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## Report of the Benthos Ecology Working Group (BEWG)

22-25 April 2013

A Coruña, Spain



**ICES**

International Council for  
the Exploration of the Sea

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## Executive summary

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The Benthos Ecology Working Group (BEWG) was hosted by the Instituto Español de Oceanografía and held its 2013 meeting at the Rectorado of the Universidad da Coruña, both in A Coruña, Spain. The meeting was attended by 16 participants, representing 8 countries. The meeting was structured along the four BEWG core business issues: Benthic long-term series and climate change, benthic indicators, species distribution modelling and disentanglement of the link between biodiversity and ecosystem functioning.

The work done by the Study Group on Climate-related changes in the Benthos of the North Sea (SGCBNS) was reviewed and agreements were made to further the work initiated within BEWG. The launch of the initiative to facilitate the analysis of benthic long-term series (BeLTS-net), shared among BEWG and SGCBNS, was prepared for.

The review comments on the draft BEWG research paper “On the myths of indicator species: issues and further consideration in the use of static concepts for ecological applications” were evaluated and practical arrangements to revise by August 2013 the manuscript were made. BEWG will further continue working on the application of benthic indicators in relation to European environmental legislation (e.g. Water Framework Directive, Marine Strategy Framework Directive and Habitats Directive). Our focus will be on (1) the position of benthos in mentioned directives and the related assessment tools and (2) the demands of those benthic indicators, their feasibility and redundancy. A work plan will be drafted intersessionally for approval and execution during the BEWG 2014 meeting.

The draft BEWG review paper on “Species distribution modelling and mapping (SDM) in the marine environment and its relevance for ecosystem management” was reviewed and agreements for final scrutinisation by autumn 2013 were made. BEWG further elaborated on an intersessional search for literature on the link between (benthos) diversity and ecosystem functioning, which will further be scrutinised intersessionally to (1) assess whether functional indicators for marine ecosystem functioning are proposed/implemented as yet, and (2) perform a gap analyses during next BEWG meeting(s). BEWG further made agreements on an intersessional drafting process to finalise a position paper on (1) the misconception between ecosystem functioning and ecosystem services, (2) the importance of benthos within this respect and (3) the ecosystem service consequences of benthic biodiversity loss.

BEWG’s next meeting will take place in Dinard, France on 28 April – 2 May 2014.

## 1 Opening of the meeting

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The Chair, S. Degraer, opened the meeting at the Rectorado of the Universidad da Coruña in A Coruña, Spain. S. Degraer welcomed the participants and gave a brief summary on the recent work carried out by the Benthos Ecology Working Group. He 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 agenda structure of the meeting follows these main themes. 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 to take the lead as editorial rapporteur. Afterwards, the participants introduced themselves and gave a short review of their scientific activities. 16 participants from 8 countries attended the meeting (Belgium, Germany, Norway, Russia, Spain, the Netherlands, United Kingdom and the United States), two participants contributed remotely (from Belgium and Germany). Finally, the local host, S. Parra welcomed the participants on behalf of the Instituto Español de Oceanografía and presented the benthos related work done at his Institute.

### **The Spanish Institute of Oceanography, IEO: A century of marine research**

S. Parra gave the introductory presentation outlining the work of the Spanish Institute of Oceanography, IEO

IEO is a public research institution depending on the Secretariat of State for Research, Development and Innovation under the Spanish Ministry of Economy and Competitiveness. It focuses on research into marine science, especially in terms of scientific knowledge of the oceans and the sustainable use of its living resources and the marine environment. It was one of the first institutions in the world to fully devote itself to research into the sea and its resources. It was officially founded in 1914, although its origins date back to the 19th century.

IEO provides scientific advice to the Spanish Government on fisheries policies, the sustainable use of fish, shellfish and other marine resources, and on the marine environment and its protection. IEO represents Spain in most international scientific organizations related with the sea, its resources and their protection.

IEO carries out its research work through its nine Oceanographic Centres distributed all around the Spanish coast. Moreover, it has the largest oceanographic fleet in the country, made up of eight ships, a tide gauge network, a permanent oceanographic buoy and satellite receiving station.

In this institution there are three main areas of research: The Marine Living Resources and Fisheries Area studies marine living resources, their biology and dynamics, and their relationships with the environment and with other marine species and human activities, under the umbrella of an ecosystem approach to fisheries management. The Marine Environment and Environmental Protection Area carries out multidisciplinary and interdisciplinary research on the dynamics of the ocean and oceanographic processes, combining physical, chemical, biological and geological information gathered via multiple platforms to evaluate their influence on the ecosystem, biodiversity and marine living resources. The Aquaculture area focuses on the improvement of production and rearing techniques of species already commercially cultivated (gilthead, bass, turbot, sea bream, sole, mussel, clams, scallop) and on the

evaluation of the potential of new species to be reared and grown in captivity (European hake, bluefin tuna, Mediterranean bonito, wreck fish).

## **2 Adoption of the agenda**

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The group unanimously adopted the agenda without changes (Annex 2).



### 3 Long-term series and climate change

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#### 3.1 Report on recent findings on long-term data series analyses and other climate change-related benthos activities.

##### 3.1.1 Scaling up-the effects of ocean acidification: moving from single species to community effects and the wider ecological implications

*Silvana Birchenough Cefas, UK reported.*

Evidence suggests that absorption of carbon dioxide (CO<sub>2</sub>) in the ocean has already decreased pH levels by 0.1 pH units since 1750 and CO<sub>2</sub> concentrations are projected to increase further by the end of the century as fossil fuel reserves continue to be exploited. The CO<sub>2</sub> increase is altering the chemistry of the oceans, making them more acidic (referred as ocean acidification-OA). The potential effects of OA have prompted considerable interest among scientists and concern among policy makers and industry (Birchenough *et al.* 2013).

According to the 2008 UK Climate Change Act the government is required to conduct a Climate Change Risk Assessment (CCRA) every five years, and shortly after that, to put in place a National Adaptation Programme (NAP) that addresses the most pressing threats or enables the UK to capitalise on any opportunities. The first UK CCRA (published in January 2012) highlighted that many maritime industries and aquatic organisms may be sensitive to OA but knowledge concerning OA effects is still limited. SB presented the outcomes of Cefas research in relation to OA and metal toxicity (Roberts *et al.*, 2013) as well as research conducted to scale up the observed OA effects resulted from laboratory experiments. Some preliminary fish analysis was also presented to showcase the effects of OA on fish consumption (ICES YOS and DAPSTOM database) to indicate the preferences of the fish, primarily on benthic echinoderms (e.g. *Amphiura*). SB also highlighted the work developed by Lee & Pinnegar (*in preparation*) to predict the OA effects on the UK shellfisheries, including aquaculture. This research is still ongoing but there was indication of considerable losses in mollusks fisheries as well as shellfish due to pH changes.

SB also introduced the aims of a new 3-year Defra funded programme PLACID (Placing Ocean acidification

PLACID project will help to address some of these gaps, concentrating mainly on understanding the OA effects on commercial species (lobsters, crab, cockles and whelks). This research will provide evidence of the effects of OA on commercial species, helping to produce marine evidence-base for the next CCRA. In particular the project will generate: (1) current understanding of OA effects in shellfish fisheries, including quantification of economic valuation and magnitudes; (2) information via multi-factorial experiments (considering different life stages) to investigate the effects of different stressors (temperature, metals, oxygen) and OA (at different pH changes) which are likely to change in the future; (3) Modelling studies will include the experimental evidence to determine some of OA effects on larval growth, Dynamic Energy Budgets (DEB) for 'scaling-up laboratory results as well as assessing the distribution of biogeography range modelling; (4) monitoring data (TA/DIC) to inform the variability of the carbonate system in UK waters in support of long-term OA observatories.

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## 3.2 BELTS-net and SGCBNS

### 3.2.1 Review activities of the Study Group on Climate-related changes in the Benthos of the North Sea (SGCBNS). Recommend future actions for SGCBNS, based on the SG's 2011/2012 work

The Study Group on Climate related Benthic processes in the North Sea (SGCBNS) was initiated by the ICES Benthos Ecology Working Group (BEWG) as a follow up initiative of the former North Sea Benthos Surveys (NSBS 1986; NSBP 2000). The aim was to facilitate future research activities concerning benthic ecosystem processes related to climate change and to establish a network of benthic long-term series. The last meeting was organized by the chairs (Silvana Birchenough, UK and Henning Reiss, Norway) of the SG in November at Plymouth Marine Laboratory, UK.

The main objectives of the SG were to study benthic ecosystem processes and to facilitate future research on this topic. These objectives were addressed by initiating two case studies on spatio-temporal patterns of bioturbation, representing a key ecosystem process in benthic environments, and to establish and further develop the benthic long-term series network (BeLTS-net) in collaboration with the Benthos Ecology Working Group (BEWG). Three papers were initiated (one paper submitted) during the course of the SG and an extensive compilation of bioturbation trait metrics of 1042 benthic species was conducted, which will be available for the scientific community.

During this year's SG meeting, the establishment and promotion of BeLTS-net was discussed (Tor a). BeLTS-net is a platform to enable joint analyses of marine benthic long term series by collaborative work of scientists. J. Craeymeersch is the chair of BeLTS-net initiative. A draft presentation provided by H. Hillewaert containing the lay-out of the website was presented and a discussion for the dissemination of the network was also covered during the meeting.

During the SG meeting also the production of a methods paper to report on the current metric used to enable the calculation of benthic bioturbation (e.g. bioturbation potential- BPC) was compiled (Paper: *Bioturbation classification of European marine infaunal invertebrates*; submitted to *Ecology and Evolution*).

The second aim of the meeting was to continue with final analysis of the work initiated in 2011 for case study 1 (Paper: *Assessment of the fine scale temporal variability in coastal sediment bioturbation*; Tor b). The preliminary results showed a high seasonal variability of bioturbation potential with maxima in the summer month in most study areas. All of the outstanding analyses were conducted at the meeting and a final draft is in preparation at present. The group agreed to submit this work to *Global Ecology and Biogeography* in the second half of 2013.

The third aim was to progress work for case study 2 (*Paper: Spatial variation in BPC and vulnerability of ecosystem functioning in the North Sea; Tor c*). The dataset of the ICES North Sea Benthos Project 2000 (NSBP 2000) will be used for this purpose. These data sets were extracted during the meeting and a compilation of additional information needed for the analyses was initiated, i.e. the update of the master species list with bioturbation categories and the compilation of macrofauna data to calculate the mean individual weights of species. First analyses and drafting of the CS2 manuscript was reported during the ICES BEWG at La Coruna and further work will be continued intersessionally and a draft document with the initial analysis will be circulated in September 2013.

### **3.2.2 Evaluate the progress made within BELTS-net and to identify further actions, taking account of the progress made within SGCBNS**

A final release of the website was presented by H. Hillewaert. The structure of the site provides for a general introduction on the aims and targets of the project as well as a layout of the concept. A comparison with other initiatives is given, focussing on the differences in concept and the relations to other networks. The mainstay of the site is a member-only forum which will facilitate exchange of information. On this forum new initiatives will be advertised and members will have access to existing contributions when they submit their results.

The final hurdle to be taken is making the site live. This requires a hosting site which supports Joomla, an open source content management system (CMS) and Kunena, a forum extension for the former. Wageningen University in The Netherlands may provide web space for the hosting.

## **4 Benthos related quality assessment**

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### **4.1 Revise the BEWG paper on “The myths of benthic indicators”, part 1**

The research manuscript “On the myths of indicator species: issues and further consideration in the use of static concepts for ecological applications” was drafted intersessionally and submitted for publication in PLOS ONE in February 2013. In summary, the paper demonstrates the indicative value of static indicator species, in which the sensitivity to stressors does not account for possible shifts in sensitivity along natural environmental gradients and between biogeographic regions, is questionable. In this paper we demonstrate how species responses (i.e. abundance of six macrobenthic species from the North Sea, Baltic Sea and the Mediterranean Sea region) to changes in sediment grain size and organic matter (OM) change along a salinity gradient and conclude with a plea for prudence when interpreting static indicator-based quality indices. In conclusion, the following points have to be carefully considered when applying static indicator-based quality indices: (1) species tolerances and preferences may change along environmental gradients and between different biogeographic regions, (2) as environment modifies species autecology, there is a need to adjust indicator species lists along major environmental gradients and (3) there is a risk of including sibling or cryptic species in calculating the index value of a species.

BEWG received the review comments prior to its meeting. During the meeting, the review comments were evaluated. The allocation of tasks on how to revise the manuscript as to comply with the review comments, were agreed upon. A revised version of the manuscript will be submitted in August 2013.

### **4.2 Review and report on the use of benthic indicators and targets within WFD, MSFD and Habitats Directive: Compatibility and complementarity**

During the BEWG meeting in 2012, it was agreed to continue working on the application of benthic indicators in relation to European environmental legislation (e.g. Water Framework Directive, Marine Strategy Framework Directive and Habitats Directive). BEWG wants to contribute to the integration of knowledge and ongoing work on indicators within the aforementioned EU directives.

A subgroup investigated contributions for comparing the various on-going initiatives on national and international level (e.g. other ICES groups, OSPAR working groups, regional groups [e.g. HELCOM]). The discussion mainly focused on two aspects: (1) the position of benthos in the above mentioned directives and the related assessment tools and (2) the demands of those benthic indicators, their feasibility and redundancy. Not only the regular and general indicators are considered, but also those reflecting on benthic functioning (productivity, traits,...). It should be noted that there is a clear discrepancy between what the wish list on indicators for a system could be and what is finally proposed by the different member states. Meanwhile there are different steps involved in compiling a reduced list.

A table summarizing information on benthic indicator selection (e.g. wish list versus proposed list) in different marine regions and countries will be constructed as a first step in contributing to this discussion by the BEWG. A second supporting step will be the discussion on the identification of criteria for defining an acceptable indicator list that is capable to signal changes within the complex benthic ecosystem.

The subgroup will tackle the task of collecting the necessary information intersessionally for further discussion and reflection during the BEWG 2014 meeting.

## 5 Marine habitat modelling and mapping

### 5.1 Introductory presentations

#### 5.1.1 Report on recent initiatives on habitat suitability modelling and mapping

Initial findings from a survey of a potential MPA on the West coast of Scotland  
*Clare Greathead, Phil Boulcott, Jose-Manuel González-Irusta, John Clarke*

An ecologically coherent network of well-managed marine protected areas is vital to conserve and regenerate our seas. In Scotland 33 Nature Conservation MPA proposals have now been developed with a further 4 MPA locations remain to be fully assessed. If every one of these proposals taken forward for designation, the new MPAs would represent 12% of the area of Scotland's seas, taking the total of all types of marine protected area to over 20%.

The primary objective of this survey was to locate suitable monitoring sites in two potential MPA locations to constitute a baseline survey for a BACI study. Subsequent surveys will aim to study the effect of closing the area to specific types of disturbance, e.g. prawn trawling. Areas within the study site (Small Isles potential MPA) were chosen that were expected to contain at least one of the Priority Marine Features (PMFs), identified by Scottish Natural Heritage that could be managed by spatial measures, specifically: Burrowed mud, *Funiculina quadrangularis* (Tall sea pen), *Pachycerianthus multiplicatus* (Fireworks anemone), *Aracnanthus sarsi* (Burrowing anemone), *Parazoanthus anguicominus* (White cluster anemone), *Swiftia pallida* (Northern sea fan), *Atrina fragilis* (Fan mussel), and *Leptometra celtica* (Celtic feather star).

In all 12 discrete sites were chosen that showed a variety of seabed types from mud to boulders; included at least one of the PMFs and were areas that were likely to stay inside the MPA and areas likely to be outside the MPA. Approximately 1 km<sup>2</sup> boxes were created at these sites. Video transects were created by lowering a camera frame to approximately 2 m above sea bed and drifting through the box (Figure 1). Notes from the video footage were taken "live". Every 1-2 min the frame was lowered to enable a photograph from the digital stills camera to be taken (1.5 m above seabed); 2232 DSI were taken.

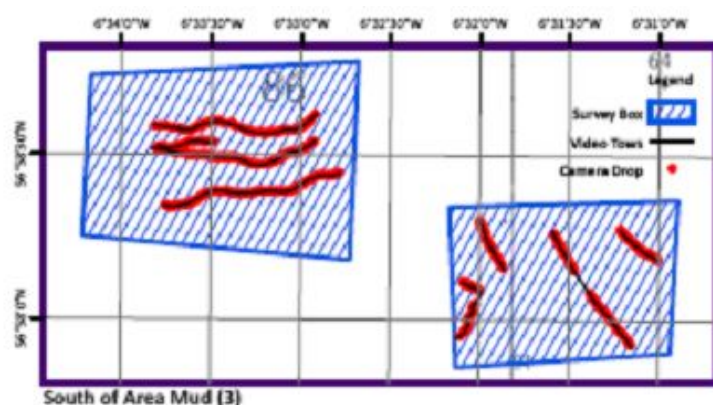


Figure 1: Site survey boxes with drift lines (Video tows) and positions of DSI (Camera drops)

All the DSI were analysed for presence and absence, which created a reduced species list of 71 taxa (some only to order or family). Burrows > 2 mm in soft sediment were also counted to potentially enable a Bioturbation score to be assigned. The substrate

type and species present were combined to create unique community codes, which were used to create community distributions in GIS. These community codes were tested using MDS plots in PRIMER. The findings of this baseline survey will be used to identify a viable survey structure for future surveys.

Data from this study and previous studies will be combined to create habitat suitability models for each of the PMFs. Also, after several more surveys comparisons will be made between sites that were outside the potential MPA and inside potential MPA using multivariate analysis of the community data and pressure data (e.g. VMS).

### 5.1.2 Species distribution models: A practical comparison in the Banco de La Concepción seamount (Canary Islands)

*C. Greathead reported on work by J.-M. González-Irusta, B. Almón, R. Sarralde and P. Martín-Sosa.*

An example to highlight potential issues with choosing the methodology for modeling species distribution: Presence/Absence vs. Presence only

This presentation was for the preliminary results of work that was carried out in collaboration with people from the Spanish Oceanographic Institute of the Canary Islands laboratory as part of the INDEMARES project. The study area was the Banco de La Concepción seamount (north-east of the Canary Islands). In the past this was an island but now it is a seamount 158 m below sea level. This seamount is one of the ten study areas included in the LIFE + project INDEMARES ([www.indemares.es](http://www.indemares.es)), whose main objective was to identify valuable areas around the Spanish coast for the Natura 2000 Network.

Two different statistics (AUC and Kappa) were used to analyse the performance of four models; Ecological Niche Factor Analysis (ENFA) and Maximum Entropy Algorithm (MAXENT) (presence only models); GLM/GAM and Random Forest (RF)(Presence/Absence models). The ecological niche of four species of sea urchin were compared (*Stylocidaris affinis*, *Coelopleurus floridanus*, *Centrostephanus longispinus* and *Cidaris cidaris*). These species were among the most abundant invertebrates (in number and biomass) in the area studied and *C. longispinus* has also management importance.

In summary the results of these analyses were:

- GLMs and Random Forest (Presence-Absence models) showed the highest values for both statistics (AUC and Kappa) in all the species studied. The differences between both models for AUC, kappa and both together were not significant in any species.
- MAXENT showed good performance in most of the studied species (although always lower than the presence-absence models), with the values of AUC and Kappa being especially high in urchins with narrow niches. The differences between MAXENT and the presence-absence models was significant in some cases depending on the species and the statistic analysed.
- ENFA showed the poorest performance of the four models analysed. The differences between ENFA and the presence-absence models were statically significant in most of the cases (for at least one of the statistics)

So, for the BEWG are these issues a concern and if so is there any advice or recommendations that the BEWG can provide?

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- MAXENT: <http://onlinelibrary.wiley.com/doi/10.1111/j.1472-4642.2010.00725.x/pdf>
- GLM/GAM: [http://cnr.usu.edu/files/uploads/faculty/edwards\\_publications\\_species\\_distributions.pdf](http://cnr.usu.edu/files/uploads/faculty/edwards_publications_species_distributions.pdf)

### 5.1.3 Predicting distribution patterns of selected North Sea benthic species in response to climate change

*M. Weinert presented.*

The overarching aim of this research is to predict the changes in distribution patterns and functional composition of benthic communities in response to the expected climate change based on IPCC scenario A1B.

Species distribution models (SDMs) have generally been under-utilized in the marine realm relative to terrestrial applications (Robinson *et al.* 2011). SDMs are numerical tools that combine observations of species occurrence or abundance with environmental estimates (Elith and Leathwick, 2009). They commonly utilize these associations to identify environmental conditions within which populations can be maintained, and to then identify where suitable environments are distributed in space (Pearson, 2007). Compared to the terrestrial environment, accessing and monitoring marine benthic species is particularly difficult and SDMs can help to predict species distribution on large scales for different regions or time periods. Knowledge of the spatial distribution of species and communities is an essential requisite to gain insight into ecological processes in marine ecosystems and to guide ecosystem management strategies, (Reiss *et al.* 2011). The use of SDMs within the research about marine benthic invertebrates is still in its early stage and when applied in the North Sea the focus of these studies was mainly on a local scale (Degraer *et al.* 2008, Meißner *et al.* 2008 and Willems *et al.* 2008). Reiss *et al.* (2011) made the first attempt to model the distribution of benthic species for the entire North Sea. Although climate change is supposed to severely affect benthic communities in the future, our understanding of distribution shifts and large scale distribution patterns is limited and mainly restricted to coastal environments (Birchenough *et al.* 2011). In this study shifts in distribution of off-shore benthic communities in response to climate change will be modelled for the first time. First preliminary results were presented at the end of the presentation.

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#### **5.1.4 Impact of introduced red king crab on the benthos of the Barents Sea.**

Igor Manushin reported on the influence of introduced red king crab (*Paralithodes camtschaticus*) on native macrobenthos of the Barents Sea.

In the early sixties of last century Soviet scientists successfully introduced red king crab from the Pacific Ocean into the Barents Sea. King crab, a predator that can weigh up to 6 kg, is a very valuable commercial product. The exploitable population is estimated at tens of millions of individuals in the Russian part of the Barents Sea. Crab area is constantly expanding and is shifting eastwards into the Russian part of the sea.

With the crab's increasing pressure on the benthos average feeding depth changed from preferred deep water to shallow waters. The area where *P. camtschaticus* occurs has been divided into two parts: west - where the crab has been living for 50 years and east where the crab has been around for 20 years. In the western part the crab had a food shortage crisis. The lowest values for the stomach fullness index were observed in the late nineties. When benthos resources were insufficient red king crab switched to consuming fish waste. In the eastern part a crisis is still ongoing as benthos consumption by the crabs has not yet reached a its estimated maximum. The feeding grounds of red king crab in the region has also shifted from deep water with an average benthos biomass, to shallow waters that sustain a much higher benthos biomass.

Food selectivity index calculations showed that the available benthos cannot sustain the existing number of crabs.

Benthos in five stations in Motovsky Bay is monitored to assess the impact of *P. camtschaticus* on the resident fauna. Total benthos biomass has decreased since the introduction of the red king crab. Some abundant species show a significantly reduced biomass while others, such as many echinoderm species, almost completely disappeared.

## **5.2 Finalise the BEWG review paper on "Species distribution modelling and mapping (SDM) in the marine environment and its relevance for ecosystem management"**

During the BEWG meeting in 2011 an initiative was started to write a review publication on the use of distribution models (DM) within an ecosystem management context. The main objective of this review is to provide an overview of the prospects and limitations of using DM for ecosystem management purposes. In total, 16 BEWG members from 9 countries contributed to the review. A first draft was distributed prior to the BEWG meeting in 2012, followed by a revision until the meeting in 2013. The aim for this year's meeting was (i) to discuss the status of the manuscript and



identify the weaknesses, (ii) to develop a working schedule for the final revision and submission of the manuscript and (iii) to identify a core group of members finalising the manuscript.

These tasks were tackled within a subgroup during the meeting, which was also designated to be the core group for the finalisation of the manuscript. The group agreed upon the main changes needed for finalising the manuscript. The manuscript at this stage provided a detailed overview of different modelling methods, data needs and different aspects of applications within ecosystem management. Nevertheless, the chapters differed remarkably in their level of technical detail and focus on management issues. The main critical points for the revision were to reduce the level of detail to an extent needed for addressing our objectives and to strengthen the core messages of the review. In addition, critical issues regarding DM applications in marine ecosystem management need to become more explicit and visible (also in the figures). Every subchapter was checked accordingly during the group discussion, specific tasks were identified and members of the core group were selected to work on the different aspects. The minutes of the subgroup discussion together with the latest version of the manuscript were distributed among the core group directly after the meeting. The revision was scheduled for end June with the aim to submit the paper end July. An additional editorial meeting to finalise the manuscript in Ghent was taken into consideration, but will depend on the timing and the available funding. The review should be either submitted to 'ICES Journal of Marine Science' or 'Global Ecology and Biogeography'. The latter journal has priority, but the editors need to be contacted first to find out if the review is suitable for this journal.

## 6 Work towards disentangling the link between biodiversity and ecosystem functioning (Tor D)

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- Review and identify benthic indicators to reflect the link between both aspects
- Review and report on how ecological function and diversity relates to different parts of the benthic communities at different spatial scales;
- Review the data compilation on functional diversity of macrobenthos in relation to ecosystem functioning, and to scope for further research

### 6.1 Linking ecological function and benthic diversity

J. Vanaverbeke reported in a Skype session on the progress with respect to Tor D: “Work towards disentangling the link between biodiversity and ecosystem functioning”. Since the meeting of BEWG in Iceland in 2012, most progress was made in the compilation of literature linking functional diversity of macrobenthos to ecosystem functioning. At BEWG 2012, four key papers dealing with the biodiversity-ecosystem functioning relation were identified:

Bolam SG, Fernandes T, Huxham M (2002) Diversity, biomass, and ecosystem processes in the marine benthos. *Ecological Monographs* 72:599-615

Covich AP, Austen MC, Bärlocher F, Chauvet E, Cardinale BJ, Biles CL, Inchausti P, Dangles O, Solan M, Gessner MO (2004) The role of biodiversity in the functioning of freshwater and marine benthic ecosystems. *BioScience* 54:767-775

Gessner M, Inchausti P, Persson L, G Raffaelli D, S Giller P (2004) Biodiversity effects on ecosystem functioning: insights from aquatic systems. *Oikos* 104:419-422

Wilsey BJ, Potvin C (2000) Biodiversity and ecosystem functioning: importance of species evenness in an old field. *Ecology* 81:887-892

Web of Science was used to run a search for all the papers that cited one of the papers mentioned above. This resulted in a list of 357 papers. This list was reviewed and cleaned by (1) removing double entries; (2) excluding papers dealing with terrestrial or freshwater habitats and (3) excluding papers obviously not dealing with marine benthos. As such, a literature, consisting of 128 papers exclusively dealing with the relation between marine macrobenthos and ecosystem functioning was obtained. A first analysis revealed that this list was not covering the majority of the macrofaunal biodiversity-ecosystem functioning field, as many papers start from the concept of ecosystem engineering. These papers were not always picked up by the Web of Science search. A fifth paper was proposed to be added to fill this gap. This paper is

Aller RC, Aller JY (1998). The effect of biogenic irrigation intensity and solute exchange on diagenetic reaction rates in marine sediments. *Journal of Marine Research* 56:905-936.

This would result in an extra 174 references, to be added to the existing list of 128 papers.

An *ad hoc* group scrutinized the references of the Aller & Aller paper during the meeting based on the three aforementioned criteria and extracted relevant papers.

The abstracts of the final list will be scanned and a table mentioning the ecosystem-function considered will be constructed, the functional aspect of the macrofauna communities will be linked to it and investigated species and possible indicators mentioned. This should result in a first overview of the recent work done in the macrofaunal biodiversity-ecosystem functioning research, and will allow to (1) assess

whether functional indicators for marine ecosystem functioning are proposed/implemented as yet, and (2) perform a gap analyses. For the latter, meta-analysis is considered, highlighting research needs to link diversity with ecosystem functioning and/or to develop suitable indicators.

## **6.2 Linking ecosystem functions and ecosystem services: misconceptions and benthos matters**

P. Montagna reported on the progress made by P. Montagna and David Yoskowitz (Texas A&M University-Corpus Christi, USA) towards drafting a paper on: Ecosystem Function and Ecosystem Services Provided by Benthos. The draft paper deals with the identification of the link between ecosystem functioning and ecosystem services, with a specific goal to identify ecosystem services provided by benthos. The draft paper draws heavily from three previous reports: a conceptual model of a bay system (Montagna et al. 1996), comparison of ecosystem functioning and productivity (Balcom et al. 2011), and conservation plan for ecosystem services (Montagna et al. 2011). In summary, ecosystem services cannot be considered the same as ecosystem functioning, since ecosystem functioning is inextricably covering those ecosystem assets linked to production and productivity. Still, many examples exist in which both terms are considered synonyms. Ecosystem services are the benefits that humans receive from our natural environment that sustains human health and well-being and hence includes traditional market and non-market assets. Understanding (the maintenance of) ecosystem services is hence key to managing sustainability in a science-based ecosystem approach which endpoint is to sustain ecosystem services. The idea and introduction of the concept of services in the terrestrial environment can be traced back to two articles from the 1960s in which all humans benefited from the existence of wildlife and not just the sportsman (Helliwell 1969; King 1966). The early work culminated in the Millennium Ecosystem Assessment. Lists of ecosystem services have evolved over the years, but a recent description of 23 ecosystem services and examples are provided by Farber et al. (2006), falling into four broad categories: supportive functions and structures, regulating services, provisioning services, and cultural services. Most of the work on ecosystem services focusing on terrestrial ecosystems, the Millennium Ecosystem Assessment (2005) listed only four ecosystem services provided by the oceans including food, climate regulation, nutrient cycling, and recreation; all of these only little related to marine benthos. Benthos however is a very important habitat component of coastal and ocean ecosystems, and this is much undervalued. On one hand, most people don't care about sand or mud, but on the other hand, nearly all ecosystem services are habitat based, and benthic habitats dominate coastal regions. There is an urgent need for a public education campaign about benthic resources at risk. In particular, we need to make sure resource managers understand importance and values of benthic ecosystems.

While reviewing the list of ecosystem services BEWG identified the open ocean to provide 20 ecosystem services (not five as previously reported). Most of these services are associated with benthic habitats. During its meeting BEWG reviewed the definition of these ecosystem services and brainstormed about examples from the benthos. Agreements were made on intersessional elaboration. A position paper on (1) the misconception between ecosystem functioning and ecosystem services, (2) the importance of benthos within this respect and (3) the ecosystem service consequences of benthic biodiversity loss, will be drafted for fine tuning during next BEWG meeting.

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## 7 Other business

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### 7.1 Update BEWG's research plan: Moving from yearly to multi-annual ToRs

BEWG reflected on the transition from annual Terms of Reference (ToRs) to multi-annual ToRs. The multi-annual structure will increase flexibility. The reporting framework will also change: the first two annual reports of a cycle will be activity reports (action points and forward plans etc.) and the 3<sup>rd</sup> annual report will be a scientific report. The latter would highlight achievements and will be used to evaluate the work of the group.

Given the election of a new chair, which is planned for during its next meeting, BEWG considers this report transitional. The report therefore follows the structure of the former ICES working group reporting template, while (1) focusing on activities rather than scientific achievements and (2) already drafting the proposed ToRs for its next meeting in multi-annual ToR perspective. BEWG is hence ready to start its multi-annual ToR cycle from 2014 onwards.

### 7.2 BEWG outreach initiatives

BEWG co-organised four theme sessions at international science conferences:

- Alistair Maltby, Erwin Winter, Steven Degraer, Bjorn Tunberg & Jennifer Dannheim: ASC 2012 Theme Session "How does renewable energy production affect aquatic life?"

During the session several presentations demonstrated that after years of monitoring we already have a relatively good view on localised environmental impacts of offshore wind developments and are able to start formulating hypothetical pathways and cumulative impacts of future development. Small-scale changes (in casu enrichment) to the soft sediment benthos nearby the windmills in Belgian waters for example were found to gradually extend to over 50 m from the erosion protection layer. This enrichment is believed to be at least partly caused by the settlement of the organic matter produced by the rich fouling communities on the artificial hard substrates, as exemplified by investigations of biofouling communities in the Netherlands and Germany. Extrapolating the locally increased productivity, not at least by blue mussels *Mytilus edulis* in German waters, to the southern North Sea actually pinpointed towards the significant ecological change (i.e. increase in filtration rate) as a consequence of the cumulative impact of the wind farm construction plans in this area. This local increase in productivity, accompanied by the absence of fisheries disturbance within the wind farms seem to also have impacted the larger soft sediment benthos at greater distance from the wind mills, as exemplified by the larger e.g. brown shrimps *Crangon crangon* and plaice *Pleuronectes platessa* inside a Belgian wind farm. Fish were also found to be attracted to the artificial hard substrates with observation of high densities of two-spotted gobies *Gobiusculus flavescens* in Danish waters, pouting *Trisopterus luscus* in Belgian waters and cod *Gadus morhua* in Dutch and Belgian waters. Although high dissimilarities in behaviour may be detected between individuals of the latter species, cod seems to feature a rather higher site fidelity, which could not be demonstrated for sole *Solea solea*. Marine mammals such as harbor porpoises *Phocoena phocoena*, were finally demonstrated to be highly sensitive to excessive noise levels generated by windmill pile driving activities. Other renewable energy installations, such as tidal bar-

rages and freshwater hydro schemes, were also shown to have major impacts on the marine ecosystem with for example, a significantly lower retention capacity of cod eggs in hydropower dam-impacted Norwegian fjords, a tidal barrage-induced mortality in estuarine fish resulting from direct strike and pressure disturbance, and a general failure of mitigating measures such as fish passages along river dams. The session also focused on how we could increase the efficiency of the monitoring in the future. High resolution imaging and consequent digital image analysis is very promising here for bird surveys, but also for biofouling analyses (e.g. barnacle recognition), as is the use of habitat maps to observe and evaluate changes in biotopes. An updated and fine-tuned Band model for bird strikes now allows for a far more detailed prediction of actual bird collision in wind farms and can make recommendations on turbine height to help developers and consenting authorities. Efficiency could however also be increased by an increased international collaboration. Lessons-learned from cross-border comparisons might help paving the best way forward, in which there should be room for an understanding- rather than an observation-oriented scientific scope. BACI studies were informative in exploring for possible effects, but the next level is understanding mechanisms underlying such effects. This will enhance extrapolation and prediction of effects for future sites and moreover enable to analyse cumulative effects in relation to other human stressors. Essential in this respect, is the a timely sharing of data and knowledge. The session ended with a call for increased attention to hypothesis based research on offshore windfarm environmental impact, which set the scene for an active discussion.

Discussion highlighted the knowledge gaps that still remain concerning ongoing renewable energy developments, such as the uncertainties around the effect of excessive noise levels on larval and juvenile fish. One observation was that we are starting to understand the changes which offshore wind developments cause, but we still are uncertain whether these changes are favourable or not. This of course is a very subjective decision and work on the cumulative impacts needs to be assessed so that strategic and legal decisions can be made. It was also highlighted that offshore wind developments need to be taken into context against other activities in the marine environment which are not assessed e.g. navy explosion tests. A further question on this subject asked what we could understand from existing knowledge on community changes from wrecks and offshore oil installations if this was upscaled to the current offshore wind development proposals, on the basis that new monitoring now might not be able to contribute to marine spatial planning in time. A final point on marine spatial planning was that as our understanding increases, we are able to construct installations with reduced impact, but that this is compromised by the, "first come, first serve" policy of marine development meaning that these sites are already occupied by less efficient and more damaging schemes.

A final reflection of the session was that offshore wind farms was quite well represented, but that the cumulative impact of other renewable energy schemes on species of ICES concern, in particular diadromous fish, is perhaps trailing behind and that this should be pursued in a future ICES workshop.

- Angel Borja, Steven Degraer & Tundi Agardy: ASLO Theme session proposal "Ecosystem-based Marine Spatial Planning for better management of our oceans".

Human pressures on marine ecosystems have recently increased dramatically with both traditional (e.g. fishing, resource extraction, pollutant discharges and shipping) and more recent (e.g. offshore aquaculture and renewable energy installations) human activities. Many countries have developed new legislation to address these challenges, seeking for a sustainable use of marine goods and services through an ecosystem-based management encompassing all ecosystem components. Marine Spatial Planning (MSP) is an excellent framework to consider present and future human activities and to systematically plan for a better management of the oceans. In this session methodologies for MSP were presented (use of GIS, niche and ecosystem models, game theory, etc.), as well as case-studies examples of MSP (e.g. Basque Country, New England, North Sea, and the wider Europe). The lessons drawn from the plenary discussion of this session include: (i) the need for a true multidisciplinary approach to MSP, including managers, policy-makers, marine scientists and socio-economists as to encompass all socio-ecological assets of the marine environment; (ii) the understanding of MSP as including all four dimensions of the marine environment (horizontal, vertical, time), including both seafloor and pelagic habitats, each with their specific temporal dynamics; (iii) the need for an early stakeholder participation not only to address conflicts among users and determine compatibilities, but also to ensure the inclusion of their knowledge and expertise throughout the MSP process, making them aware of concepts like MSP and ecosystem-based management; and (iv) the importance of a clear communication and education on uncertainty in MSP, which by no means equals unreliability.

BEWG proposed two new theme sessions to be organised during the ASC 2013, both of which were unfortunately declined:

- Henning Reiss & Silvana Birchenough: Theme session proposal “Long-term changes of benthos and climate change effects”.
- Steven Degraer, Jacques Populus & Roger Coggan: Theme session proposal “Better maps for better management: Improving the integrity of habitat maps”.

Outreach initiatives are highly valued by BEWG, as to increase its visibility and as such create a platform for attracting the attention (new) benthos ecologists. New outreach initiatives considered are:

- A proposal for a Theme Session at the ICES ASC 2014,
- A presentation of this year’s main achievements at the Science Steering Group on Ecosystem Functioning session at the ASC 2013: key messages from BELTS-Net and SGCBNS, and from its papers on species distribution modelling, on the myths of indicators and/or on ecosystem services
- Launch and continued promotion of BELTS-net also outside ICES, e.g. European Biological Symposium.
- The importance of using the standard acknowledgment text for publications or presentations from initiatives originating with BEWG, was highlighted once more: ‘This publication was initiated and facilitated by the Benthos Ecology Working group (BEWG), which is an expert group of the International Council for the Exploration of the Sea (ICES)’

The potential platforms for outreach initiatives will be monitored intersessionally and opportunities highlighted within BEWG.

### **7.3 Reports from relevant conferences, workshops, etc.**

Jennifer Dannheim reported on the newly established ICES working group on “Marine Benthic and Renewable Energy Developments” (WGMBRED). The group met a first time in Caen (19-22 March 2013) and is chaired by J. Dannheim (AWI, Germany) and Andrew Gill (Cranfield University, UK). The meeting was attended by 21 experts, representing nine countries. The meeting focused on three topics, basically dealt with in three subgroup with plenary feedback sessions: (a) a ‘knowledge group’ evaluating and reviewing existing knowledge on the effects of offshore renewable constructions and related topics (e.g. artificial reefs), (b) a ‘monitoring group’ reviewing and evaluating sampling techniques and the scientific efficiency of ongoing monitoring programmes and (c) a ‘metadatabase group’ developing a database of metadata that will help to cross-foster research and target monitoring, as well as future modelling approaches. More details on its achievements may be found at <http://www.ices.dk/community/groups/Pages/WGMBRED.aspx>.

WGMBRED will hold its next meeting in Talin, Estonia (25-28 March 2014).



## **8 Meeting conclusions**

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The group opted to hold next year's meeting on 28 April – 2 May in Dinard, France. Nicolas Desroy from CRESCO – IFREMER (Laboratoires Environnement Littoral & Ressources Aquacoles Finistère - Bretagne Nord, Station de Dinard) accepted to host the meeting.

The Chair thanked the local host and his team for their excellent hospitality and generosity. Next to the excellent accommodation provided to BEWG, especially the excursion to Santiago de Compostella and the dinner at Domos were much appreciated.

He also thanked the participants for their input and closed the meeting on Friday, 14:30 hours.

## Annex 1: List of participants

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## **Annex 2: Agenda and Meeting Structure**

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### **Terms of Reference and Expert Group Recommendations for this meeting**

#### **Terms of References**

- a) Evaluate the progress made within BELTS-net and to identify further actions, taking account of the progress made within SGCBNS;
- b) Review and report on the use of benthic indicators and targets within WFD, MSFD and Habitats Directive: Compatibility and complementarity;
- c) Compare and report on the performance of different quantitative species distribution modelling techniques;
- d) Work towards disentangling the link between biodiversity and ecosystem functioning:
  - Review and identify benthic indicators to reflect the link between both aspects;
  - Review and report on how ecological function and diversity relates to different parts of the benthic communities at different spatial scales;
  - Review the data compilation on functional diversity of macrobenthos in relation to ecosystem functioning, and to scope for further research;
  - Finalise the paper on the link between ecosystem functions and ecosystem services.

## Meeting structure

### THEME 1: LONG-TERM SERIES AND CLIMATE CHANGE

#### ISSUE 1.A: Report on recent findings on long-term data series analyses and other climate change-related benthos activities.

- Coordination: Steven Degraer
- Introductory presentations:
  - Silvana Birchenough: Scaling up-the effects of ocean acidification: moving from single species to community effects and the wider ecological implications

#### ISSUE 1.B: BELTS-net and SGCBNS

- 1.B.1 Review activities of the Study Group on Climate-related changes in the Benthos of the North Sea (SGCBNS). Recommend future actions for SGCBNS, based on the SG's 2011/2012 work
  - Coordination: Silvana Birchenough & Henning Reiss
  - Introductory presentations
    - Silvana Birchenough & Carl Van Colen: State of the art on the BeLTS-net paper "Long-term trends and regime shifts" (case study 1)
    - Gert Van Hoey: Case study 2 progress...
    - Silvana Birchenough: methods paper...
- 1.B.2 Evaluate the progress made within BELTS-net and to identify further actions, taking account of the progress made within SGCBNS (ToR a)
  - Coordination: Johan Craeymeersch & Silvana Birchenough
  - BeLTS-net operational...
    - Hans Hillewaert: Walking through the BeLTS-net website...
  - Introduction to and discussion on ongoing and planned future BeLTS-net actions and scientific activities

### THEME 2: BENTHOS-RELATED QUALITY ASSESSMENT

#### ISSUE 2.A: Revise the BEWG paper on "The myths of benthic indicators: The crux with indicator species" (wrapping up BEWG 2012 ToR c)

- Coordination: Michael Zettler

#### ISSUE 2.B: Review and report on the use of benthic indicators and targets within WFD, MSFD and Habitats Directive: Compatibility and complementarity (ToR b): Planning for future work...

- Coordination: Gert Van Hoey

### THEME 3: MARINE HABITAT MODELLING AND MAPPING

#### ISSUE 3.A: Report on recent initiatives on habitat suitability modelling and mapping

- Coordination: Steven Degraer
- Introductory presentation
  - Clare Greathead: On the impact of fishing and fisheries closures on benthos: linking habitat suitability, niche preferences, recovery and connectivity.
  - Clare Greathead: An example to highlight the difficulties with choosing the correct method for modelling species distribution
  - Michael Weinert: Predicting distribution patterns of North Sea benthic species in response to climate change

#### ISSUE 3.B: Finalise the BEWG review paper on “Species distribution modelling and mapping (SDM) in the marine environment and its relevance for ecosystem management” (wrapping up BEWG 2012 ToR d)

- Coordination: Henning Reiss

### THEME 4: Work towards disentangling the link between biodiversity and ecosystem functioning (ToR d)

#### ISSUE 4.A: Review and identify benthic indicators to reflect the link between both aspects

- Coordination: Steven Degraer

#### ISSUE 4.B: Review and report on how ecological function and diversity relates to different parts of the benthic communities at different spatial scales;

- Coordination: Steven Degraer (*yet to be confirmed*)

#### ISSUE 4.C: Review the data compilation on functional diversity of macrobenthos in relation to ecosystem functioning, and to scope for further research

- Coordination: Jan Vanaverbeke (remotely)

#### ISSUE 4.D: “Finalise” the paper on the link between ecosystem functions and ecosystem services (ToR d.1)

- Coordination: Paul Montagna
- Introductory presentation
  - Paul Montagna: first draft of the “ecosystem services” document
- Making progress during BEWG 2013 meeting...

### THEME 5: OTHER BUSINESS

#### ISSUE 5.A: Update BEWG’s research plan: Moving from yearly to Multi-annual ToRs...

- Coordination: Steven Degraer

**ISSUE 5.B: BEWG Valorization initiatives**

- 5.B.1 Conference contributions, workshop organization, etc.
  - Coordination: Steven Degraer
  - Summary presentations
    - Steven Degraer, Bjorn Tunberg & Jennifer Dannheim: ASC 2012 Theme Session “How does renewable energy production affect aquatic life?”
    - Steven Degraer, Angel Borja & Tundi Agardy: ASLO Theme session proposal “Ecosystem-based Marine Spatial Planning for better management of our oceans”.
    - Henning Reiss & Silvana Birchenough: Theme session proposal “Long-term changes of benthos and climate change effects” during the ASC 2013 – declined
    - Steven Degraer, Jacques Populus & Roger Coggan: Theme session proposal “Better maps for better management: Improving the integrity of habitat maps” during the ASC 2013 – declined
- 5.B.2 Suggestion(s) for new valorisation initiatives
  - Coordination: Steven Degraer
- 5.B.3 Content for renewed ICES website
  - Coordination: Steven Degraer

**ISSUE 5.C Any other business**

- Coordination: Steven Degraer
- Presentations
  - Clare Greathead: Initial results from a BACI study at a potential MPA on the West coast of Scotland
  - Igor Manushin: Impact of an introduced red king crab on the benthos of the Barents Sea
  - Jennifer Dannheim & Steven Degraer: Outcomes of the WGMBRED workshop
  - Silvana Birchenough: Conference announcement “3rd ICES/PICES/IOC conference on climate change (Rio de Janeiro, 2015)” and BEWG involvement

**ISSUE 5.D: Meeting conclusions**

- Coordination: Steven Degraer
- Selection of next year’s meeting place and date
- Summary of action points (incl. responsibilities and time lines), recommendations and Multi-Annual Terms of Reference

**Anticipated time schedule**

<b>Monday</b>	
<b>9h30 – 10h00</b>	Arrival of participants
<b>10h00 – 11h00</b>	Spanish welcome, and practicalities (e.g. reporting) Adoption of agenda BEWG 2013 workshop
<b>pm</b>	Theme 1: Long-term series and climate change <ul style="list-style-type: none"> <li>• Issues 1.A &amp; 1.B (leads: Silvana, Henning and Johan)</li> </ul>
<b>Tuesday</b>	
<b>am</b>	Theme 3: Marine habitat modelling and mapping <ul style="list-style-type: none"> <li>• Issues 3.A (lead: Steven)</li> <li>• Issue 3.B – Introduction to the subgroup work to be done (lead: Henning)</li> </ul>
<b>pm</b>	Theme 4: Biodiversity and ecosystem functioning <ul style="list-style-type: none"> <li>• Issue 4.C – Introduction to the subgroup work to be done (lead: Jan)</li> <li>• Issues 4.A, 4.B (lead: Steven)</li> <li>• Issue 4.D – Introduction to the subgroup work to be done (lead: Paul)</li> </ul>
<b>Wednesday</b>	
<b>am</b>	Theme 2: Benthos-related quality assessment <ul style="list-style-type: none"> <li>• Issue 2.B (lead: Gert)</li> <li>• Issue 2.A – Introduction to the subgroup work to be done (lead: Michael)</li> </ul>
<b>pm</b>	Excursion to Santiago de Compostela + workshop dinner (lead: Santiago)
<b>Thursday</b>	
<b>am</b>	Subgroup work Intermediate plenary feedback on subgroup work: state of the art on intermediate achievements and workplan for afternoon session
<b>pm</b>	Subgroup work (continued) Plenary feedback on subgroup work & agreement on intersessional work, if needed (incl. Jan – remotely)
<b>Friday</b>	
<b>am</b>	Theme 5: Other business <ul style="list-style-type: none"> <li>• Issue 5.C (lead: Steven; incl. Jennifer - remotely)</li> <li>• Issue 5.A &amp; 4.B (lead: Steven)</li> <li>• Issue 5.D (lead: Steven)</li> </ul>
<b>pm</b>	Subgroup work & start intersessional work (continued.)



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

The **Benthos Ecology Working Group** (BEWG), chaired by Steven Degraer, Belgium, will meet in Dinard, France on 28 April – 2 May 2014, to work on ToRs and generate deliverables as listed in the Table below.

BEWG will report on the activities of 2013-2014 by 15 June 2014 to SSGEF.

#### ToR descriptors

ToR	Description	Background	Science Plan topics addressed	Duration	Expected Deliverables
a	Long-term benthic series and climate change	BELTS-net will aid creating the forum for further identification	1.1		
	1. To progress towards an understanding change in the benthos, e.g. regime shifts, seasonality, fine spatial scale variability	of major ecosystem regime shifts, seasonality and fine scale spatial variability, and as such for further consideration of the impact of climate change onto the benthos. Given the need to compile, combine and integrate different databases the identification of methodological issues in long-term series comparability is considered most important.		Years 1-3	Research paper(s)
	2. Facilitate collaboration by further development and promotion of the BEWG Benthic Long-Term Series network (BeLTS-net)			Years 1-3	Website and discussion forum
	3. To identify methodological issues in long-term series comparability			Years 1-2	Position paper

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b	Species distribution modelling and mapping	Species distribution modelling (SDM) helps understanding the distribution of species and communities. As such, it helps elaborating a scientifically-sound management of the marine ecosystem. While qualitative SDM (i.e. modelling the likelihood of occurrence of benthic feature) has been regularly applied, today attention is needed to quantitative modelling techniques (e.g. modelling densities or biomass. BEWG will therefore compare and report on the performance of different qualitative and quantitative species distribution modelling methods, e.g. methods validity, and explore the applicability of different qualitative and quantitative species distribution modelling methods, e.g. limitations, purposes, knowledge gaps	Various issues under topic 3		
	1. To compare and report on the performance of different qualitative and quantitative species distribution modelling methods, e.g. methods validity			Years 1-2	Review paper
	2. To explore the applicability of different qualitative and quantitative species distribution modelling methods, e.g. limitations, purposes, knowledge gaps			Years 2-3	Position paper

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c	Benthos and legislative drivers	A wide suite of benthic quality indicators were developed, intercalibrated and applied within the framework of several international regulations. At present, the most relevant directives within the Northatlantic realm are the Water Framework Directive, the Habitats Directive and the Marine Strategy Framework Directive. BEWG will investigate the Compatibility and complementarity within the use of benthic indicators and targets for management. It will further continue scientifically investigating the importance of species autecology in indicator development and application and review the development of effective monitoring programmes, e.g. design, harmonisation and quality assessments	Various issues under topic 2.		
	1. To report on the use of benthic indicators and targets for management: Compatibility and complementarity			Years 1-2	Position paper
	2. On the myths on indicators: To investigate the importance of species autecology in indicator development and application			Years 1-3	Research paper(s)
	3. To review the development of effective monitoring programmes, e.g. design, harmonisation and quality assessments			Years 2-3	Review paper

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d	Benthic biodiversity and ecosystem functioning	Disentangling the link between biodiversity and ecosystem functioning is currently considered key to a full understanding of the health of marine ecosystems. This topic hence became a cross-cutting theme since the BEWG 2012 meeting. BEWG will therefore review and identify benthic indicators to reflect the link between biodiversity and ecosystem functioning and review how ecological function and diversity relates to different parts of the benthic communities at different spatial scales, taking account of e.g. ecological processes and biological traits. BEWG will also scope for research on the functional diversity of macrobenthos in relation to ecosystem functioning, for which a first data compilation will be dealt with intersessionally. From a more conceptual perspective, BEWG will continue investigating the link between ecosystem functioning and ecosystem services.	1.2
	1. To identify the links between benthic biodiversity and ecosystem functioning, e.g. literature review, ecological processes, biological traits.		Years 1-3  Year 1
	2. To identify the links between benthic functions and ecosystem services.		Research paper(s)  Viewpoint paper

**Summary of the Work Plan**

Year 1	ToRs a.1-3, b.1, c.1-2, d.1-2
Year 2	ToRs a.1-3, b.1-2, c.1-3, d.1
Year 3	ToRs a.1-2, b.2, c.2-3, d.1

**Supporting information**

Priority	The current activities of BEWG will continue along the three major vertical axes of priority within BEWG: long-term series and climate change, benthic indicators and EU directives, and species distribution modelling, and one cross-cutting (horizontal) axis on benthic biodiversity and ecosystem functioning. All issues mentioned fit the ICES Science Programme and may hence be considered of high priority.
Resource requirements	The research programmes which provide the main input to this group are already underway, and resources are already committed. The additional resource required to undertake additional activities in the framework of this group is negligible.
Participants	The Group is normally attended by some 15-30 members and guests.
Secretariat facilities	None.
Financial	No financial implications.
Linkages to ACOM and groups under ACOM	There are no obvious direct linkages.
Linkages to other committees or groups	There is a possibility for interaction of several ICES expert groups, among which WGMHM and WGEXT.
Linkages to other organizations	

## Annex 4: Action points

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### Long-term benthic series and climate change

- S. Birchenough
  - to draft abstract on BeLTS-net for ASC 2013 poster. If abstract would be too late, a poster on BeLTS-net is still likely to be presented at the ASC 2013
  - to circulate the SGCBNS paper on Spatial variation in BpC and vulnerability of ecosystem functioning in the North Sea by September 2013
- J. Craeymeersch
  - to draft an electronic flyer and circulated before ASC 2013.
- H. Hillewaert
  - to launch the BeLTS-net website
- P. Montagna
  - to give start of the North-American long-term series (metadata) list to be included in BeLTS-net.
- C. Greathead
  - to contact potential sources for Canadian long-term series data after launch of BELTS-net.

### Species distribution modelling and mapping

- H. Reiss, with assistance from S. Birchenough and S. Degraer
  - to finalise and submit the review paper on “Species distribution modelling and mapping in the marine environment and its relevance for ecosystem management”. All information has been collated and a work plan to finalise paper formulated during the subgroup meeting.
- M. Gogina
  - to prepare for a work plan to compare and report on the performance of different quantitative species distribution modelling techniques.

### Benthos and legislative drivers

- M. Zettler
  - to coordinate co-authors input to address reviewers’ comments on the draft paper “On the myths of indicator species: issues and further consideration in the use of static concepts for ecological applications”
- C. Greathead
  - final read through and check for flow and sense of the draft paper “On the myths of indicator species: issues and further consideration in the use of static concepts for ecological applications”
- G. Van Hoey

- to initiate and lead on an intersessional compilation of an overview table on benthos indicators covering the entire ICES area.
- to prepare for a work plan to report on the “use of benthic indicators and targets for management: Compatibility and complementarity” (including redundancy) for BEWG 2014

#### Benthic biodiversity and ecosystem functioning

- M. Zettler
  - to prepare for a work plan on biological trait analysis at BEWG 2014
- J. Vanaverbeke
  - to finalise the reference list review, lead on the initial analysis of these lists and prepare for a work plan for the 2014 meeting.
- P. Montagna, with help from nominated members
  - to intersessionally lead on finishing the paper on “Linking ecosystem functions and ecosystem services: misconceptions and benthos matters” with help from nominated members.

#### Outreach

- All
  - to identify platforms (e.g. meetings and conferences) that could be used to promote papers and initiatives of the BEWG.