with obtaining data, but fulfilled its purpose of bringing some data together in one place and concentrating focus on the benthic time-series available. EMODNET Biology phase III was introduced, for more information see: <http://www.emodnet-biology.eu/news-0?p=show&id=4960>

BEWG members are participants in this initiative as well as the ICES Secretariat. The chair will explore potential avenues to invite BEWG to participate on relevant surveys and workshop meetings.

A metadata table of long-term series is available. Despite having some gaps a full table might not necessary to have full coverage for a review paper on benthic long-term series. A simpler analysis paper might also be an option.

Species distribution modelling and mapping (ToR b)

Introductory presentation:

Towards a benthic ecosystem functioning map: interregional comparison of two approaches

Mayya Gogina, Alexa Wrede, Jennifer Dannheim, Jan Holstein, Henning Reiss, Jan Vanaverbeke, Gert van Hoey, Nicolas Destroy, Steven Degraer, Vera Van Lancker, Aurélie Foveau, Silvana Birchenough, Michael L. Zettler

Based on macrobenthic data available from four regions (German Baltic Sea, German North Sea, Belgian North Sea and English Channel) community bioturbation potential (BPc), an indicator of benthic faunal function based on bioturbation, was constructed. Key species contributing to bioturbation at each of the study areas were identified. Different sets of relevant available environmental layers were used as predictors to model and map the spatial distribution of this indicator, separately for each area, to explore the drivers of BPc patterns, and to highlight the regional differences. Results of two model-

ling approaches are to be compared: i) BPC initially calculated per station is treated as response variable for distribution modelling with random forest ensemble learning method; or ii) BPP of key species (responsible for 70–90 % of total BPC) were used as response variables to predict their full coverage distributions, and these population estimates are subsequently summed up to the BPC. The applications of the regionally derived maps are discussed.

A sub-group discussed on how to conclude and produce a structure for a paper.

Benthos and legislative drivers (ToR c)

On the use of benthic indicators and targets for management: Compatibility and complementarity (c.1)

Introductory presentations:

A regional benthos assessment method for the southern North Sea using Margalef diversity and reference value modelling

Willem M.G.M. van Loon; Dennis J Walvoort; Gert van Hoey; Christina Vina-Herbon; Abigayil Blandon; Roland Pesch; Petra Schmitt; Jorg Scholle; Karin Heyer; Marc Lavaleye; Graham Philips; Gerard Duineveld; Mats Blomqvist

The aims of this study were to develop (a) a common benthos assessment method, which is the most sensitive and precise for common pressures in the Southern and Northern North Sea, especially fisheries and organic enrichment, (b) is the most precise to model reference values, (c) shows the best assessment precision and (d) is suitable for use as a common method within the Southern North Sea, and potentially in other European marine regions. Margalef diversity appeared to be the best performing benthic index regarding these four criteria, even better than several MMI combinations with e.g. AMBI and the Infaunal Trophic Index. Therefore, this relatively simple and very practical index and reference estimation method was selected as benthos assessment method for European OSPAR and MSFD applications, and applied to the benthos data from the Southern North Sea in the period 2010–2015. The results show in general lower normalized Margalef scores in coastal waters, and higher normalized Margalef scores especially in the deeper offshore water.

Reference values of the tested benthic indexes (species richness, Margalef diversity, SNA index, Shannon index, PIE index, AMBI, ITI) were estimated using index values from a six-year period, and an improved variable percentile method, in which the percentile value used is adjusted to the average ICES fishing pressure in the period 2009–2013. The percentile values used were 75 (low fishing pressure), 95 (medium fishing pressure) and 99 (high fishing pressure). The estimated reference values obtained using this method appeared to correlate quite well with the median depth of the assessment areas, with model precisions of R^2 0.86 for Margalef (sigmoid model) and R^2 0.95 for SNA (linear model). It appeared that this depth-reference value of Margalef was quite useful to assist in the estimation and confirmation of reference values, for example in the case of insufficient benthos data within an assessment area.

For the fisheries-index testing normalized index values were used (index value divided by estimated reference value), because it was assumed that the same level of fisheries

pressure has a larger absolute effect on more biodiverse and deeper living benthic communities compared to more robust benthic communities in the coastal zone, but that the relative effect, tested using normalized index values, is comparable. A clear exponentially decreasing relation (R^2 0.26, $p < 0.00001$) between both subsurface and surface fishing activity and normalized (assessment value divided by reference value) Margalef diversity values was found, with an asymptotic normalized Margalef value of approximately 0.45 at a fishing activity > 2.3 subsurface sweeps/year. This asymptotic value is predominantly found in coastal waters, and probably shows that the naturally already more robust benthic communities have transformed into resilient benthic communities, which are not sensitive any more to increasing fishing pressure.

Discussion:

The subsequent discussion was mainly focusing on the validity of the chosen approach, since it mainly reflects the fisheries effort patterns. Thorough testing of the model is required to provide a fit for purpose tool used in management.

BENMMI benthos data analysis software: functions and some applications

Willem van Loon, Dennis Walvoort and Gert van Hoey

A case study within the Southern North Sea was performed for the development of an OSPAR BH2 common benthos indicator to optimize the most pressure sensitive benthos MMI and to make it applicable to the available benthos data.

A benthos data analysis tool was developed in the statistical open source software R, called BENMMI. It does among others a clean-up of benthos data, species name standardization according to WoRMS, data exploration, index calculation, optimization of MMIs using the benthos data combined with pressure data, index and EQR calculation, assessments of areas and habitats, and reporting of results in a report and data files. This tool will be made freely available on the R CRAN website in the course of 2017.

National or regional red lists of marine benthic species and its use in terms of nature conservation

Michael L. Zettler and Mayya Gogina

So-called “Red Lists” or “Red Data Books” exist for many plants and animals around the world on local, national, regional and global scale. So far there are only few red lists existing around the world that encompass marine benthic species. Some of these instruments also exist for marine invertebrates to document the threat of species in different spatial scales. The presentation demonstrates an example from the German Baltic Sea to encourage an exchange of ideas or an initiative on simple questions dealing with “Red Lists”. Few of these questions could be: (i) Do we need a red list for marine invertebrates in the ICES area? (ii) Do we place our Marine Protected Areas (MPAs) correct or (iii) do MPAs cover hot spots of biodiversity/red listed species?

Update on the progress made on development and use of OSPAR benthic habitat indicators and perspectives on applying ecosystem and risk-based approaches**Guérin Laurent, Elliott Sophie, Vina-Herbon Cristina, Meakins Bryony, Pesch Roland and Serrano Alberto**

The Marine Strategy Framework Directive (MSFD) aims to implement an integrated ecosystem-based and a risk-based approach, to manage the anthropogenic pressures on the marine environment within European Union waters. MSFD reporting by Member States is made up of numerous indicators which help quantify, pressure or impact on components of the marine environment or its state. Unfortunately, there are many unknowns about the marine environment including the extent and condition of benthic habitats and the effect of accumulative or co-occurring pressures and impacts on benthic habitats from anthropogenic activities.

Through work developed within the European funded EcApRHA project in conjunction with the development of indicators within OSPAR's regional seas convention, several indicators were developed as well as integration methods to combine them. Two of these benthic habitat indicators have been adopted and used to contribute to the OSPAR 2017 intermediate assessment. Two others have been recently developed and are soon to be proposed for adoption as common indicators for the next cycle. The last indicator is still under-developed. New integration methods provide perspectives towards a future, more efficient and complete assessment of benthic habitats, against various pressure types.

Overview and progress of the Benthoval project**Celine Labrune, Olivier Gauthier, Jacques Grall, Anxo Conde and Antoine Grémare**

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 BVal, 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 the proportion of species abundance from the reference station that are lost in the tested station. This index is tested on Scandinavian datasets related to metals disturbance and on a French dataset of maerl beds physically impacted by extraction. Results obtained with the BVal index are compared with those obtained with other biotic indices.

Discussion:

The group discussion addressed several methodological issues relevant in such kind of ecosystem assessment. The value of such additional indices that specifically capture the dynamics of regional systems was pointed out, whereas other more widely used indices were not suitable. Especially the importance of disappearance of species from sites should be weighed more strongly within benthic quality assessments.

On the myths on indicators: To investigate the importance of species autecology in indicator development and application (c.2)

An update was given on the group on last year's initiative on studying the variability in expert assessments of benthic species tolerances/sensitivities. The subsequent plenary discussion was focusing on the immediate actions necessary to promote this initiative. Controversial opinions were apparent about including a thorough review of the sensitive of the selected species. However, it was agreed that we will continue with the study based on the original objectives and evaluate the actual results before we decide about the level of literature based sensitivity assessment. Immediate action was taken by approaching a social scientist to assist in the development of the questionnaire, and to draft the species list for the different regions.

To review the development of effective monitoring programmes, e.g. design, techniques, improvements, harmonisation and quality assessments (c.3)

Based on an initiative from 2016 (ICES CM 2016/SSGEPD:04), G. Van Hoey presented the paper 'Back to the future: Designing a regional monitoring programme to support marine benthic ecosystem assessments' (Van Hoey *et al.*), which was submitted in March 2017 to ICES Journal of Marine Science. In a brief discussion, the division of ecoregions into strata with similar characteristics was highlighted as an important approach.

Benthic biodiversity and ecosystem functioning (ToR d)**Update overview and current plans (d.1)**

Introductory presentations:

The essential role of the benthic fauna communities in the coastal biotopes of the Puck Bay**Urszula Janas, Marta Słomińska, Halina Kendzierska and Marta Tykarska**

The Gulf of Gdańsk is characterized by relatively high heterogeneity of coastal biotopes and diversity of benthic communities. However, to date the role of these communities in benthic nutrient fluxes and sediment reworking is still not well understood. The complex information about how different benthic taxa influence biogeochemical processes is essential to get comprehensive view of ecosystems functioning. In our study we focus on the functional role of benthic fauna in organic matter transformation and nutrient fluxes at the water-sediment interface in different biotopes of the Puck Bay. For this purpose, we compare structural and functional diversity of macrozoobenthos using Biological Trait Analysis (BTA), burial depth and Bioturbation Potential Index (BPI) at the bare soft sediment inhabited by different species of infauna as well as on the *Zostera* meadows and *Mytilus* beds. We found more pronounced differences in biological traits than just taking into account taxa composition and biomass. However, data about some biological traits are limited (e.g. nitrogen or phosphorus content in animals). This functional approach will be further used together with oxygen and nutrient fluxes measurements, which were simultaneously run in our studies, to show broader view of coastal biotopes functioning and the effect of different benthic communities on the processes in the sediment-water interface. The presented results are part of the studies on the role of benthic fauna in the coastal filter of the Baltic Sea realised within BONUS-COCOA project.

The importance of size: an investigation towards a quantitative bioirrigation model

Alexa Wrede, Lars Gutow, Jennifer Dannheim and Thomas Brey

Biogeochemical cycling in shallow water marine systems is strongly promoted by macrofaunal activities such as bioirrigation. Attempts to predict bioirrigation have been made through various models. Nevertheless, the focus of these models remains on the physical environment around the bioturbator and reduces the organism to a mechanistic entity. Considering however the changes in functional species composition that are caused by anthropogenic interventions and climate change, only a model that understands the bioirrigator as a living organism will be able to realistically describe and predict spatial and temporal patterns of bioirrigation.

A good approach has been made by Solan *et al.* (2004) who proposed the descriptive non-quantitative concept of community bioturbation potential (BPC). Accordingly, this study aims to combine the basic concept of BPC with the information gained from single and multispecies mesocosm experiments to develop a bioirrigation model, which will for the first time enable the quantitative modelling of macrofaunal bioirrigation activity over large spatial and temporal scales.

Reference:

Solan, M., Cardinale, B.J., Downing, A.L., Engelhardt, K.A.M., Ruesink, J.L., Srivastava, D.S., 2004. Extinction and ecosystem function in the marine benthos. *Science* 306, 1177-1180.

In the literature survey it became apparent that there are so far very few studies on the link between biodiversity and ecosystem functioning. As a lot of effort was put into the literature survey and we see a clear need for studies on this topic it was decided to write a viewpoint paper. This viewpoint paper will focus on the lack of research on the link between biodiversity and ecosystem functioning that is however clearly wanted by the MSFD D6.

It was decided on the draft's preliminary structure that will state that that so far indicators are structural while functionality is lacking in literature. Furthermore, also in monitoring there is an apparent lack in studies on ecosystem functioning. It was argued that indicators like the bioturbation potential (BPC) can be a way forward for the MSFD. A suggestion to submit a viewpoint article to the journal "ECOLOGICAL INDICATORS" was decided due to the high impact and speedy turnover.

The high number of citations was discussed as a problem for a viewpoint paper. As a solution it was proposed to present the literature references of the survey in the supplementary material. It was also proposed to communicate on this topic with the editors when handing in. To highlight the message of the viewpoint paper it was proposed to create a horrendogram. However, it was argued that there is already a paper out that could be cited. As another issue the time scale of indicators was brought up. The deadline for a first draft of the paper was set for the 10th of July.

J. Vanaverbeke advertised the summer school that will be held on STARESO (Corsica) from the 17–21 July (<http://labos.ulg.ac.be/mast/wp-content/uploads/sites/37/2017/05/SummerSchoolAnnouncement-.pdf>). It will focus on the relationship between biodiversity and ecosystem functioning. The summer school will

encompass the theoretical background, hands on practical experience and modelling. In general, the target participators are early career scientists.

Update on ongoing case study “Changes in functional composition along a sediment gradient” (d.2)

Introductory presentations:

Marine and freshwater Amphipoda from the Baltic Sea and adjacent territories

Michael L. Zettler and Anja Zettler

A new key book on amphipods for the Baltic Sea was presented. It is an attempt to consider all marine species observed at least once in the whole catchment area including some newly arrived non-indigenous species. 243 amphipod species (190 marine and 53 freshwater species) are listed and in most instances pictured and described. The present book covers species of three different amphipod suborders, Gammaridea, Senticaudata and Hyperiidea.

Reference:

Zettler, M. L. & Zettler, A. (2017) Marine and freshwater Amphipoda from the Baltic Sea and adjacent territories – Tierwelt Deutschlands 83. Teil, Herxheim, 845 pp.

Marine invertebrates of the Belgian part of the North Sea

Hans Hillewaert

A poster on invertebrate species of the Belgian part of the North Sea (BPNS) was presented. With a mere 3450 km², the BPNS represents only a small fraction of the North Sea. Five distinct communities are described for the area. The structural characteristics in the muddy *Limecola balthica*, fine muddy sand *Abra alba* community and the well sorted medium sand *Nephtys cirrosa* community had been defined previously (Van Hoey *et al.*, 2004, Degraer *et al.*, 2008). However, in the offshore area there is the *Hesionura elongata* community (previously *Ophelia borealis*), found in medium to coarse sands. Though this community was initially described by low diversity and abundance, it now has second highest diversity and moderate abundances. Also a new community, the *Magelona-Ensis directus* community, was found in fine sand in very shallow water and characterized by low diversity values and the dominance of the alien invasive species *Ensis directus*.

Since the arrival of decent digital imaging techniques in 2005 the collection of high resolution photographs of benthic and epibenthic species has steadily increased resulting in the current poster.

Z-stacking, a technique which combines multiple images taken at different focus distances to give a resulting image with a great depth of field was explained.

Changes in functional composition along sediment gradients

Alexander Darr and Michael L. Zettler

Understanding the influence of environmental parameters on macrobenthic 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 macrobenthic communities in the western Baltic Sea is determinable, but less distinct than on species composition. 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, ...). 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 were planned to be finished until the end of the 2015, while analysis was foreseen to start in 2016.

Discussion:

The emphasis of the case study initiative needs to change as although the data required has been collected, to produce a paper on the original purpose would involve too much work to harmonise and QA the different data sets. There was interest to take this work forward but addressing different research questions, however a potentially similar paper (Bolam *et al.*) that has been recently published needs to be considered.

Reference:

Bolam, S. G., C. Garcia, J. Eggleton, A. J. Kenny, Lene Buhl-Mortensen, G. Gonzalez-Mirelis, Tobias van Kooten *et al.* (2017). "Differences in biological traits composition of benthic assemblages between unimpacted habitats." *Marine Environmental Research* 126:1-13.

Update on planned work assessing new functional indicator needs to support MSFD requirements (d.3)

Introductory presentations:

Ecological Engineering: The implications of faunal species loss on carbon sequestration by coastal sediments.

William Hunter, Neil Ogle and Nessa O'Connor

Coastal seas cover 7 % of the global seafloor but account for 80 % of marine carbon dioxide fixation and burial. Consequently, they are important in the regulation of atmospheric carbon dioxide and in marine nutrient cycles. Coastal ecosystems are sensitive to human-induced pressure from fisheries and pollution resulting in faunal species loss. In marine sediments, microbial activity is a major driver of carbon fixation, recycling and burial. These microbial processes are mediated by changes in faunal activity, bioturbation and trophic interactions. Faunal species loss will, therefore, have indirect effects upon primary production by the microphytobenthos (primarily diatoms and cyanobacteria) at the sediment surface, and the recycling of organic matter by heterotrophic microorgan-

isms. Mesocosm-based experiments were conducted to test how the presence of three ecosystem engineers, the shore crab (*Carcinus maenas*), the ragworm (*Alitta virens*) and the lugworm (*Arenicola marina*), affected micro-algal carbon fixation at the sediment surface, and the recycling carbon within the sediment community. Stable-isotope pulse chase techniques were employed to trace the fixation of ¹³C-labelled sodium bicarbonate by the microphytobenthos and the retention of carbon in the sediment microbial community, alongside changes in sediment community respiration, primary production and dissolved nutrient fluxes. The results of these experiments provide new insights into the mechanisms through which faunal species loss alters carbon sequestration within coastal sediments.

Update on the draft paper 'ecosystem functions and ecosystem services: misconceptions and benthos matters' (d.4)

This work has been ongoing since 2014. There was a presentation and a draft report presented to show case the progress done to date. A list was created to relate ecosystem services to the respective ecosystem functions. This was done by compiling an Excel table that also included the different habitats. For many functions it was argued that one has to distinguish between minor and major contribution of the habitat to that function. It was stressed that it will be very important to introduce benchmarks that define minor and major contribution. The work is being translated into a peer review publication led by Paul Montagna.

Introductory presentations:

The Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES) initiative and its relevance to the ICES-BEWG

Paolo Magni

The Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES) is an independent intergovernmental body open to all member countries of the United Nations established in Panama in April 2012. Its objective is to provide policy relevant scientific information as well as policy relevant information drawn from indigenous and local knowledge to inform decision making, in response to requests made by governments and other stakeholders (Díaz *et al.* 2015a, b).

Four Regional/Sub-regional assessments (Africa, the Americas, Asia and the Pacific, and Europe and Central Asia) are currently being carried out on biodiversity and ecosystem services. These assessments are conducted by experts from each relevant region, selected from the lists of nominations received from governments and organizations, and undertake periodically external reviews. IPBES aims to finalize these assessments at the sixth session of the IPBES Plenary in March 2018.

As a Lead Author nominated by the EuroMarine Network (<https://www.euromarinenetwork.eu/>) and selected by IPBES for the Asia-Pacific assessment, I provided a general overview of this initiative and related assessments with a focus on their relevance to the marine realm and the benthos. On a related note, a call for reviewers for the regional and global assessments (<http://ipbes.net/sod-review>) within BEWG members was made. Links are possible with other initiatives: United Nations and UNEP.

References:

- Díaz, S., *et al.*, 2015a. The IPBES Conceptual Framework – connecting nature and people. *Current Opinion in Environmental Sustainability*, 14: 1-16.
- Díaz, S., Demissew, S., Joly, C., Lonsdale, W.M., Larigauderie A., 2015. A Rosetta Stone for Nature's Benefits to People. *PLoS Biology* 13(1): e1002040.

Benthic Biodiversity and conservation: to review the role of benthic ecology in MPA's (ToR e)

Introductory presentations:

A benthic ecology perspective for evaluating the effectiveness of MPAs – are the current MPAs enough to protect endangered benthic species?**Paolo Magni and Clare Greathead**

Implementation of the MSFD will ultimately require programmes of measures that balance human activity with a functioning marine ecosystem. MPAs can be viewed as one of the many management tools available to reach Good Environmental Status (GES). Therefore, 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. These MPAs should, if utilised correctly, contribute to an ecosystem's resilience to further anthropogenic pressures such as climate change.

This ToR reflected concern within ICES-BEWG that the process of selecting MPAs within these networks did not adequately consider the unique conditions required for benthic habitats and species to achieve GES. In addition, benthic habitat and species are poorly considered when assessing the performance of MPAs and the effectiveness of conservation measures. An MPA's objectives may include protection of benthic habitats and species, but pressures that affect these features are not removed. Also there may be a mismatch in an MPA's objectives and the use of measurements that are not adequate for assessing benthos.

It was decided to summarize MPA case studies in a table (including the entries on MPA's adjustment, scoping, assessment, and performance measures) using the conceptual scheme published by Stelzenmüller *et al.* 2013 as a starting point. It was agreed that the initiative will consider those MPA's within European marine regions the BEWG had experts for. This allowed a neutral way for evaluating MPA management from a benthic ecology point of view, exploring whether benthos was tackled adequately. An evaluation of the populated table will be conducted using a critical mass of case studies. A manuscript draft was developed on the issues highlighted in the table and subsequent analysis of responses. Plenary discussions around this ToR also emphasised the importance of benthic ecological functions to the success of MPAs. Specifically, that conservation measures to reduce anthropogenic pressures in MPAs may not adequately consider the ecological functions and therefore services provided by benthic habitats and species. This topic could be addressed further in future MA ToRs.

Reference:

Stelzenmüller, V., Breen, P., Stamford, T., Thomsen, F., Badalamenti, F., Borja, Á., *et al.* (2013). Monitoring and evaluation of spatially managed areas: a generic framework for implementation of ecosystem based marine management and its application. *Marine Policy*, 37:149-164.

ICES Working Group on Marine Benthic and offshore Renewable Energy Development– WGMBRED (Gdynia, 6–10/03/2017)

J. Dannheim provided an overview of the ongoing work of the ICES working group on “Marine Benthic and Renewable Energy Developments” (WGMBRED) established in 2012. The group met for the fifth time in Gdynia, Poland. The second meeting within the second 3-year multi-annual cycle and was co-chaired by J. Dannheim (AWI, Germany) and Andrew B. Gill (Cape Euleuthera, The Bahamas, affiliated to Cranfield, UK). The meeting continued to work across the established terms of references.

WGMBRED works towards the understanding of ongoing knowledge gaps related to the benthic ecosystem by differentiating among different marine renewable energy technologies, i.e. particularly wave, tidal and tidal stream energy devices in contrast to offshore wind farms. This work continues to update a matrix summarising the cause-effect relationships of different energy devices on benthos. A network and interaction analysis under ToR c, covers the information within WGMBRED in co-ordination to other relevant groups (advisors, regulators, stakeholders, policy makers, scientists, etc.) to support the evaluation on how the impact of WGMBRED can modify the ongoing scientific outputs. An overview of the current results based on the network analysis was supported by a questionnaire sent out to colleagues. A total of 220 respondents contributed to the study. Overall ToR d concentrates on the assessment of ecologically relevant temporal and spatial scales in relation to MREDs effects on the benthic system and the evaluation of the consequences in relation to environmental policy and decision-making. Further work concentrated on ToR d deals with assessing relevant indicators, exploring options to enable their operation in support of assessing ecosystem functioning with regards to observed changes in benthos resulting from WGMBRED at scales connected to the work developed under ToR a. WGMBRED agreed to combine scale issues (ToR a) and indicators (ToR d) aspects jointly as there is a complementary aspect. Dedicated case studies on scale and indicators were developed across representative areas (e.g. North Sea, Baltic Sea, West of Scotland). These case studies are focussing on the benthic ecosystem functions for societally important issues (e.g. biodiversity, food provision and biogeochemical services) helping to identify indicators on ecologically relevant scales. A summary of their annual report can be found at:

www.ices.dk/community/groups/Pages/WGMBRED.aspx