Report of the Working Group on Benthos Ecology (BEWG)

20–24 April

Askö, Stockholm, Sweden

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Executive summary

The Benthos Ecology Working Group (BEWG) held its 2009 meeting at the Askö Laboratory, which is a facility of the University of Stockholm, Sweden. Twenty participants representing twelve countries attended and worked on the proposed agenda. Participants also reported on ongoing benthos research within the ICES region.

ToR a) The BEWG reviewed the outcome of the WKCBNS (Wilhelmshaven, December 2008). The "Small scale box approach" was presented together with various hypotheses on the impacts of climate change on the benthos. The creation of an *ad hoc* Study Group (Chairs: H. Reiss and S. Birchenough) to further the research ideas was proposed. Close collaboration with other ICES EGs, especially those with an expertise in ecosystem and habitat suitability modeling and habitat mapping was deemed to be beneficial for the development of this SG.

ToR b) & ToR d) The group reviewed some new developments and challenges in environmental metrics. Based on this review a discussion about the added value to the future exploitation and elaboration of environmental metrics from the BEWG was initiated. It was clear that the technical aspects of environmental metrics, such as metric development, adjustment and intercalibration, are beyond the scope of the BEWG. However, the group decided to collate a viewpoint document on the lessons-learned from the application of environmental metrics within the Water Framework Directive as a starting point for an optimised use within the Marine Strategy Framework Directive.

ToR c) To keep the BEWG informed about current research initiatives, there were several reports on new developments in ongoing benthic research in the ICES area. Two presentations focused on fundamental ecological issues with high relevance for marine management, i.e. the scale-dependency of spatial and temporal variation and the benthic larvae settlement cues. Examples of impact studies were presented for several water bodies, i.e. Florida and the Netherlands, and impact types, i.e. mussel fisheries and dredging. Attention was also given to mapping of the benthic ecosystem, i.e. in Norwegian and Cornish peninsula waters (MAREANO project). Furthermore, an introduction to two recently started initiatives were presented: WISER (Water bodies in Europe: Integrative Systems to assess Ecological status and Recovery) and the Spanish research activities in the high seas of the South-West Atlantic Ocean.

ToR e) As an introduction five members presented recent work on long-term changes in benthos. The group discussed and decided that hypotheses, regarding the effects of climate change on the benthos, should be selected from the WKCBNS that are feasible to be dealt with using long-term series. Appropriate datasets now have to be selected and analyzed for sudden changes (i.e. regime shifts), gradual long-term changes and oscillations with an agreed set of parameters to enable further comparisons. This intersessional work will take the form of an informal network, with strict agreements on objectives and timing for delivery of preliminary work.

ToR f) After a short introduction of the SGCC, the SGCC request on the possible contribution of the BEWG to the ICES position paper on Climate Change was highlighted. A structure of the BEWG contribution to the ICES position paper was agreed upon and responsibilities were delegated. After the SGCC approval of this structure (June 2009), a time line for further elaboration of this initiative will set. A draft ver-

sion of the BEWG contribution should be ready prior to and be finalized during the BEWG 2010 meeting.

ToR g) Harmonisation of the JAMP Eutrophication monitoring guidelines with the ISO 16665 guidelines was conducted during the 2009 meeting as per the review conducted in 2008 with the new TIMES recommendations.

Additional ICES requests) To be able to evaluate the interaction between the blue mussel fishery and the mussel eating bird populations in Natura 2000 sites in the Danish waters, the BEWG was requested to advise on methodologies for the estimation of the blue mussel stock and annual blue mussel production in the Danish part of the Wadden Sea and in other relevant Danish NATURA 2000 sites. J. Craeymeersch dealt with this request and a report was sent to ICES on 21/04/2009.

A second additional request on "The role of CFP in implementing an ecosystem approach to marine management" was focused on the indicator "Areas not impacted by mobile bottom gear". The BEWG discussion lead to five suggestions for further elaboration, related to (1) the necessary high spatial and temporal resolution of VMS data, (2) the need for data on fisheries intensity, (3) the need for VMS from smaller fishing vessels, (4) the need for pings on "fishing" versus "non-fishing", as well as fishing gear used and (5) the importance of the geographic consistency of areas not impacted by mobile bottom gear.

Any other business

Based on a presentation and request from Chilean fjord ecologists, the BEWG proposed the establishment of a new Study Group on fjord ecosystems. This will complement existing scientific needs which are already alive in the ICES world and is in agreement with ongoing activities elsewhere in Europe. A theme session for the 2010 or 2011 ICES Annual Science Conference will be appropriate to attract the necessary attention to this new topic.

The next meeting of the Benthos Ecology Working Group will take place in Edgewater, MD, USA, from 19–23 April 2010.

1   Opening of the meeting

The Chair, Steven Degraer, opened the meeting at the Askö Marine Laboratory, Sweden, welcoming the participants. An ICES SharePoint site was made available before and during the meeting. This proved to be a valuable tool to speed up the work and make exchange of information more efficiently. Local host H. Kautsky welcomed the group on behalf of the Askö Marine Laboratory staff followed up by housekeeping information. The participants then introduced themselves and gave a short review of their scientific activities. 20 participants from twelve countries attended the meeting (Belgium, Chile, Germany, Italy, Netherlands, Norway, Poland, Spain, Sweden, United Kingdom, Denmark and United States). Apologies were received from E. Bonsdorff, A. Borja, G. Duineveld, M. Guerra, J. Hiddink, H. Hummel, I. Kröncke, K. Mo, A. Norkko, F. O'Beirn, E. Rachor, M. Robertson, D. Schiedek, J. Sorensen, E. Verling and W. Willems. The Chair expressed his wish to have daily Rapporteurs, together with an Editing Rapporteur who would bring the daily contributions together into the final report. H. Hillewaert was appointed Editorial Rapporteur; daily Rapporteurs were J. Craeymeersch, C. Van Colen, S. Birchenough and P. Magni.

2   Adoption of the agenda

The group unanimously adopted the agenda without changes.

3   Long-term changes in benthos in relation to Climate Change (ToR e)

3.1   Introduction

As an introduction to this topic, five members presented recent work on long-term changes in benthos. I. Muxika (Spain) presented new research on *Gelidium* with respect to Climate Change, and new research on climate affections within Basque estuaries and coasts. H. Kautsky (Sweden) reported on long-term changes in phytobenthic communities in the Baltic. S. Birchenough (UK) presented some of the work that CEFAS is taking forward in terms of climatic events and benthic diversity. J. Warzocha (Poland) reported on long-term changes in macrobenthic communities in the southern Baltic. The group further discussed a draft research proposal by A. Borja (presented by I. Muxika), mainly aiming at detecting shifting distributions of selected macrobenthis species, and reconsidered findings from WKCBNS in December 2008.

M. Zettler pointed parallel initiatives occurring at MarBEF project LargeNet. The BEWG will inform the MARBEF LargeNet group about the BEWG initiative on long-term data analysis in relation to climate change, as to avoid duplication of the work and attract attention to our initiatives

3.2   *Gelidium corneum* macroalgae response to climatic change, within the Basque coast (northern Spain)

I. Muxika presented new research on *Gelidium corneum* with respect to Climate Change.

Gelidium corneum is a macroalgae structuring sublittoral benthic communities, between 0 and 15 m water depth, within the northern coast of Spain. It is used for agar-agar extraction, both from cast-offs collecting or direct exploitation. Within the

Basque Country there exists a monitoring program to assess the situation of this important macroalgae. An extensive annual sampling is undertaken in an area extending 30 km, in the eastern part of this region. A total of 100 samples are taken annually, determining macroalgae cover and total biomass. The dataset covers 1983, 1986 and 1993 onwards.

Environmental data, such as daily sun hours, temperature, wave height and wave energy, and some teleconnection patterns (i.e. EA, NAO), were also obtained and studied for the period 1993–2008. The most important factors explaining *Gelidium* biomass were sun hours and waves.

Currently we are working with Bayesian networks in order to predict future changes in biomass depending on predicted changes in the abovementioned factors, described in the literature or derived by us in a project on the impacts on climate change within the Basque coast.

3.3 Long-term changes in phytobenthic communities in the Baltic

H. Kautsky reported on long-term changes in phytobenthic communities in the Baltic.

The phytobenthic communities along the Swedish coast of the Baltic Sea have increased their depth distribution, which indicates an improvement of the coastal water quality. The long term trend in the depth distribution of e.g. *Fucus vesiculosus* in the Åland Sea (Gräsö-Singö area) was reduced from 11.5 m in the 1940s (Mats Waern 1952) to 8.5 m in the year 1984 (Kautsky *et al*. 1986), but since then has increased again. In the year 2006, *Fucus* was found at the same depths as in the 1940s. Some observations of *Fucus* maximum depth were even deeper than was found in the 1940s. The graph below shows the temporal change of the average depth of *Fucus vesiculosus* in the Åland Sea, based on 10 stations.
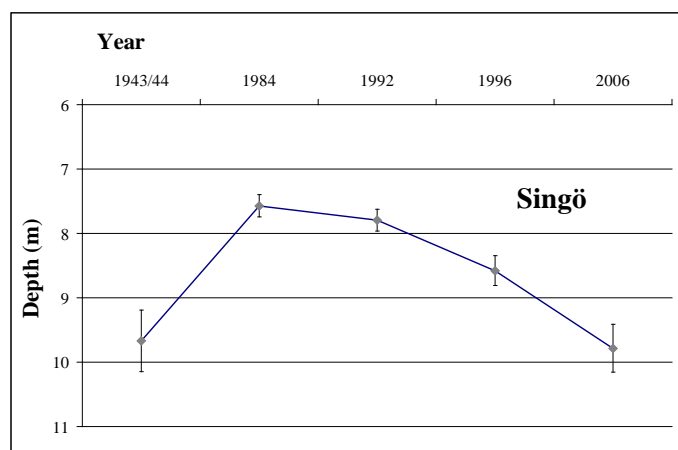
In the Askö area, northern Baltic proper, similar temporal developments were seen in the national monitoring data (Swedish EPA). The trend since the year 1993 was an increase with ca 1 m in the depth penetration of *Fucus*, based on 30 stations mean. The maximum depth increased between the 1970s and the year 1993 with ca 1 m (does not show in the graph below).
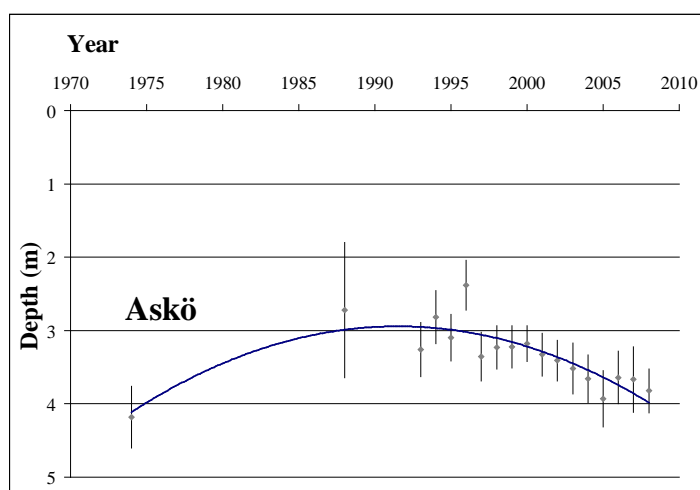
These changes were not only restricted to the *Fucus* community but was relevant for the whole phytobenthic plant community. This was also reflected in the WFD index for the vegetation covered substrates in the Swedish waters of the Baltic Sea. In the Askö area where data are more abundant, there was a significant increase of the index value from 1993 to the year 2008. The Swedish index is based on ca 5–15 selected species per station where the present maximum depth for each single species is compared with historical data from pristine areas. Below, the index values are plotted for the Askö area and Gotland, Baltic proper and the Bothnian Sea (Västernorrland, started in 2007).
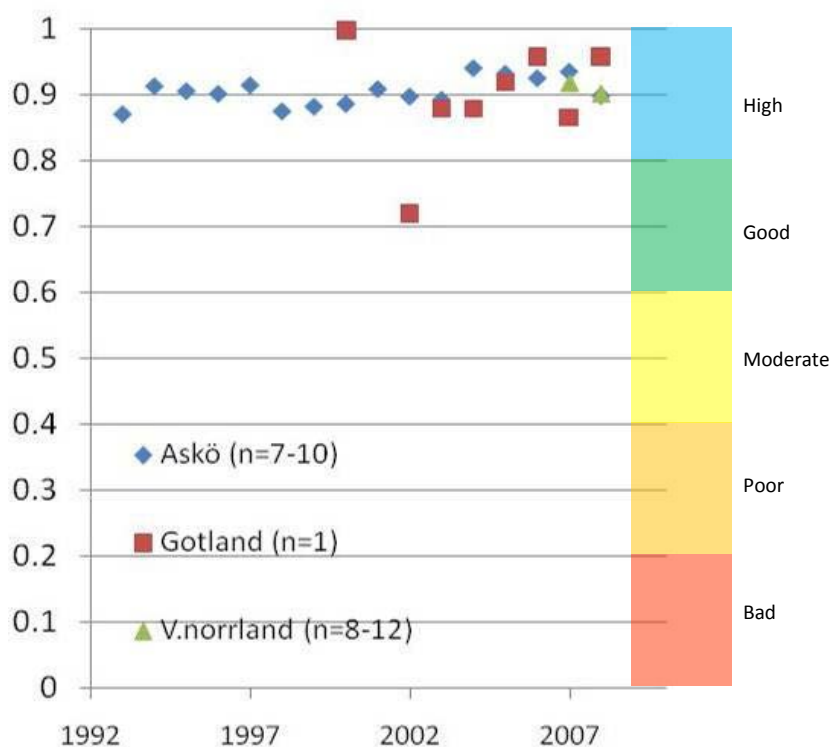
The observed increase in depth penetration of the plants was set in relation to the increase in Secchi depth readings in the areas by ca 1 m, as well as a reduction of the pelagic spring bloom to about half. The reason for the better conditions in the pelagic system is most probable the increase in the sewage treatment along the coast the last 30 years, and perhaps also a reduced amount of nutrients in the land runoff.

There has also been a change in the biomass of animals in the Askö area, where, e.g. the blue mussel *Mytilus edulis* has decreased, especially in the inner archipelago area. One of the features in common for all stations was the larger decrease in biomass in the year 1994. This decrease was due to an unusually warm summer, with one month of over 20°C in the water down to ca 20 m depth, and a low pelagic primary production. The consequence was probably that the high temperature made the *Mytilus* population to increase its respiration and consequently needed more energy, but starved to death due to the low pelagic production. In the year 1996, again the summer was unusually hot, but now the pelagic production was higher and the *Mytilus* community was not as influenced, except for the inner parts of the archipelago. In the year 2000, again the hot summer was reflected in a decrease of *Mytilus*, but at the same time *Cerastoderma glaucum*, *Balanus improvisus* and *Electra crustulenta* increased, which all might benefit from warmer water or can utilize the increase in food particles as the *Mytilus* population decreased.
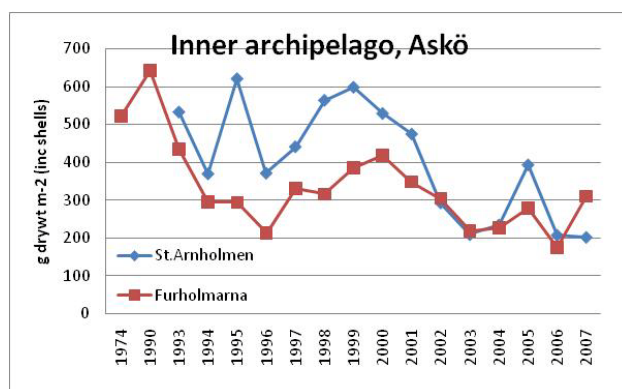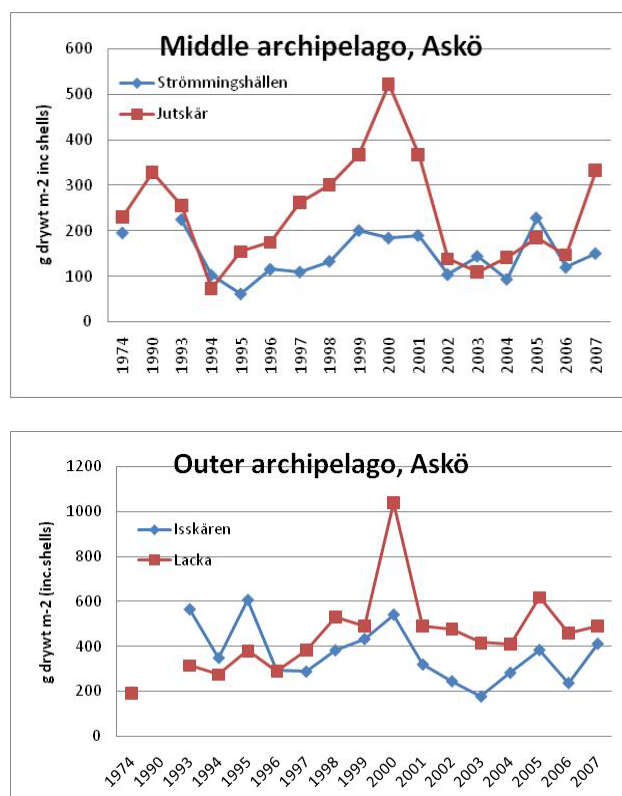
3.4 Assessing macrobenthic patterns with time−series to enhance current understanding of climatic changes in the UK

S. Birchenough presented work done by Cefas.

Cefas has a recognised track record on advising government (i.e. Defra) on sea disposal practices under the Food and Environment Protection Act (FEPA) and monitoring programmes (i.e. Clean Seas Environmental Monitoring Programme (CSEMP formerly known as NMMP). As part of this regular exercise an annual collection of macrobenthic infauna data and its associated physical variables has been gathered at over a range of sites in UK waters. In the majority of cases, these data sets have not yet been analysed to its full potential. Macrobenthic infaunal communities are especially suited for long-term comparative investigations since species possess low mobility or sessile habits, long-lived and capable of integrate effects of environmental changes over time (Rees *et al.*, 2002). The macrobenthos is straightforward to sample quantitatively and is of great significance for environmental surveillance for the reasons outlined above. It is in fact the main component of biological trend monitoring programmes aimed at assessing the status of benthic ecosystems (Rees *et al.*, 2002).

Annually, offshore sites are monitored with the view of assessing the biological, chemical and sediment status on a number of sites. Whilst monitoring provides information on the health and status of the communities and sediments within the site in relation to manmade activities (i.e. dredged material disposal, aggregate extraction and recovery from sewage sludge disposal) there is still a limited understanding on time series data sets, human activities and climatic events in relation to seabed ecology. Climatic events can affect population dynamics over time and space, phenology and geography of communities (and species) (Dulvy *et al.*, 2008). Furthermore, climatic events can produce habitat loss, which can affect species distribution resulting on species extinction over time, which can have severe implication on biodiversity. There is still uncertainty in terms of the magnitude and spatial changes resulting

from climatic forces (POST, 2007) in the marine environment. Initial research conducted in the North Sea, has indicated the potential shift in distribution of species (and communities), which benefit or suffer from warming temperatures south of the Dogger Bank (see e.g. Wieking and Kröncke, 2001).

ICES BEWG (2008) has already discussed and developed a conceptual model of the links between climate change and benthic communities, based on this research we aimed to investigate macrobenthic time series data in relation to a wide range of climatic proxies and ecosystems components. Cefas has a long history of collecting time-series at dredged material disposal sites and former sewage-sludge, as part of a strategic assessment of the consequences of marine organic enrichment under UKMMAS auspices. Time series are important that it contributes to understand the community (and species) patterns and responses over time offering information on distribution, allowing the development of indicators of change. Furthermore, time-series can help to elucidate changes over small and large-scale parameters, which are important to understand habitat quality and biodiversity

3.5 Long-term environmental, anthropogenic and climatic factors affecting soft-bottom benthic communities within the Basque estuaries

I. Muxigo presented work done by A. Borja, L. Pérez and himself.

Estuarine and coastal seas have been used for human settlement and marine resources exploitation through the history. Centuries of overexploitation, habitat transformation and pollution have contributed to estuarine degradation and biodiversity loss. Hence, there is an increasing need to restore degraded estuarine and coastal ecosystems. In this way, the Water Framework Directive emphasises the need of implementing monitoring programmes, providing a new view of water resources management in Europe, which is based mainly upon ecological elements (phytoplankton, macroalgae, benthos and fishes). Due to the huge industrial development that took place in the 19th century in the Basque Country, human activities highly damaged the ecological status of the Basque estuaries. After many decades of discharges of industrial and urban waste waters into the estuaries, water treatment schemes have been implemented in most of them. Moreover, the Littoral Quality Monitoring Network has monitored the Basque coastal and estuarine water quality since 1994.

The objective of this study is to determine the variability in Basque estuarine soft-bottom macrofaunal communities explained by anthropogenic, climatic and sedimentological factors. Moreover, time trends in these variables were analysed, using data provided by the LQM since 1995. Multivariate analysis revealed that anthropogenic variables explained the variability in the densities of the species in a higher extent (16.4%) than the climatic variables (15.4%). It also revealed that the general physico-chemical characteristics are of special relevance (17.2%). Thus, some estuaries have communities with presence of pollution indicator species as a result of the low percentage of oxygen saturation and, in some cases, the high levels of heavy metals. Moreover, in estuaries in which the structural parameters of the communities were explained by anthropogenic variables, general improvement trends in the quality of the benthic community status and sediment quality were observed. Although the water treatment in the Basque estuaries, and the closure of major industries, have led to a gradual recovery of the benthic communities, there is still some work to be done, in

order to achieve a "good water status for all water bodies for 2015", as required by the WFD.

3.6 Long-term changes in macrobenthic communities in the southern Baltic.

J. Warzocha (Poland) reported on: Long- term macrozoobenthic changes in the southern Baltic (Polish EEZ).

The studies on distribution and long-term variability of benthic communities were a contribution to the project „Ecosystem Approach to Marine Spatial Planning – Polish Marine Areas and the NATURA 2000 Network" -supported by a grant from Iceland, Liechtenstein and Norway through the EEA Financial Mechanism. Long-term changes were studied by comparing data from the 4 periods; (I) 1948–1952, (II) 1971–1976, (III) 1978–1983, (IV) 2000–2008, covering the entire area of the Polish EEZ. A Petersen grab was used in the period from 1948-1976 and a van Veen grab and box corer from 1978 to present. All available present and historical data were included into a database both, as Excel files and GIS layers. The comparisons of data sets from the Gulf of Gdańsk have already been finalized. Altogether 280 stations representing different periods were selected for cluster analyses, which allowed separating 9 groups of stations at a 50% similarity threshold. The spatial distribution maps show changes from one investigation period to the next, especially on the muddy bottom above the halocline in the sheltered western part of the bay. All stations from this side showed a drastic decrease in species richness since 2000. The observed changes were related mainly to eutrophication and introduction of new alien species. Besides these factors, some of the observed phenomena seem also to be triggered by variation in oceanographic and climatic conditions.

3.7 Research proposal: Benthic evidence of CC: shifting distributions of selected macrobenthic species

I. Muxika presented.

Until now most, if not all, long-term series were collected and studied locally, without strong links to other long-term datasets.

However, we are convinced that, if we integrate many (15-25?) series, ideally covering the whole latitudinal gradient of the Northeast Atlantic (Portugal/Galicia to Norway, including North Sea and Baltic Sea), we should be able to observe and document latitudinal shifts for a selected number of species, and temporal synchronisms or delays in abundance or species composition among different time-series. Eventually, we should be able to relate these changes to teleconnection patterns (NAO, EA, AO,…), temperature increase, precipitation, etc.

The idea and research outline could be similar to those studies undertaken by the ICES Working Group on Zooplankton Ecology (see http://www.wgze.net/).

We should be able to select some species (5-10?) which can be presented in the whole latitudinal range and try to explain co-variance or shifts in abundance along this latitudinal gradient. Additionally, we could also select some warm and cold water species and try to detect changes in the abundance through the latitudinal gradient and years.

We would need specific densities for soft-bottom benthic macroinvertebrates from stations up to 50 m water depth (more or less), located in coastal areas without or

with minor anthropogenic pressures. The length of the time-series should be of more than 10 years.

Colleagues have agreed to participate in this proposal, by providing available data, These are: V. Quintino (Portugal); S. Parra, INSUB and Á. Borja (Spain, from Galicia to the French border); J.-C. Dauvin (France); C. Frid (UK); S. Birchenough (UK); C. Van Colen, G. Van Hoey and S. Degraer (Belgium); A. Schröder, H. Reiss, H. Rumohr and M. Zettler (Germany); J. Warzocha (Poland); and B. Tunberg (Sweden).

3.8 Discussion

The group decided that hypotheses should be selected from the WKCBNS list, which are feasible for further analysis with existing long-term series, taking into account recent publications on climate change. Then appropriate datasets could be selected and analyzed for sudden changes (regime shifts), long-term changes and oscillations. Common and opposite phenomena should eventually be discussed in the light of climate change, and hypotheses about the underlying processes made.

A. Schroeder led sub-group discussions and provided an overview of the general actions discussed over plenary.

B. Tunberg indicated that there is existing data from 1973-1999 of near shore and offshore sites in Swedish waters. It was agreed that individuals will up-date the existing time-series table/map saved on the ICES BEWG SharePoint during the meeting, to reflect new information.

Participants also agreed on developing collaborative work, which will contain further analyses/results (on published or unpublished records), using standardised analyses. Intercessional work will continue by means of interrogating the long-term datasets with an agreed set of parameters to enable further comparisons. Questions in relation to long-term series (LTS) are outlined below:

- Are there changes in latitudinal range of species? (This initiative was proposed by A. Borja/I. Muxika), initial requirements to develop this work will be to send a complete species list by the end of May. This will enable identification of an appropriate set of species. Once further questions have been formulated by A. Borja/I. Muxika the full data set will be requested.

- Are there "regime shifts" in benthic communities that can be identified in data sets across the geographical range (i.e. same timing; similar phenomena)? It was agreed that A. Schroeder, J. Craeymeersch, C. Van Colen, I. Muxika, H. Reiss, S. Parra and S. Birchenough will assess their own data sets and provide general observed 'phenomena 'in a 2-3 page document by end of July at the BEWG share point. All other long-term data series within the BEWG holders are invited to join this initiative.

Discussions in relation to a detailed analysis (i.e. SOP) were agreed by the participants and further details on calculation methods and data format are stated below:

- Trend/shifts analysis based on time series of annual values of the following parameters:
    - o abundance; biomass, species density (number of species per sample), species richness (ES50) Shannon diversity (log e) and Pielou's evenness

- Community analysis
    - inter-annual similarity (Bray Curtis similarity measures, based on 4th root transformation of data sets)
    - Identifying overall patterns (e.g. initially by MDS) and relating this information to existing published literature, which explains 'shifts' on specific areas.
    - ABC-curves (Warwick, 1986)

A template on the expected formats will be placed on the SharePoint.

Further work will be conducted once site-specific analyses have been conducted by the sub-group participants. S. Birchenough volunteered to compile results on a draft document for circulation. This information will then form the basis for further assessment which will be assisted by Dr J. Barry (Cefas senior statistician) on suitable long-term analytical approaches to enable comparisons on existing results. The draft will be circulated by mid-September, and depending on the outcome from this work, further direction on this effort will be decided at a later stage.

Participants also agreed on questions, which will be to be tackled on a later stage, these are highlighted below:

- Are there changes in the production and biomass of benthic species (with implications for food web-dynamics?)?
- Are there community changes including habitat forming species (resulting in altered habitats)?
- [Phenology / changes in timing of reproduction etc. can only be dealt with in data sets with high temporal resolution (e.g. monthly – intertidal?).]

If this is the case for the proposed questions outlined above, can we detect the following issues:

- Are correlations apparent with local climatic factors or large scale indices, e.g. changes in:
    - Temperature
    - Salinity (runoff)
    - NAO; EA
    - Frequency of storms?
- Are correlations noticeable with changes in primary production?
- Are effects of distinct events (extreme situations instead of average values) acting as disturbances?

The BEWG agreed that this initiative will enable to establish an open informal network to promote exchange of observed phenomena on existing and additional LTS. Alternatively, (part of) this initiative could be framed within the proposed Study Group on Climate-related Benthic Processes in the North Sea (see 5.).

Climate effects affecting communities will be assessed initially by excluding anthropogenic effects on the data as much as possible. Anthropogenic effects in relation to climate effects will be dealt in more detail once the climatic patterns have been assessed.

An approach to simplify this work will be to initially look at the benthic patterns in relation to physical variables (i.e. temperature, storms, etc.) and then build up from these patterns observed, with view on further exploring complex questions (i.e. primary production, food webs, habitat forming species, etc.)

4   Benthos–related quality assessment (ToR b and ToR d)

4.1   Introduction

The BEWG reviewed new developments in environmental metrics and quality assessment covering phytobenthic and zoobenthic topics (**TOR b** & **d**). An overview of several benthos indicator tools that are used in Belgium, the Netherlands, Spain, Germany and Italy was presented as an introduction.

G. Van Hoey presented the BEQI concept, its applicability and the webtool to calculate the BEQI which is being developed by VLIZ (Flemish Marine Institute) and which will be available from June 2009. The BEQI concept was used to assess the benthic habitat quality in the Belgian coastal environment for the FWD, of which preliminary results were presented by H. Hillewaert. P. Magni presented the BenTOC initiative of Lagunet. M. Zettler gave a presentation about the adjustment of benthic ecological quality assessments to effects of salinity. I. Muxika presented the use of quality indices developed at AZTI (Spain) which were employed to evaluate the state of estuarine and coastal environments in relation to changing pressures. Additionally, there was a written contribution by A. Norkko about an integrated thematic assessment that is used in the Baltic Sea in relation to eutrophication.

4.2   BEQI concept, applicability (BE, NL, DE) and web tool

The Benthic Ecosystem Quality Index (BEQI) has been developed by the Netherlands Institute of Ecology on behalf of the Institute for Coastal and Marine Management. It is based on an ecosystem functioning approach (Ysebaert and Herman, 2004), which aims to give an indication about ecosystem structure and functioning, and about biological relationships. BEQI evaluates at the scale of a whole water body, contrary to methods applied by other member states that evaluate the ecological status per sampling station. The BEQI is used as official indicator for the evaluation of the coastal and transitional water bodies in Belgium and the Netherlands.

The BEQI is a multi metric method distinguishing three scale levels to asses overall ecosystem functioning.

The first level is the ecosystem level (the whole water body). Central at this level is the role of the macrobenthos in ecosystem functioning. The macrobenthic community is an important link in the food web between primary production and predatory invertebrate, fish and bird populations. As such it exerts top down control on the primary producers and bottom up control on the higher trophic levels while the reverse, control by primary producers and predatory consumers on the macrobenthic community act just as well. The dynamics of this interplay is fundamental to ecosystem functioning.

The second level is the habitat level. The macrobenthic communities in the ecosystem depend on the physical and chemical characteristics of the habitat. In transitional waters, strong gradients of physical energy due to waves and tides, as well as strong chemical gradients in salt and other constituents shape the habitat structure of the system. Thus, a diversity of habitats is typically found, and this diversity, characterized by the occurrence and the relative surface area of different habitat types, is a major factor determining occurrence, density and biomass of macrobenthos. Additional biogenic structures like the eco-elements mussel beds, oyster reefs and seagrass beds modify conditions at a local and possibly larger scale, and are also included in the second assessment level.

The third level concerns the within habitat macrobenthic community composition. Total biomass, total density, number of species and species composition are community characteristics that respond to different types of stress. The type of response may serve as a first indicator of the stressor type. Detection of changes in within-habitat communities may also help understanding responses at the ecosystem level.

The BEQI multimetric integrates the information of the three levels and primarily aims at providing a signal that is capable of showing significant **deviations** from a defined reference state.

For the moment a web application is developed by the Flanders Marine Institute (www.vliz.be) to make it able to calculate the EQR values for all parameter of the three levels. This tool is mainly developed for calculating EQR values in the context of the WFD in Belgium and the Netherlands, but this also provides the opportunity to other scientists to evaluate their water systems or use it in impact assessment. A clear manual will be available at the web site.

4.3 WFD implementation for the Belgian coastal waters

The Water Framework Directive (2000/60/EG) aims to achieve a good ecological and chemical quality status for all water types by 2015. The quality status of a water body can be determined based on the evaluation of biological, chemical and hydro-morphological quality elements. The evaluation of those quality elements is based on the integration of well defined biological quality criteria. Each of these criteria supports a classification (bad, poor, moderate, good and high) aiming at measuring the 'health' of the system compared to reference conditions. Article 8 of the WFD describes the need for monitoring programmes for the quality elements in their waters. These aspects were outlined for the quality element macro-invertebrates (benthos) in the Belgian coastal zone (< 1 nautical mile) in this study. The entire Belgian coast covers only one water body, which is, however,divided into three zones for the assessment; (1) a western zone, from the French border to Middelkerke, including the Yzer estuary; (2) a central zone, from Middelkerke to De Haan, including the harbour of Oostende; and (3) an eastern zone, from De Haan towards the Schelde estuary, including the harbours of Blankenberge and Zeebrugge. The evaluation tool for macro-invertebrates is the Benthic Ecosystem Quality Index (BEQI) (Van Hoey *et al.*, 2007; Ysebaert *et al.*, submitted), which aims at providing a signal that is capable of showing significant deviations from a defined reference state at three levels (1: ecosystem; 2: habitat; 3: community). An important aspect within the BEQI is the use of the habitat approach, which presumed that there is a habitat typology within the water body. The habitat typology for the Belgian coast includes three types: (1) *Abra alba* habitat (muddy fine sand), (2) *Nephtys cirrosa* habitat (well sorted medium sand), (3) *Macoma balthica* habitat (mud) (Van Hoey *et al.*, 2004).

The monitoring strategy for the quality element benthos at our Belgian coast is randomly stratified, resulting in nine sampling locations within the 1 mile zone of the coast and covering the most important habitats in each zone. At those sampling locations, 15 Van Veen samples were randomly taken within an area of 0.6 km². This monitoring program started in autumn 2007 and continued in 2008, with a few adaptations to improve the coverage of each habitat in each zone with enough samples to fulfil the required assessment precision of the BEQI evaluation tool.

The reference conditions for the benthos at the Belgian coast were defined based on all available data (ILVO, Ghent University) and the period 1994–2004 was selected as reference period, because it shows the best temporal and spatial variability in benthos

sampling points within the Belgian Coastal zone (< 6 nautical mile). This data could be linked to the 3 main habitat types, based on a detailed community analysis. Consequently, enough samples were available for each habitat type to determine the reference boundary values needed in the BEQI evaluation tool.

Based on the monitoring data of 2007 and the defined reference conditions, an assessment of the quality element benthos for the Belgian coast was made. The BEQI score at level 1 is set on 0.6 (moderate/good), based on expert judgement, whereas BEQI level 2 is not included in the assessment of the Belgian Coast. The overall score at level 3 of the BEQI for the benthos at the Belgian coast, by averaging the scores per habitat (*Abra alba*: 0.61; *Macoma balthica*: 0.53; *Nephtys cirrosa*: 0.75) over the three zones, is 0.63, which means a good status. However, the ecological status of the benthos along the Belgian coast is not 'good' everywhere; the *Macoma balthica* habitat in zone 3 for example showed a moderate status. By combination of the different levels, the EQR score for the Belgian coast is 0.62, which means a good status for the Belgian coast for the quality element benthos, but some parameters show significant changes compared to the reference state.

4.4 Assessing phyto– and zoobenthic quality within the Water Framework Directive in the Basque Country (Spain)

I. Muxika presented work done at AZTI by A. Borcha, G.Rodríguez and himself on Spanish methodology to assess both quality elements and the response to pressures and evolution of M-AMBI values.

In the Basque coast, CFR is used in phytobenthic quality assessment, whereas M-AMBI is use for soft-bottom zoobenthic quality assessment.

CFR is a multimetric tool that takes into account, the richness of selected macro-algal populations (those which structure Cantabrian shallow waters), their coverage and the coverage of pollution indicator species. On the other hand, M-AMBI is a multivariate tool, which incorporates AMBI, richness and Shannon diversity, within the assessment.

In this contribution several examples of these applications to different water bodies, are presented. The time-series extend to samples collected between 1995 and 2007, showing the evolution of M-AMBI values under different pressures, i.e. urban and industrial discharges, dredging and disposal of sediments, and engineering works (such as land reclamation or marina construction). Also, for illustrating the benthic quality recovery after positive actions has been undertaken, i.e. the removal of point-source discharges or water treatment programmes. In most cases, M-AMBI responds to these pressures as expected, with decreases in the ecological status immediately following the pressure.

4.5 An adjustment of benthic ecological quality assessment to effects of salinity

M. Zettler presented a recent study on salinity effects influencing BQI performance.

In areas with strong environmental gradients, like the brackish southern Baltic, it is well known that species can adapt and change their live history (Remane, 1958). The salinity gradient is so strong in the southern Baltic that in the same geographical area a large range of salinity can be measured. Therefore the impact of salinity on ecological status classification was investigated in this study. As Zettler *et al.* (2007) found, the fixed ecological species reference list needs reconsideration in the Baltic. This and

the adaptive behaviour of species have to be considered in a species sensitivity/tolerance reference list. In this study, the focus was on the problem of defining species references. Static reference lists have more often been used than other methods. Even though these lists have been enlarged in recent years, each species is always categorised only once in a distinct ecological group.

The performance of the 'Benthic Quality Index' (BQI) was tested and the calculation procedure adapted along the strong natural salinity gradient in the southern Baltic Sea. This study was based on a very large dataset sampled during the HELCOM monitoring program and further investigations, allowing evaluation of the influence of salinity on the classification of ecological quality and species sensitivity. The species reference lists were calculated for seven salinity ranges and two depth horizons. This constitutes a significant advance on the system of static species reference lists.

The natural salinity gradient was shown to have a severe impact on the BQI based EcoQ. The calculation procedure was adapted to reduce the salinity effects to a minimum.

The complete list of $ES50_{0.05}$ values can be downloaded from the website of the Leibniz-Institute for Baltic Sea Research Warnemünde

(http://www.io-warnemuende.de/michael-zettler.html).

4.6 "The BenTOC initiative of Lagunet" on the title "Animal–sediment relationships: Evaluating the 'Pearson–Rosenberg paradigm' in Mediterranean coastal lagoons"

P. Magni reported.

Through the collaborative efforts of several institutions and scientists within BenTOC initiative of LaguNet (Italian Network for Lagoon Research), the applicability of the Pearson-Rosenberg (P-R, 1978) conceptual model describing a generalized pattern of response of benthic communities in relation to organic enrichment to Mediterranean coastal lagoons was investigated. Matching data on the structure of macrobenthic communities and TOC content of sediments were obtained and analyzed from 349 stations representing the three Mediterranean Sea coastal lagoons of Cabras, Orbetello, and Venice (Italy). Consistent with P-R model predictions, benthic diversity and abundance showed two different peaks at low (> 2.5–5 mg g^{-1}) and high (> 25–30 mg g^{-1}) total organic carbon (TOC) ranges, respectively (Magni *et al*., 2009). TOC thresholds were identified indicating that risks of reduced benthic diversity should be relatively low at TOC values < about 10 mg g^{-1}, high at TOC values > about 28 mg g^{-1}, and intermediate at values in-between. While not a direct measure of causality, it is anticipated that these TOC thresholds should serve as a general screening-level indicator for evaluating the likelihood of reduced sediment quality and associated bioeffects in such eutrophic systems of the Mediterranean Sea.

This study reinforces the importance of reliable and accurate taxonomy as a starting foundation for the integration of diversity measures and other benthic indicators into comprehensive data sets for large-scale management purposes. It also highlights the value of collaborative regional programmes to help develop consistent and comprehensive sets of indicators and processes that provide a basis for understanding the unique properties of specific ecosystems, such as Mediterranean coastal lagoons.

4.7 Eutrophication in the Baltic Sea: An integrated thematic assessment of the effects of nutrient enrichment in the Baltic Sea region

For more than three decades, the Helsinki Commission (HELCOM) has coordinated monitoring and assessment activities in the Baltic Sea region. In 2005, the Commission adopted a new Monitoring and Assessment Strategy. As a result, focus of the assessment activities shifted towards integrated thematic assessments, which concentrate on specific issues and are more detailed and solution-oriented than the previous, broad Periodic Assessments of the State of the Marine Environment in the Baltic Sea Area published in 1980, 1987, 1990, 1996, 2002 and 2003.

The effects of nutrient enrichment, also known as eutrophication, are perhaps the single greatest threat to the Baltic Sea environment. Understanding of eutrophication becomes clearer when one considers the origin of the word, which has its root in two Greek words: '*eu*' which means 'good' or 'well', and '*trope*' which mean 'nourishment'. Consequently, a translation would be 'well nourished', but the modern use of the word eutrophication is related to excess loads of nutrients, nutrient enrichment, and adverse effects in aquatic ecosystems. Nutrient enrichment results in an increase in productivity and undesirable changes in ecosystem structure and functioning. Marine systems such as the Baltic Sea can cope with the increases to some extent. When the limits of 'normal' ecosystem structure and functioning are exceeded, however, the ecosystem as a whole is confronted with the problem of eutrophication.

This report describes and documents the degree and effects of nutrient enrichment and eutrophication in the Baltic Sea including the Kattegat/ Belt Sea area. The objectives of this eutrophication assessment are:

1) To define the issue, by answering the questions: 'What is nutrient enrichment and eutrophication?' and 'How are nutrient loads, nutrient concentrations, biological quality elements and other effects interlinked?'

2) To document the eutrophication status of the Baltic Sea by focusing on the following chemical and biological quality elements: nutrients, phytoplankton, water transparency, submerged aquatic vegetation, oxygen concentrations, and benthic fauna.

3) To document the causes of eutrophication by describing nutrient loads (waterborne and airborne) to the Baltic Sea including their sources.

4) To discuss solutions to the eutrophication problems in the Baltic Sea, e.g. by assessing existing national and Baltic-wide strategies, actions and measures to combat eutrophication, and by outlining supplementary measures required to reduce eutrophication to acceptable levels also taking into account future challenges related to changing environmental conditions and human pressures.

This report is directly linked to the HELCOM Baltic Sea Action Plan, which identified eutrophication as one of the four main issues to address in order to improve the environmental health of the Baltic Sea. The Action Plan sets a strategic goal related to eutrophication, namely, 'Baltic Sea unaffected by eutrophication', and identified a set of Ecological Objectives which corresponds to good ecological/environmental status. This thematic assessment addresses each of the Ecological Objectives for eutrophica-

tion and enables an evaluation of progress towards the Ecological Objectives. In the Baltic Sea Action Plan, the Contracting Parties acknowledged that a harmonized approach to assessing the eutrophication status of the Baltic Sea is required. Therefore, the Contracting Parties agreed to further develop a common HELCOM assessment tool for use in a Baltic-wide thematic assessment of eutrophication in coastal as well as open sea waters.

Ecological objectives related to eutrophication were adopted in the HELCOM Baltic Sea Action Plan. They are: concentrations of nutrients close to natural levels, clear water, natural level of algal blooms, natural distribution and occurrence of plants and animals, and natural oxygen levels. In some coastal areas, the classification presented in the Baltic Sea-wide eutrophication assessment cannot be directly compared to the results of national assessments and the Baltic Sea intercalibration exercise *sensu* the Water Framework Directive owing to differences in spatial and temporal scaling, as well as the use of parameters that are considered supporting in WFD.

This thematic eutrophication assessment is aimed at decision-makers, managers, scientists, educators and others interested in the health status of the Baltic Sea; it includes a glossary in order to support readers without a professional background in marine ecology or oceanography. The full report is available via http://meeting.helcom.fi/c/document_library/get_file?p_l_id=79889&folderId=377779 &name=DLFE-36818.pdf.

4.8   Discussion

Concerns were raised about the requirement of (1) good reference sites and (2) the knowledge of the surface of the different habitat types (waterbodies) for the calculation of the BEQI. Often, this is not known which may hamper the applicability of the BEQI in other regions. Such reference sites should be judged by experts or based on old maps (if available). Whenever this information is lacking, the level 1 and 3 of the BEQI can still be calculated regardless.

The group further discussed how the expertise in the BEWG can present an added value for (future) environmental metrics/quality assessment research. It was agreed to draft a viewpoint paper, which will mainly focus on the "lessons learned" from the application of benthic metrics within e.g. the Water Framework Directive (WFD) and present guidelines/recommendations for future applications instead of making an intercalibration between different indices. Such approach will provide useful recommendations for the European Marine Strategy from a benthic scientific point of view. Further, it was decided that such viewpoint paper will greatly benefit from a word-wide focus (i.e. including indices from the US, Chile and Argentina) instead of a limited focus on indices only used in European waterbodies.

A vast amount of papers on the comparison of indices and reviews on the existence and use of all kind of indicators can already be found in literature. The BEWG has spent lots of time on this topic, collecting information and feeding it into its reports. The Water Framework Directive (WFD) is already a few years in charge and the European Marine Strategy (EMS) has started. Thus, a BEWG viewpoint on how to possibly move forward with benthic metrics within the EMS is considered worthwhile. The BEWG will publish their views on the environmental quality assessment process with the use of benthic indicators. During a subgroup discussion seven main viewpoint topics were determined:

1)   Intercalibration process.

2) Identification of the reference condition

3) Invasive species in relation to quality assessment

4) Sampling efforts needed to assess the environment;

5) Quality assurance of the process

6) Ecosystem approach

7) Measuring anthropogenic versus natural impacts with indicators.

In order to speed up the internal review process by the co-authors of this paper, a *Google document* approach to share editing the paper was suggested.

Annex 6 outlines the structure of the paper, with indication of the contributors and a tentative time line. The group will take the necessary actions to try to finish this by the end of 2009.

Towards the end of the afternoon session, H. Rumohr showed pictures of the deployment of a Sediment Profile Imagery (SPI) and videos recorded during a SPI survey (courtesy of R. Diaz).

5   Planning the next North Sea Benthos Project taking into consideration the findings from WKCBNS in December 2008 (ToR a)

H. Reiss presented the "Climate related Benthic Processes in the North Sea (CBNS)" workshop.

The North Sea benthos survey was initiated by the BEWG in 1986: 321 stations; 2000 (1999-2002): 1570 stations. This work led to some publications, e.g. Rees *et al*. 2007. Structure and dynamics of the North Sea. ICES Cooperative Research Report 2007. New surveys should be done within the frame of Climate Change, preferably integrated into existing (international) programmes (such as the IBTS).

The "Small scale box approach" was presented together with various hypotheses. It was recommended to use existing datasets (NSBS, NSBP) and to initiate ecosystem and habitats suitability modeling. Selection of some of these would be feasible for the BEWG group in close cooperation with other ICES EGs, especially those with an expertise in ecosystem and habitat suitability modeling and habitat mapping.

The creation of an *ad hoc* Study group was proposed with H. Reiss as chair and S. Birchenough co-chairing (see Annex 7). Establishment of the Study group was planned for the coming summer at the SCICOM (science community) meeting (June-July 2009).

6   Benthos in fjord ecosystems: possibilities for future integration into BEWG

6.1   Work in the Chilean fjords

G. Försterra presented.

Fjord regions are important coastal marine areas subject to fast economic development. Nevertheless the actual research effort dedicated to fjord regions does not adequately reflect their importance. Exemplified by Chilean Patagonia, particularities of fjord regions are described, most serious gaps in knowledge are identified and focuses for research efforts are proposed.

Recent studies indicate extraordinary species diversity and discovered a huge number of unknown benthic species. Even more dramatic than the lack of taxonomic knowledge is the lack of information on the ecological interactions and dynamics. As a consequence, management of high impact activities, like salmon farming and fisheries, through regulatory or technical solutions alone in such complex and poorly known ecosystems is highly risky. Alternatively we propose spatial management with highly protected MPAs to back up management experiments in the non-protected areas. Large-scale inventories and biogeographic analyses are necessary to support such spatial planning.

A fjord research network and a fjord forum have been initiated to promote fjord-related research, and to enhance exchange of experience and data. Since most fjord regions are located in countries that have member or observer status in the ICES network, ICES could be a perfect platform into which the existing initiatives could be integrated with the idea to form experts groups, stimulate joint projects and council decision makers.

6.2 Proposal for a fjord study/working group and possibilities for cooperation

V. Häussermann and G. Försterra outlined a proposal for a fjord working/study group.

6.2.1 Proposal

Fjord regions are important coastal areas. They are important in size since the real coastline they cover is a multitude of the geographical extension, they are ecologically important since they harbour a wide variety of marine habitats and are areas of elevated marine biodiversity, and they are economically important since they often represent areas of high production and are important reproduction areas for commercially important species.

This general importance is only poorly reflected in the actual research activity that is dedicated to fjord areas. The reasons for this may be manifold and differ between the regions, but harsh climatic and marine conditions, generally low population, benthic communities that are difficult to access from larger research vessels, and last but not least research fashions in the past are among the predominant reasons. While the Norwegian fjord region is comparably well studied through a long history of marine science, other areas like in Greenland, British Columbia or even more dramatic in Chile are more poorly known than many polar or deep sea areas.

The scarcity of researchers was often accompanied by a strong isolation of their activity. As a consequence, important questions like the origin of deep water emergence have been addressed separately in the different fjord regions with different outcomes. Nevertheless, despite all differences and particularities, fjord regions have many situations, elements and dynamics in common. This situation asks for strong interdisciplinary, international and intercontinental cooperation.

Therefore in 2004 the Fjord Research Network (www.fjord-research.net) was started, which is a communication and cooperation platform between marine scientists (mainly biologists) who work in fjord regions. Since this initiative started out from Chile, most affiliates come from there but there are also partners from British Columbia, Alaska, New Zealand, Tasmania and Norway. Parallel to this platform, a Scottish initiative was created with similar goals. This group that is called the Fjord Forum

attracted mainly oceanographers from Europe and eastern North America. On May 7 and 8 in Bergen, Norway, there will be a "Fjord meeting" where, among others, a fusion of the two groups is planned. A formalization and vitalization of the network is envisioned to define basic structures.

Since one of the main ideas is to bring researchers together and facilitate information exchange and to stimulate cooperative projects it is believed that this idea fits perfectly into the framework of ICES. Most of the countries that have fjords and consequently most of the researchers who work in and with fjord environments come from countries that are either ICES core members or affiliate countries to the ICES network.

Fjord research is special, both technically and thematically but is underrepresented in relation to its importance. It is generally not or only insufficiently covered by existing research frame works. Therefore fjord research might be integrated into existing work groups, like for example the benthic group from ICES, but should be named and treated as an independent research focus.

6.2.2 Discussion

H. Rumohr observed that in addition to other Southern hemisphere countries, Chile is an affiliate country of ICES. Chile could be a case where ICES countries can learn to avoid making mistakes when applying experiences to the northern hemisphere. A Fjord Working/Study Group could be highly valuable.

Integration of this group within BEWG would however not be favourable. Working Groups such as BEWG are long-term initiatives. A separate Study Group, related to oceanography, aquaculture and this Benthos Ecology group would be more appropriate. BEWG proposed the establishment of a new Study Group with a North-Atlantic chair. The proposal can be found in Annex 8.

A ToR could be provided and a research scenario developed, followed by knowledge transfer and cooperation scenarios.

A theme session for the 2010 or 2011 ICES Annual Science Conference may be appropriate.

7 BEWG contribution to the ICES position paper on climate change (ToR f)

7.1 Report on the ICES Steering Group on Climate Change meeting (Halifax, 24/09/2008)

S. Degraer reported on the outcomes of the SGCC meeting, relevant to the BEWG.

After a short introduction to the SGCC membership, mission and objectives, responsibilities and tasks, as well as its road map for 2009-2010 (for details see http://www.ices.dk/reports/SCICOM/2008/sgcc08.pdf), the SGCC request to the BEWG was highlighted. This request targets the possible contribution of the BEWG to the ICES position paper on Climate Change, which is due by the end of 2010 and will be a major result of the SGCC. It was clarified that within the benthos-related chapter in this ICES position paper the BEWG is expected to report on what we know and what it is we do not understand. We should further include predictions or future research activities.

7.2 Evaluate and report on the response to ToR a in the BEWG 2008 report for its usefulness as a starting point for a benthos–related chapter in the ICES position paper on climate change.

The SGCC request (ToR f) was discussed in plenary.

H. Reiss reported on last year's BEWG report on the effects of climate change to the benthos. Within this part of the BEWG report, a literature search formed the basis for the delineation of a series of benthos-related hypotheses related to climate change. S. Degraer listed the hypotheses which were amended by the BEWG. A structure of the BEWG contribution to the ICES position paper was agreed upon and responsibilities were delegated (see Annex 9). It was agreed that every contributor will come up with half to one page of a summary of what is known and what is not-known on the subject, taking the BEWG 2008 report as a baseline for further literature. S. Degraer will report on these agreements to the SGCC during its meeting early June 2009 and will provide feedback to the BEWG. Based on this feedback a time line for further elaboration of this initiative will be proposed to the BEWG contributors. It was however already agreed that a compiled draft version of the BEWG contribution should be ready prior to the BEWG 2010 meeting, so we could use the BEWG 2010 meeting to finalize the publication.

8 Report on new developments in ongoing benthic research in the ICES area (ToR c)

8.1 Spatial and temporal variation of soft bottom benthos on different scales

A. Schröder reported

Numerous applications for offshore wind farms are currently already covering large areas of the German EEZ of the North Sea. Each of these projects has to carry out investigations on the status of the biota in the respective area for two years prior to the installation of the wind farm (as well as during the construction and operational phase). These data shall now be analysed in conjunction with other available data to assess of ecological effects of wind-farms on a wider scale instead of on a case-by-case basis, but also to address scientifically interesting questions regarding benthic communities.

The presently available data from the first 17 approved wind farm applications shall now be used in conjunction with data from scientific projects and monitoring programs for an analysis of spatial and temporal variability of benthic (and demersal fish) communities. A preliminary analysis of long-term series and selected spatial data indicates that spatial variability does not only depend on the sampled scale, but is also an inherent property of a certain habitat. However, the spatial variability of the benthic community at a given location does also change over time depending on external influences. Further analyses will be conducted on the whole data set as soon as the quality assurance process will be finished.

This research is part of the recently started project "StUKplus-Data", which is intended as a "cooperative analysis of data from research, environmental monitoring and environmental impact studies from offshore wind farms in the German EEZ". It includes data on marine mammals and sea birds, benthos and demersal fishes as well as hydrographical data and human influences. The analyses are carried out in coop-

eration between the German Federal Maritime and Hydrographic Agency (BSH) in Hamburg, the Research and Technology Centre (FTZ) in Büsum and the Alfred-Wegener-Institute for Polar and Marine Research (AWI) in Bremerhaven with contributions from several associated institutes. The intended outcome will be an integrated evaluation of the ecological effect-monitoring of offshore wind farms.

8.2 Impact of mussel fisheries on biodiversity

J. Craeymeersch gave an account.

In 2004 a new policy on shellfish fisheries came into effect in the Dutch coastal waters. In this policy it was concluded that insufficient knowledge exists on the effects of mussel seed fisheries on the nature value of the Subtidal part of the Dutch Wadden Sea. To study these effects a research project was started in 2006 in cooperation with NGO's, fishermen and policy makers. The project will run up to 2012. In total 40 areas divided into one fished and one non-fished subarea will be monitored before and after mussel seed fishery in spring or autumn. Data will be collected on mussel bed contours and patterns (side scan sonar), infauna, epifauna and sediment (boxcorer), mussel biomass (modified hydraulic dredge) and black box information for fisheries intensity. A subtidal survey in the western Dutch Wadden Sea will allow comparison of the natural value of subtidal mussel beds to culture plots and other subtidal habitat.

8.3 The MAREANO project.

The delegate for Institute of Marine Research (IMR), L. Buhl-Mortensen (IMR) presented an overview of the work that has been undertaken under the MAREANO seabed mapping programme in the southern Barents Sea.MAREANO (**Ma**rine **AREA**database for **NO**rwegian coast and sea areas) is a multidisciplinary mapping programme, focusing on offshore areas in the southern Barents Sea in a first phase (-2010). It is a collaborative venture between three main partners: the Institute for Marine Research (IMR), Geological Survey of Norway (NGU) and the Norwegian Hydrographic Service, coordinated by IMR. MAREANO was initiated to address the lack of knowledge about the seabed, natural resources and pollutants which is required for informed, sustainable management.

The project is financed through an inter-ministerial financial collaboration between the ministry of the Environment, Fisheries and Coastal Affairs and Trade and Industry, with a yearly budget of around 5 million Euro. The first phase of the MAREANO mapping began in 2005 and will deliver results for a revision of the Barents Sea management plan in spring 2010. The plan is that mapping will be continued in the Barents Sea after 2010 and in addition mapping will start in the Norwegian Sea. The mapping programme includes acquisition of multibeam bathymetry and backscatter data together with a comprehensive, integrated biological and geological sampling programme. Equipment used includes underwater video (CAMPOD), box corer, grab, epibenthic-sled, and beam trawl. Multicore samples are also taken for assessments of organic and inorganic contaminants in the sediment, and some shallow seismic data are also acquired.

The MAREANO concept of ground-truthing

Depending on the topographical variability the density of stations needed for ground- truthing will differ. In the high relief area presently mapped numbers of video transects are 10–15 / 1000 km^2 and sampling stations 3–5 / 1000 km^2. Mapping steps are:

1) Multibeam mapping > topography

2) Interpreting Multibeam backscatter > indicating sediment softness

3) Information from 1 and 2 are user to position sampling stations

4) Video documentation and sampling of sediment and fauna > sediment-, biodiversity and "naturtype" habitat maps
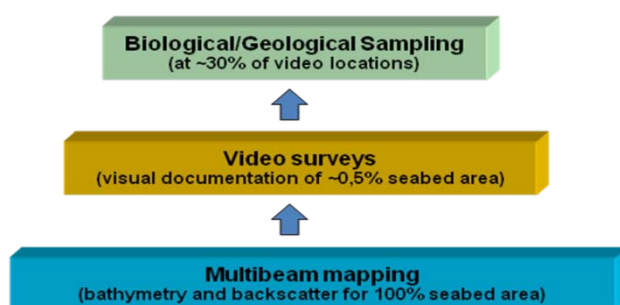
Mapping outputs from the project include bathymetric data, geological maps (morphology, hard and soft seabed, sediment grain size distribution, sedimentary environment (erosion & deposition areas), and genesis), biological maps (including biodiversity and faunal distribution, i.e. species abundance and biomass), benthic habitat maps, and environmental geochemistry maps (contaminants). All results from MAREANO are integrated in the web portal, www.mareano.no. Other relevant datasets are also made available via this web portal by the project partners.

The MAREANO (phase 1) area covers 162 000 km², and mapping has been prioritised in key areas (Eggakanten, Troms II and Nordland VII) within the MAREANO area, including areas of interest for commercial exploitation. Biological and geological sampling during the 2007–2008 period was conducted in Troms II and Nordland VII. Multibeam data acquisition continued in Nordland VII during 2007 out to the 1000 m depth contour. During 2007 a decision was taken by government to extend the MAREANO area beyond the 1000 m contour in Nordland VII and Troms II. The maximum depth in these sectors is 2700 m. This area was sampled during two research cruises in 2008.

Arealer i km2	
navn	areal
Eggakanten	12470
Eggakanten grunnere enn 500 m	8085
Eggakanten, 500-1000 m	4385
Nordland VI	23347
Nordland VI, dypere enn 1000 m	7700
Nordland VI, grunnere enn 1000 m	15647
Nordland VII	23895
Nordland VII grunnere enn 500 m	11685
Nordland VII 500-1000 m	2041
Nordland VII, 1000-1500 m	1880
Nordland VII, 1500-2000 m	1667
Nordland VII, 2000-2500 m	3464
Nordland VII, dypere enn 2500 m	3148
Troms II	5750
Troms II grunnere enn 500 m	3774
Troms II 500-1000 m	439
Troms II, 1000-1500 m	513
Troms II, 1500-2000 m	872
Troms II, 2000-2500 m	152

Areas mapped by MAREANO for distribution of sediments and bottom communities.

IMR and NGU cooperate to perform the habitat mapping following biological analy-sis of the video and sample data at IMR. Tromsøflaket is currently being used as a case-study area to develop suitable habitat modelling methods and products from MAREANO. Multivariate statistical methods are used to relate bottom environment (including multiscale physical descriptors of the seabed derived from multibeam data) and fauna distribution in order to find objective criteria for definition of habi-tats and biotopes. Through the use of assisted GIS analyses biotops/habitats are pre-dicted in new areas. For future MAREANO cruises an important task will be to ground truth predicted occurrences of bottom fauna/biotopes based on observed rela-tionships and to test the reliability of these predictions in the wider MAREANO area.

Identified habitats/biotops at the Tromsøflak area

Using multivariate methods to relate sediment characteristics and fauna together with assisted GIS analysis a map showing the distribution of six habitats was pro-duced. Based on these results the occurrence of habitats was predicted in adjacent area.
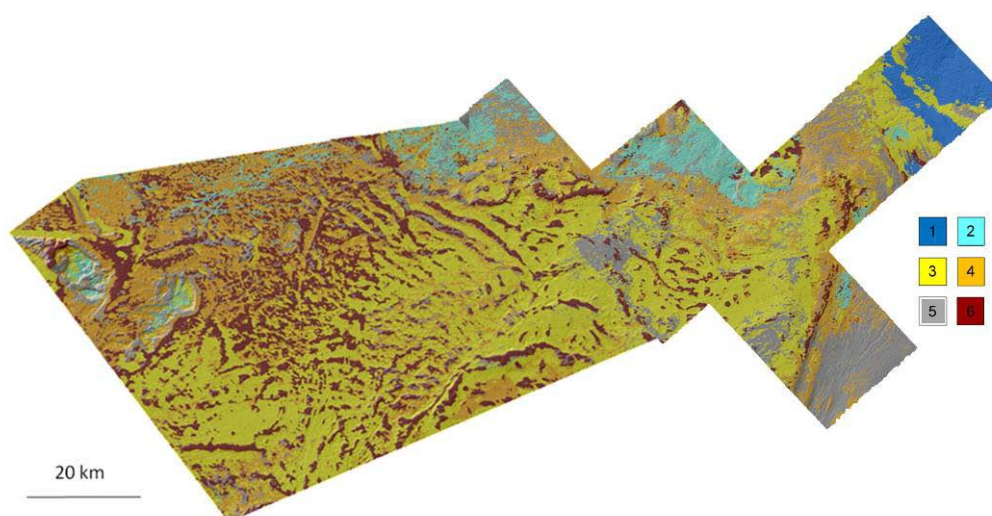
Distribution of the six identified habitats at the Tromsøflaket area.

Analysis of the distribution of mega fauna (video observations) connected to different landscapes and landscape element was analysed for the Nordland VII and Troms II area. Map of occurrence of habitats defined as threatened and declining by OSPAR was produced.
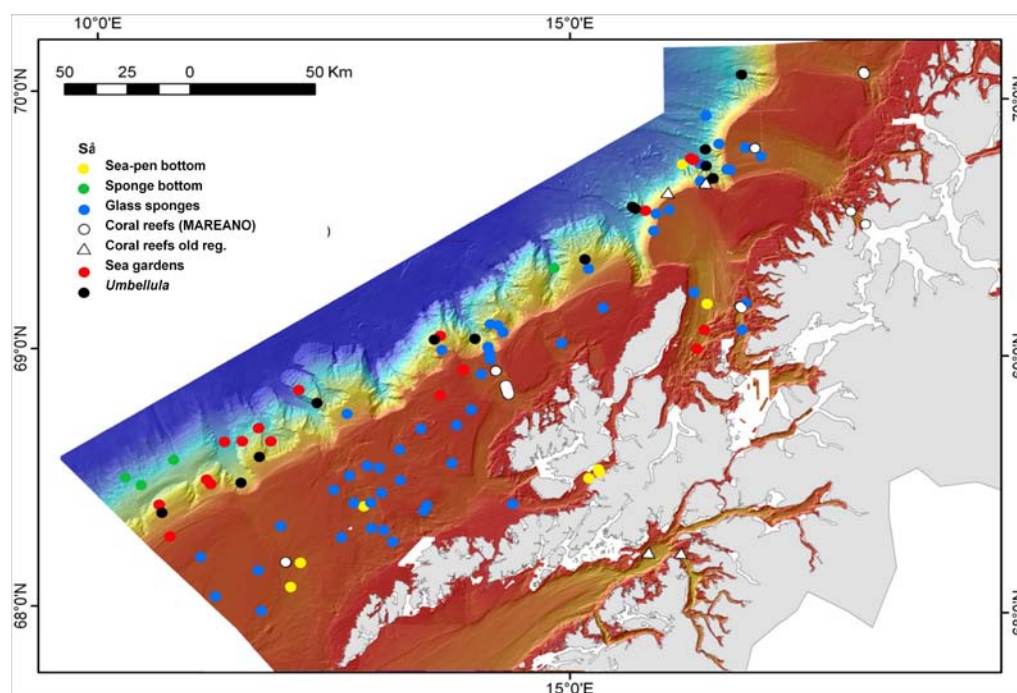
Habitats defined as threatened and declining by OSPAR together with *Umbellula* and glass-sponges.

8.4   Larval settlement response to benthic diatom films

C. Van Colen introduced a project which will investigate the effects of benthic diatom films (BDF) on the (post)larval settlement success of the macrobenthic species *Hediste diversicolor*, *Macoma balthica*, *Cerastoderma edule* and *Pygospio elegans*. One of the most important challenges in estuarine benthic ecology is to understand the spatial and temporal variability in soft-sediment communities. The entry of juveniles into the

adult population (i.e. juvenile recruitment) is of fundamental importance to the variability in macrobenthos community structure because it is the foundation upon which all subsequent interactions within the community take place. The majority of marine benthic invertebrates display a life cycle with a dispersive (i.e. pelagic) larval phase during which they distribute and settle down into new habitats and develop to the benthic stage (i.e. settlement). Consequently, knowledge on the processes that determine the benthic settlement success are important to understand changes in recruitment success.

Pilot annular flume tests with *Macoma balthica* larvae revealed that competent *M. balthica* larvae settled significantly more in BDF as compared to control sediments. Comparison with the settlement of freeze-killed larvae revealed that, active selection, active secondary dispersal and, at low flow velocities (5 cm s^{-1}), also passive adhesion are important mechanisms that determine the settlement of *M. balthica* larvae in BDF. In order to delineate insights in the driving processes of the settlement response of the selected macrobenthic species, future experiments will manipulate the chemical products derived from different diatom communities (e.g. EPS).

8.5 Benthic Infaunal Monitoring in St Lucie Estuary and the Southern Indian River Lagoon

B.Tunberg gave an account.

This project is part of the Comprehensive Everglades Restoration Plan (CERP), financed by South Florida Water Management District. The St Lucie River Estuary (SLE) and the Southern Indian River Lagoon (IRL) constitute the convergence of a major riverine estuary and the southern terminus of a 185 km long bar-built lagoonal estuary in eastern Florida. The SLE is connected to the large, but heavily polluted, Lake Okeechobee through canal C-44, which empties into the South Fork of the estuary. Historically, natural freshwater discharges into these water bodies sustained an ecologically appropriate range of salinity conditions to facilitate the presence of healthy floral and faunal communities. Recently, large volumes of nutrient laden and polluted fresh water have been drained from mainly the C-44 canal (Lake Okeechobee). In addition, the recent urbanization of Florida's coastal regions and the ensuing increased demand for water and flood control have led to frequent high and low salinity extremes within the coastal water bodies. Managing for these demands has subsequently resulted in a shift in the ecological components that historically defined the coastal water bodies to communities that have been deemed less desirable.

The benthic sampling program is a fixed site monitoring effort directed at identifying trends in macrobenthic conditions. Three replicate samples are collected using a Petit Ponar grab, which samples a 0.02 m^2 area. It involves sampling at 15 sites, 13 of which have been sampled since the program's inception in February 2005, with two inner estuary sites added in July 2007. Each site is visited 4 times per year, twice (January and April) during months that typically fall into Florida's dry season (November–April) and twice (July and October) during months that typically fall into Florida's wet season (May–October).

These sites span all salinity regimes within the St. Lucie Estuary and the Southern Indian River Lagoon (SLE/IRL-S) and cover the watershed in such a way that benthic

responses to hydrologic events stemming from the system's tributaries can be detected and analyzed.

Between February 2005 and October 2008, the project conducted 16 sampling events. A total of 660 ponar samples have been collected so far, along with 440 sediment cores. An average of 53601 individual animals was counted per year, or 13,400 per quarter. A total of 212,247 individual animals have been processed and identified (January 2009). The faunal data as well as the environmental variables are being entered into a customized web-based database.

The St. Lucie Estuary and the Indian River Lagoon display a spectrum of soft-bottom community types along the salinity gradient typical of most estuaries. Sites within a given salinity zone tend to be more similar to each other than to sites in other salinity zones, with four major zones present (Oligohaline, Mesohaline, Polyhaline, and Euhaline). The SLE main stem exhibits very poor ecological health. The north fork river of the estuary, along with the upper south fork are slightly better, but still with impaired ecological health. Moving out of the SLE and into the Indian River Lagoon estuary, the ecological health improves dramatically. The IRL sites exhibit high diversity and abundance.

8.6 Pre and Post Dredge Benthic Environmental Monitoring in the Sebastian River Estuary, Eastern Florida

B. Tunberg presented post-dredging study.

This study provides the basis for post-dredge assessment, including:

1) assessing any temporal and spatial changes that may be attributed to the effects of the soft sediment removal.

2) determining whether unacceptable impacts are occurring within and around the soft sediment removal sites.

3) establishing the nature and rate of recolonization by benthic invertebrates following cessation of the soft sediment removal.

Quantitative benthic infaunal sampling (with replication), sediment analyses and water quality measurements have been performed quarterly at 8 sites in the Sebastian River Estuary, eastern Florida, since April 2004. The study covers the area from the Indian River Lagoon (east and close to the US1 highway bridge) and to the west of the railroad trestle. The pre dredge data indicated that the ecological conditions were poor from the US1 bridge and west to the railroad trestle, but good in large areas west of the trestle further into the River, with a rich infaunal community and high bottom oxygen and salinity concentrations. The preliminary conclusion from these studies is that dredging could be performed from the US1 bridge and west to the railroad trestle without any serious ecological consequences, provided a minimal release of suspended matter into the water column. Because of the large areas with good environmental conditions west of the trestle, the conclusion was that dredging should be performed with the greatest caution here and should also be as limited as possible. The very negative benthic development detected in October 2004 throughout the system was most likely caused by the powerful hurricanes Frances and Jeanne. Large freshwater discharge to the Sebastian River via the North Prong (primarily through the C-54 canal) and to a lesser extent from the South Prong, continued for a duration of approximately 6 weeks. This event significantly impacted the benthic environment, inducing hypoxia and low salinities that resulted in a rapid drop in benthic taxa and diversity. However, recovery was fairly rapid as indicated by the data from January

and May 2005. As expected, the sediment in the dredged areas was defaunated as a result. Recovery of individuals and taxa were fairly rapid, though multivariate analyses indicated that differences in community structure existed between the assemblages prior to and after the dredging occurred. The poor conditions that existed in these areas prior to dredging hampered further analysis until a longer time-series can be generated as infaunal abundance and diversity was very low prior to dredging in the main Sebastian River basin.

8.7 WISER – Water bodies in Europe: Integrative Systems to assess Ecological status and Recovery

I. Muxika reported on a recently started European project.

WISER is a project approved under the 7th European Framework Programme. The WISER consortium has succeeded in bringing expertise together (see partners in Table 1) in order to remove as many still existing obstacles for Water Framework Directive (WFD) implementation as possible, in the fields of the ecological assessment and intercalibration, the linkage of assessment and restoration and the linkage of assessment and climate change.

Table 1. Organisations participating in WISER project. Daniel Hering (University of Duisburg-Essen) is the coordinator.

Participant No.	Participant organisation name	Short name	Country
1 (Coordinator)	University of Duisburg-Essen	UDE	Germany
2	Norwegian Institute for Water Research	NIVA	Norway
3	Natural Environment Research Council Centre for Ecology & Hydrology	NERC	UK
4	AZTI-Tecnalia Foundation	AZTI	Spain
5	University of Hull, Institute of Estuarine & Coastal Studies	UHULL	UK
6	Aarhus University - National Environmental Research Institute	AU	Denmark
7	French Research Institute for agricultural and environmental engineering	CEMAGREF	France
8	Swedish University of Agricultural Sciences	SLU	Sweden
9	European Commission Joint Research Centre	EC-JRC	EU
10	Institute of Environmental Protection	IEP	Poland
11	Forschungsverbund Berlin e.V.	FVB.IGB	Germany
12	Finnish Environment Institute	SYKE	Finland
13	Consejo Superior de Investigaciones Científicas	CSIC	Spain
14	ALTERRA Green World Research	ALTERRA	The Netherlands
15	Universität für Bodenkultur Wien	BOKU	Austria
16	Estonian University of Life Sciences	EMU	Estonia
17	University College London	UCL	UK
18	Institute for Ecosystem Studies	CNR	Italy
19	WL	Delft Hydraulics (Deltares)	DELFT	The Netherlands
20	Institute of Marine Research, University of Coimbra	IMAR	Portugal
21	Institute of Oceanology, Bulgarian Academy of Sciences	IO-BAS	Bulgaria
22	Trinity College Dublin	TCD	Ireland
23	University of Salento	USALENTO	Italy
24	University of Bournemouth	BourneU	UK
25	Università degli Studi di Milano	UMIL	Italy

The main aims of the project are directed to answering next questions:

- Which **biological indicators** are best suited for the assessment of aquatic ecosystems? Which are most reliable? Which are redundant? This aim is limited to lakes (with a special focus on hydromorphological degradation) and coastal and transitional waters, for which assessment systems are still partly lacking.

- How can assessment results obtained with different Biological Quality Elements (BQEs) or from different sites best be compared, intercalibrated and combined into an *integrated appraisal* of ecological status?

- How do *BQEs recover from degradation*, in particular hydromorphological degradation and eutrophication, and how is assessment and restoration affected by global change?

- How (un)certain are ecological status assessment results and predictions of the outcome of management measures? How can *uncertainty* be quantified and consequently minimised?

These objectives will be achieved by (1) combining and evaluating a large number of databases provided by the partners and resulting from WFD monitoring programmes and (2) by a dedicated field exercise targeted towards the estimation of uncertainty and towards the comparison of different BQEs.

The consortium will work in close connection with international, national and regional authorities responsible for WFD implementation, in order to ensure efficient links between science and policy.

WISER will therefore close the gaps still obstructing the WFD monitoring programmes and the intercalibration process, and will take the implementation of the WFD forward to focus on recovery and rehabilitation.

8.8 Mapping subtidal habitats around the Cornish peninsula: an assessment of suitability for Special Areas of Conservation status

S. Birchenough gave an update on the work currently conducted on Special Areas of Conservation (SAC's) in UK waters.

The 'Habitats Directive' (92/43/EEC) is considered on the strongest wildlife pieces of legislation emplaced during the 20th Century. At a European level this legislation provides for the creation of a network of protected terrestrial and marine wildlife areas (known as the Natura 2000 series) across the European Union. Generically these areas are Special Areas of Conservation (SAC's) or known as European Marine Sites. For each site, necessary conservation measures are applied for their maintenance or restoration, to 'favourable conservation status'. The Habitats Directive is transposed into UK law via the Offshore Marine Conservation (Natural Habitats, &c.) Regulations 2007. In UK waters, conservation agencies have responsibility for the 0-12 nm (Natural England, NE thereafter) and 12-24 nm (Joint Nature Conservation Committee, JNCC thereafter) to advise the U.K. Government on sites, which qualify as possible SAC's on both of the jurisdictional zones.

The decision to designate a new SAC is founded upon the classification of European level priority species and habitats are identified strategically on a bio-geographical regional basis. There is range of priority habitats (i.e. sandbanks, reefs, sea caves and submarine structures made by leaking gases) that are known to occur in U.K. offshore waters (JNCC, 2009). Sites which are eligible for designation as marine SAC's are selected on the basis of criteria set out in Annex III (Stage 1A) to the Habitats Directive. Sites are considered only if they include Habitats Directive Annex I habitat or Annex II species. Annex I habitats are assessed on the basis of their representativity, area and conservation of the structure and function of the habitat. For Annex II species, it must be demonstrated that the site contains a clearly identifiable area that is distinct in terms of the physical and biological factors controlling the distribution, survival and reproduction of the Annex II species.

Increasing conservation demands for inventorying marine species and habitats present in these priority areas has motivated scientists to explore new areas of the seafloor that have never been studied to this level of details and coverage. Furthermore, recent advances in technology has allowed scientists to sample and display scientific information (in this case Annex I habitat or Annex II species) into marine habitat maps to assist in the communication of these findings to conservation agencies, legislatory bodies and the general public. Marine habitat maps are valuable tools that can display the distribution of species and habitats in a format that combined data and statistics. This information is fundamental for the sustainable management of offshore resources. The ability to visualise a virtual seabed has led to an increased interest in the use of habitat maps for nature conservation, economic development and resolving conflicts of multiple impacts on the seafloor (i.e. in support of Marine Spatial Planning). The production of high-resolution habitat maps in a cost-effective approach combining acoustic technology and ground-truthing techniques to continuously cover large areas of the seabed and delineate benthic habitats.

This work presented here was to characterise the benthic habitats and the nature of these habitats. This information has been presented as the first marine habitat map covering the 0–12 m for the areas of Cape Bank and Lizard Point, which are considered to be 'potential candidates' for SAC designation.

For further information on this work see the link below:

http://www.naturalengland.org.uk/

8.9 Activities and preliminary results of Spanish research cruises aiming the study of Vulnerable Marine Ecosystems (VME) on the High Seas (HS) of the South West Atlantic

S. Parra reported.

Following recommendations by UN (UNGA Resolutions 59/25 and 61/105), the Spanish Institute of Oceanography, jointly with the Spanish General Secretariat for the Sea, conducted a series of research cruises from October 2007 to April 2009. A total of eleven research cruises on the High Seas of the South West Atlantic were aimed at the study of Vulnerable Marine Ecosystems, fish stock status and the interactions of fishing activities with VMEs on the mentioned area. The study has a multidisciplinary strategy that includes both an abiotic scenario and the benthic and demersal communities. Concerning the abiotic scenario, the morpho-sedimentary and bathymetric characteristics of the seabed and the characteristics of the water column were measured. Benthic communities were studied by using a multi-gear system. Demersal fish and larger epibenthic communities were sampled using a Lofoten trawl. Additionally, larger hard-bottom epibenthos was sampled with a rock-dredge and a box corer (0.25 m^{-2}) was used to sample endobenthos. Sampling by trawling and dredges was also complemented with visual techniques: a photogrammetry camera and remotely operated vehicles (ROV). The information presented in this work is based on an ecosystem approach. The preliminary results of those cruises combined with previous information from the commercial fishery, describing the footprint of the Spanish fisheries on the HS of the SW Atlantic, the spatial distribution of fish and benthic species, geomorphologic and hydrographical characteristics of the study area, as well as the possible interactions between anthropogenic activities and VMEs.

9   Report on update JAMP Eutrophication monitoring guidelines (ToR g)

H. Rumohr and a small drafting group reviewed the JAMP guidelines.

Whereas the update in 2008 was done with the new TIMES recommendations in view this year's update was done to harmonize with the ISO 16665 guidelines which are legally binding. Problem was that the JAMP guidelines are very general on 13 pages whereas the ISO guidelines are fairly detailed on 30 pages. They were written with a consequent view on the earlier version of the ICES TIMES 27 document. In this update new literature was incorporated as well as new aspects in technical innovation of sampling, sample preservation and use of freely available software. Since the JAMP guidelines are fairly general, the reader is advised to use the ISO guidelines when detailed questions on sampling and sample processing are to be cleared. *Voucher specimens should be deposited regularly at museums to make later taxonomic checks possible. Biological material could also be collected as reference specimens for herbaria etc. and for algal toxins (in conjunction with other monitoring programmes). The use of fixation and preservation media has to be cleared with the receiving institutes since formalin fixed samples are unsuitable for the increasing number of genetic analyses of sampled material.* Contradictory statements in the document were corrected into: *For visual inspections during low tide in intertidal areas, manual mapping is sufficient. For aerial surveillance vertical images and video recordings are generally cost-effective techniques.*

The revised guidelines are at Annex 10. A document with *track changes* enabled can be provided on request by H. Rumohr.

10   Additional requests

10.1 "Request for a quote and a schedule on indicators to support an ecosystem approach to fisheries" with special attention to the indicator "Areas not impacted by mobile bottom gear"

S. Degraer presented a brief overview of an EC request on "The role of CFP in implementing an ecosystem approach to marine management".

A list of proposed indicators for time series analysis was presented. Among these, the importance and relevance to BEWG activities of the item "Spatial and temporal distribution of fishing effort" and more specifically "Areas not impacted by mobile bottom gear" was highlighted, as proposed by the ICES Secretariat. The BEWG discussion focused on the five issues, as raised during the EC Ad Hoc Meeting of independent experts on Indicators and associated data requirements to measure the impacts of fisheries on the marine ecosystem: (1) vessel size for and frequency of VMS logging, (2) the need for fishing versus non-fishing pings, (3) the need to agree on a datum for geographic positioning, (4) grid cell resolution and (5) frequency of reporting.

A. Schroeder reported on a German initiative, during which similar exercises have been done for the German EEZ. The ICES/BfN-project entitled "*Environmentally Sound Fishery Management in Protected Areas [EMPAS]*" was started in ICES in February 2006 based on funding from the German Federal Agency for Nature Conservation (BfN). The main aim of the project is to develop fisheries management plans for each of ten German NATURA 2000 sites. To reach this goal, the fishing intensity was calculated

based on VMS data. Details on the methods, results and recommendations can be accessed via the project's web site at ICES: http://www.ices.dk/projects/empas.asp

The BEWG came to the following suggestions:

1) VMS data should be collected with a spatial and temporal resolution as high as technically feasible and stored in a format as basic as possible to allow for an optimal and maximal data exploration. The present resolution is to low to allow an overlay of fishing intensity and habitat features, which is essential for an assessment of the ecosystem effects on different habitats.

2) Although the BEWG acknowledges the fact that the intensity of fisheries disturbance is out of the scope of the request on "areas not impacted by mobile fishing gear", the BEWG strongly emphasizes the need for data on fisheries intensity as to further evaluate the impact of fisheries on the benthic ecosystem.

3) Since also smaller fishing vessels might have a substantial impact on the benthic ecosystem, it is needed to also collect VMS from fishing vessels less than 15 m in length. VMS data from 10 m vessels were considered important

4) Pings should not only report on the vessel position and speed, but should also include information on "fishing" versus "non-fishing", as well as the fishing gear used. Although the latter is again out of the scope of the request on "areas not impacted by mobile fishing gear", such information would allow for a further evaluation of the impact of fisheries on the benthic ecosystem.

5) Not only the proportion of the area not impacted by mobile fishing gear is important, but also the geographic consistency of these areas. It is for example better to have a smaller proportion of the area unfished for decades, than a larger proportion of which the geographic position is regularly changing.

10.2 Estimation of the blue mussel

To be able to evaluate the interaction between the blue mussel fishery and the mussel eating bird populations in Natura 2000 sites in the Danish waters, ICES is requested to advise on methodologies for:

Estimation of the blue mussel stock and annual blue mussel production in the Danish part of the Wadden Sea and in other relevant Danish NATURA 2000 sites

J. Craeymeersch reported and the text can be found at Annex 11.

11   Any other business

11.1 Ecology of Marine Sediments

H. Rumohr introduced the new (second edition) book on ECOLOGY OF MARINE SEDIMENTS by the late John S. Gray and Michael Elliott (Oxford University Press, 2009). The book is a valuable contribution to benthic ecology, which contains modern ecology standards. This work is the last contribution of our valuable colleague J. Gray. M. Elliott stood for the new concept of the book that incorporated all aspects from modern benthic science to management.

11.2 Climate Impacts on the Baltic Sea: From Science to Policy

This advanced course, held from 27 July–5 August 2009 at Nexø, Bornholm, Denmark will help you develop skills in and understanding of the observation, modeling, projection and interpretation of physical and biological changes in the Baltic Sea, and will attempt to bridge the gap between scientific knowledge and management and policy requirements and actions.

Through lectures and hands-on exercises, a team of 19 prominent lecturers will cover topics such as climate and ecosystem modeling, climate effects on eutrophication, hydrography and different trophic levels, ecosystem management, societal issues and policy. After the course, you will be able to describe processes, analyze time series, evaluate monitoring systems and develop and communicate environmental policy advice and recommendations.

The course is targeted at PhD students in natural science and environmental disciplines dealing with climate change and its effects on the Baltic Sea ecosystem, but other applicants may apply as well.

More information at www.aqua.dtu.dk/baltic2009.

11.3 Baltic Sea Science Congress

The 7th Baltic Sea Science Congress will take place on August 17-21, 2009 at the premises of Tallinn University of Technology (www.ttu.ee).

11.4 Estuaries and Coasts in a Changing World

Estuaries and Coasts in a Changing World, the CERF 2009 Conference will be held in Portland, Oregon · 1-5 November 2009.

More information at www.sgmeet.com/cerf2009/

11.5 Group on Biodiversity Science (SGBIODIV)

H. Reiss reported.

The Study Group on Biodiversity Science (SGBIODIV) met from 17–20 March 2009 at the German Centre for Marine Biodiversity Research in Wilhelmshaven, Germany.

Despite the importance of biodiversity, as well as the legal and other requirements to protect the marine environment and regulate human impacts in the North Atlantic, Biodiversity Science has not traditionally been considered a core focus of the ICES community. In recent years, biodiversity issues have become an increasingly important element of ICES' advisory work and biodiversity is one of the research topics identified in the ICES Science Plan as being of strategic importance to the advisory needs of ICES. The European Commission's (EC) recent Marine Strategy Framework Directive (MSFD) also highlights the importance of marine biodiversity, and so requests for information from ICES on the monitoring, assessment and integration of biodiversity information will likely increase. Although a wide variety of ICES Expert Groups are involved in certain aspects of marine biodiversity, there has to date been little coordinated integration and synthesis of the information and advice they produce.

There are critical gaps in current research expertise and data management, which affect the ability of ICES to provide effective management advice in terms of biodiversity. A better understanding of the resilience and stability of marine ecosystems as

well as the role of disturbance is required in order to assess anthropogenic impacts on biodiversity. Better syntheses of biodiversity information, including its functional and social-economic importance is needed to allow managers to make more informed decisions.

SGBioDiv has explored options for the integration of Biodiversity Science into the present ICES science and advisory structure. These options seek to deliver biodiversity information at both an operational level (i.e. to respond to immediate client requests), as well as on a more strategic level (i.e. to improve ICES' ability to undertake Biodiversity Science and to develop integrated biodiversity advice). Specifically, SGBioDiv has

- reviewed the assessment, advisory and governance structure within ICES in order to determine the most appropriate levels at which Biodiversity Science should be coordinated,

- explored options for the integration of Biodiversity Science into the ICES science and advisory community and

- developed a working plan to integrate and communicate ICES Biodiversity Science.

Biodiversity is an overarching theme to much of ICES' work, and in order to address ICES' fundamental goals, it is vital that Biodiversity Science be addressed in a better coordinated and more integrated way. Key recommendations include:

- The establishment of SGBIODIV as a Working Group on Biodiversity (WGBIODIV) with a mandate to deliver Biodiversity Science as an overarching theme and in a coordinated manner.

- The development of a structured work plan for ICES Biodiversity Science that considers the issues identified by SGBIODIV with regard to the availability and quality of relevant expertise and data, better integration of biodiversity information into management strategies, the development, application and utility of biodiversity indicators and future communication of ICES Biodiversity Science.

Pressures on marine biodiversity are global and, as stated in the ICES Science Plan "*global problems require global approaches*".

11.6 Working Group on the Effects of Extraction of Marine Sediments on the Marine Ecosystem (WGEXT)

K. Hostens reported by mail.

The Working Group on the effects of extraction of marine sediments on the marine ecosystem (WGEXT) was hosted by Stony Brook University in Manhattan (USA) and was attended by 13 participants from eight ICES member countries (USA, UK, Spain, Ireland, Belgium, Netherlands, Sweden, France and Finland). Data from other ICES countries (Germany and Denmark) were available through correspondence.

For 13 (out of 21) ICES countries, the total extracted amount of sand and gravel in 2008 was reported and the development of EIAs, changes to the legislative regime, marine resource and habitat mapping programs, and research projects relevant to the assessment of environmental effects were reviewed. The group updated the current member list and will try to get data from the lacking countries through the ICES and OSPAR representatives.

The majority of the extraction takes place from the North Sea and the English Channel, with additional extractions in the North Atlantic primarily by France. Activity in the Netherlands and the United Kingdom accounted for 75% of the total extractions. The main use for marine aggregates continues to be for construction (41%) and beach nourishment (39%), with additional volumes used primarily for land reclamation in the Netherlands. Less than 15% of marine aggregate is exported.

Few changes to legislative and administrative frameworks were to be reported. Explicit attention was given to the use of Electronic Monitoring Systems (so-called black boxes on extraction vessels). To be up to date and as it is stated in the Guidelines itself, a five-yearly thorough revision of the text of the ICES 2003 Guidelines for Marine Sediment Extraction was made. These changes will be suggested to be taken over by ICES SCICOM/ACOM in the updated ICES 2009 Guidelines.

The Cooperative Research report (based on sand extraction data from 2001 to 2005) is in the final editing phase and will normally be published in June. The content of a new Cooperative Research report was discussed, and will be based on data from 2005 to 2009 and will be sent to the editors in October 2011.

Some time was spent to formulate our concerns about two of the head issues (seabed integrity and noise) of the EU Marine Strategy Framework Directive, which is now discussed in a joint project by ICES and JRC. Accepting a strong statement like 'the structure and functioning of the ecosystem may not be adversely affected by human activities', might have a very 'limitative' effect on the extraction of sand and gravel.

Several presentations were given:

1) David Carlin (UK) gave a brief output from a workshop to review the usefulness of the existing 2002 Guidelines on benthic studies & the marine aggregate regulation process. The WGEXT members were asked to comment on a draft of the report which will be sent in summer 2009.

2) Henry Bokuniewicz (USA) showed an overview of the different projects related to aggregate extraction in New York: (a) the New York harbor deepening project (to 17 meters); (b) mitigation in Jamaica Bay to compensate for lost salt marshes; (c) New York offshore mud dump site for 50 years which is now a HARS remediation area; (d) management of the beach nourishment suppletions, taking into account the regional sediment budget of Long Island.

3) Laura Weiss (UK) presented the use of an electronic monitoring system (EMS, black boxes) in the UK, the capabilities of the CEFAS software, the use of EMS in advice and risk assessments, the protection of data by sending them through encrypted mails.

4) Carlos Hernandez (ES) and Chris Dijkshoorn (NL) both showed the use and dataflow of the black box systems in their respective countries (and video monitoring in AZTI).

5) Ad Stolk (NL) reported on the Dutch projects 'Delta Commission 2','Maasvlakte 2' and 'Sand Engine'. Within DC2 different scenarios were modeled in which the Dutch need of sand extraction is forecasted for the next 100 years, taking into account sea level rise. For spatial planning purposes, a regional approach to sand extraction is proposed, where f.e. in The Wadden Sea and Voordelta the priority is given to nature, while in the southern Dutch coast the demands of the industry and the lower cost of extraction have priority. For 'Maasvlakte 2' the present status of the sand ex-

traction (total 360 Mm³ sand) for the enlargement of Rotterdam Harbor is shown. 'Sand engine' is a project in which an underwater dam (need of 20 Mm³ sand) will be built perpendicular to the Dutch coast to provide a kind of natural beach nourishment.

6) Gerry Sutton (IR) gave an update on the status of the projects Maggnet (COST) and Mesma (EC-7th frame program).

On Thursday an excursion was made on New York Bay and surroundings, where we got an excellent overview and lots of information by several USA scientists of the US Army Corps of Engineers on the different projects on sand extraction that are carried out. After 15 years the different authorities and institutes at least understand the huge advantages of one vision and of working together towards one estuary and one port, through beneficial use of dredged material (be it mud, sand or gravel) for deepening, maintenance, building, land reclamation, nourishment, mitigating purposes, etc.

ICES WGEXT is invited by Dr. Ingemar Cato to meet again 20–23 April 2010, in Abisko, Sweden.

11.7 ICES SCICOM

H. Rumohr outlined the new structures and priorities of SCICOM in ICES

11.7.1 Structure and mandate

The ICES Council has delegated its science authority to the Science Committee (SCICOM). This Committee shall establish the mechanisms necessary to deliver the Science Plan, including:

- Continuous development of the strategic plan for and implementation of research based on advisory needs,
- Effective communication of research results for inclusion in the advisory work at the strategic as well as the operative level,
- Coordination of cross disciplinary within the science network,
- Functioning as the scientific steering group for the ASC,
- Taking initiatives to develop science in response to both science and advisory needs,
- Leading programmes by overseeing a system of expert groups within the remit of the Programme.

See: http://www.ices.dk/assets/ssi/text/WhatsnewScience/ICES_Science_Plan__2009-2013.pdf

11.7.2 Mandate and membership

SCICOM is authorized to communicate to third-parties on behalf of the Council on science strategic matters and is free to institute structures and processes to ensure that inter alia science programmes, regional considerations, science disciplines, and publications are appropriately considered.

SCICOM, under the direction of a Chair (Serge Labonté, Canada) appointed by the Council, has one member per member country and alternates nominated by the national delegates.

11.7.3 Activities

SCICOM had its first meeting in Copenhagen in the first week of January 2009. They discussed how the expertise of Expert Groups was matching with the priorities identified in the **2009–2013 Science Plan.** They were engaged into strategic discussions on challenges and priorities, integration of disciplines, collaboration and partnerships. They also discussed mechanisms and structures that would be required to bridge meaningfully Expert Groups and SCICOM. The 16 research topics in the three thematic areas of the Science Plan are critical to the advisory process, both in the short and the long term

11.7.4 Science plan (2009–2013)

1 Introduction

2 A Changing Environment for Oceans and Coastal Management

3 Scope of ICES Science Activities

4 High Priority Research Topics

4.1 Understanding Ecosystem Functioning

4.2 Understanding of Interactions of Human Activities with Ecosystems

4.3 Development of Options for Sustainable Use of Ecosystems

5 Delivery of Science Programme (2009–2013)

5.1 Enhanced Research Coordination in the North Atlantic

5.2 New Governance of ICES Science

5.3 Enhanced Science Capacity

11.7.5 Priorities

The first thematic area is entitled

Understanding Ecosystem Functioning.

The research topics include:

- Climate change processes and predictions of impacts;
- Fish life history information in support of EAM;
- Biodiversity and the health of marine ecosystems;
- The role of coastal zone habitat in population dynamics of commercially exploited species;
- Top predators (marine mammals, seabirds, and large pelagics) in marine ecosystems;
- Sensitive ecosystems (deep-sea coral, seamounts, Arctic) as well as rare and data-poor species;
- Integration of surveys in support of EAM.

The second thematic area is entitled:

Understanding Interactions of Human Activities with Ecosystems.

The research topics include:

- Impacts of fishing on marine ecosystems;

- Carrying capacity and ecosystem interactions associated with mariculture;

- Influence of development of renewable energy resources (e.g. wind, hydropower, tidal and waves) on marine habitat and biota;

- Population and community level impacts of contaminants, eutrophication, and habitat changes in the coastal zone;

- Introduced and invasive species, their impacts on ecosystems and interactions with climate change processes.

The third thematic area is entitled:

Development of options for sustainable use of ecosystems

The research topics include:

- Marine living resource management tools;

- Operational modelling combining oceanographic, ecosystem, and population processes;

- Marine spatial planning, including the effectiveness of management practices [e.g. Marine Protected Areas (MPAs)], and its role in the conservation of biodiversity;

- Contributions to socio-economic understanding of ecosystem goods and services;

- and forecasting of the impact of human activities.

The group considered the new structures and found their expertise and activity centres well represented in the new structures.

12 Closing of the meeting

The Chair thanked the local host and his team for their hospitality and generosity. He also thanked the participants for their input especially the rapporteurs and the editing rapporteur and closed the meeting on Friday, 11:00 hours.

Annex 1: List of participants

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Annex 2: Agenda

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ICES-BEWG MEETING 2009
ANNOTATED AGENDA
Askø (Sweden), 20/04/2009 – 24/04/2009

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MONDAY 20/04/2009

Evening session (17h00 – 18h30)

Practicalities (Hasse Kautsky)
- o Getting installed…
- o BEWG *cuisine...*
- o Getting connected to the internet…
- o Other practicalities?

Organisation of the meeting (Steven Degraer)
- o ToRs in connection to Themes, Issues and Topics
- o Report compilation: Hans Hillewaert
- o Connection to internet: Sharepoint connection
- o Agenda: Fine-tuning with issue/topic coordinators

TUESDAY 21/04/2009

Morning session (9h00 – 13h00) - plenary

Adoption of agenda

Introduction to Theme 1, Issue A, Long-term changes in benthos in relation to CC

Coordination: Alex Schroeder & Inigo Muxika

Contribution to:

ToR e: Assess long-term observations of phyto- and zoobenthos with the aim of identifying effects of climate change.

Objectives of Theme 1, Issue A:

- o How to scientifically validate this own initiative?
- o Future integration into BEWG research papers?
- o Formal engagements?
- o Appointment of rapporteur
- o Presentations
  - Inigo Muxika (Spain): to present new research on *Gelidium* with respect to Climate Change
  - Hasse Kautsky (Sweden): to report on long-term changes in phytobenthic communities in the Baltic
  - Silvana Birchenough (UK): to present some of the work that CEFAS is taking forward in terms of climatic events and benthic diversity
  - Inigo Muxika (Spain): to present new research climate affections within Basque estuaries and coasts

- Jan Warzocha (Poland): to report on long-term changes in macrobenthic communities in the southern Baltic.
  - o Research proposal (Angel Borja / Inigo Muxika): "Benthic evidence of CC: shifting distributions of selected macrobenthic species"
  - o General discussion
    - Suggestions?
    - Recommendations?
    - Tasks for further subgroup discussions?

Afternoon session (14h00 – 18h00) - plenary

Introduction to Theme 2, Benthos-related quality assessment

Coordination: Gert Van Hoey

Contribution to:

ToR b: Review new developments in environmental metrics and plan future joint activities

ToR d: Report on recent developments in environmental quality assessment covering phytobenthic and zoobenthic topics

Objectives of Theme 2

- o How to scientifically validate this own initiative?
- o Future integration into BEWG research papers?
- o Formal engagements?
- o Appointment of rapporteur
- o Presentations
  - Gert Van Hoey (Belgium): BEQI concept, applicability (BE, NL, DE) and web tool
  - Hans Hillewaert (Belgium): WFD implementation for the Belgian coastal waters
  - Inigo Muxika (Spain): Spanish methodology to assess both quality elements, together with the response to pressures and evolution
  - Michael Zettler (Germany): An adjustment of benthic ecological quality assessment to effects of salinity
  - Paolo Magni (Italy): "The BenTOC initiative of Lagunet" on the title "Animal-sediment relationships: Evaluating the 'Pearson-Rosenberg paradigm' in Mediterranean coastal lagoons"
- o Written contribution:
  - Alf Norkko (Finland): Eutrophication in the Baltic Sea: An integrated thematic assessment of the effects of nutrient enrichment in the Baltic Sea region (sharepoint document: BSEB115B_Eutrophication.pdf).
- o General discussion
  - Suggestions?
  - Recommendations?
  - Tasks for further subgroup discussions?

Participation in the two subgroups?

Commit to subgroups

WEDNESDAY 22/04/2009

Morning session (9h00 – 13h00) – subgroups/plenary

Subgroup meetings
- o Subgroup Theme 1, Issue A
  - ▪ Appointment of rapporteur
  - ▪ …
- o Subgroup Theme 2
  - ▪ Appointment of rapporteur
  - ▪ …
- o Plenary reporting on subgroup discussion outcomes
  - ▪ Need for further elaboration?

Theme 1, Issue C: Plan the next North Sea Benthos Project taking into consideration the findings from WKCBNS in December 08

Coordination: Henning Reiss

Contribution to:

ToR a: Plan the next North Sea Benthos Project taking into consideration the findings from WKCBNS in December 08

- o Appointment of rapporteur
- o Presentation
  - ▪ Henning Reiss: Main outcome of and suggestions from WKCBNS
- o General discussion

Afternoon session (14h00 – 18h00) – plenary

Appointment of rapporteur

Benthos in fjord ecosystems: possibilities for future integration into BEWG

Coordination: Steven Degraer
- o Presentations
  - ▪ Vreni Häussermann / Günter Försterra (Chile): to present the work in the Chilean fjords
  - ▪ Vreni Häussermann / Günter Försterra (Chile): proposal for a fjord study/working group and possibilities for cooperation (see also sharepoint document: Proposal for Fjord Ecology WG.doc)
- o Discussion
  - ▪ Evaluate need for a Fjord EG
  - ▪ Best way forward: WG, SG or WK…

Theme 1, ISSUE B: BEWG contribution to the ICES position paper on climate change

Coordination: Steven Degraer

Contribution to:

ToR f: Evaluate and report on the response to ToR a (effects of climate change on the benthos) in the BEWG 2008 report for its usefulness as a starting point for a benthos-related chapter in the ICES position paper on climate change.

- Presentation
    - o Steven Degraer: Report on the ICES Steering Group on Climate Change meeting (Halifax, 24/09/2008)

- Evaluate and report on the response to ToR a (effects of climate change on the benthos) in the BEWG 2008 report for its usefulness as a starting point for a benthos-related chapter in the ICES position paper on climate change.

THURSDAY 23/04/2009

Morning session (9h00 – 13h00) – plenary

Appointment of rapporteur

Report on new developments in ongoing benthic research in the ICES area

Coordination: Steven Degraer

Contribution to:

ToR c: Report on new developments in ongoing benthic research in the ICES area

- Presentations:
    - o Alex Schroeder (Germany): present something on spatial and temporal variation of soft bottom benthos on different scales
    - o Lene Buhl-Mortensen (Norway): update on the MAREANO project and will report on new developments in Habitat Mapping
    - o Johan Craeymeersch (the Netherlands): to report on the impact of mussel fisheries on biodiversity
    - o Carl Van Colen (Belgium): to present current macrobenthos research activities at Ghent University (Belgium)
    - o Björn Tunberg (USA): to present an overview of US benthos initiatives (to catch up with our US colleagues…)
    - o Angel Borja / Inigo Muxika (Spain): to report on the recently started European project WISER
    - o Silvana Birchenough (UK): update on the work currently conducted on Special Areas of Conservation (SAC's) in UK waters
    - o Santiago Parra (Spain): Activities and preliminary results of Spanish research cruises aiming the study of Vulnerable Marine Ecosystems (VME) on the High Seas (HS) of the South West Atlantic

Additional EC request: "Request for a quote and a schedule on indicators to support an ecosystem approach to fisheries"

Coordination: Steven Degraer

Presentation

o   Steven Degraer: Introduction to the EC request
o   Brainstorm

▪   area to be covered

▪   data needs and resolution

▪   advice to ICES for further elaboration (time-series (analyses) from 2010 on-wards)

Afternoon session (14h00 – 18h00) – plenary

Appointment of rapporteur

Report on update JAMP Eutrophication monitoring guidelines

Coordination: Heye Rumohr

Contribution to:

ToR g: Report on update JAMP Eutrophication monitoring guidelines. (OSPAR request no. 6, 2009). (see sharepoint site,

http://groupnet.ices.dk/BEWG2009/default.aspx: ISO 6665 guidelines.pdf)

Any other business

Coordination: Steven Degraer

Announcements

ICES Insight 2009 (email dd. 16/04/2009)

Other?

o   Suggestions for future theme sessions for ICES Annual Science Conferences
o   Upcoming Conferences and Symposia
o   Location of next year's meeting

Presentation

o   Björn Tunberg (USA): Invitation from Smithsonian Center (SERC), Washington D.C.

Other business

Recupel time

FRIDAY 24/04/2009

Morning session (9h00 – 11h30)

Finalization and adoption of the BEWG 2009 meeting report

Annex 3: BEWG terms of reference for the next meeting

The **Benthos Ecology Working Group** [BEWG] chaired by Steven Degraer, Belgium, will meet in Edgewater, MD, USA, 19–23 April 2010 to:

a) finalise and adopt the BEWG contribution to the ICES Position Paper on Climate Change

b) consider the status of the intercessional BEWG work on long-term data series analyses with special attention to climate change and to decide on future actions

c) consider the outcome of the Study Group on Climate-Related Processes within the Benthos of the North Sea and to formulate recommendations regarding its future actions

d) report on exciting developments in ongoing phyto- and zoobenthic research in the ICES area, with special attention to North-American activities

e) consider the status of the BEWG viewpoint paper on benthic indicators and evaluate ongoing developments on ecological quality assessment.

f) explore the feasibility and added value of a Study Group on Habitat Suitability Modelling as an "interface" between BEWG and WGMHM and recommend future actions

BEWG will report by mid May to the attention of SCICOM.

Supporting Information

Priority:	The current activities of this Group will lead ICES into issues related to the ecosystem affects of fisheries, especially with regard to the application of the Precautionary Approach. Consequently, these activities are considered to have a very high priority.

Scientific justification and relation to action plan:	*ICES Science Plan, Priority 1 "Understanding ecosystem functioning"* *Research topic "Climate change processes and prediction of impacts"* **Term of Reference a)** A vast amount of scientific literature on the impacts of climate change on the benthos exists. A concise overview of what is know, what is not known and where to put future emphasis is however still lacking. This BEWG publication will contribute to the ICES Position Paper on Climate Change (due by end 2010) as initiated by SGCC. **Term of Reference b)** Evaluating the intercessional analyses of long-term data series will help identifying major ecosystem regime shifts, including their geographical spread, as starting point for further consideration of the impact of climate change onto the benthos. **Term of Reference c)** To ensure a proper follow-up of the SGCBNS (SG proposal in Annex 7) by the BEWG, an open discussion on the SGCBNS' future is needed. This will also help to attract scientists from outside the North Sea bordering countries to get involved in this initiative. SGCBNS focuses on climate-related processes in relation to climate change, taking the North Sea only as a case-study. *ICES Science Plan, Priority 2: "Understanding interations of human activities with ecosystems"* *Various Research topics* **Term of Reference d)** This is a prerequisite for the scientific information status of the group **Term of Reference e)** This viewpoint paper on benthic metrics will help to incorporate the lessons-learned from the WFD into the MSFD. *ICES Science Plan, Priority 3: "Development of options for sustainable use of ecosystems"* *Various Research topics* **Term of Reference f)** Habitat suitability modelling (HSM) helps understanding the distribution of species and communities. As such, it helps elaborating a scientifically-sound management of the marine ecosystem. Two EGs are currently embracing HSM, namely the BEWG and the SGMHM. To maximize the use of human resources in HSM, clear agreements between both EGs are needed.
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 20–25 members and guests.
Secretariat facilities:	None.
Financial:	No financial implications.
Linkages to advisory committees:	There are linkages to ACOM.
Linkages to other committees or groups:	There is a close working relationship with WGMHM, WGECO, WGEXT, MHC
Linkages to other organizations:	MARBEF

Annex 4: Recommendations

RECOMMENDATION	FOR FOLLOW UP BY:
1. To establish an informal network/group/discussion forum to promote exchange of observed phenomena to be looked for in other long-term data series.	BEWG
2. To establish a Fjord Study Group to channel the ICES expertise on fjord ecosystems and to promote the exchange of knowledge of different disciplines (see Annex 8)	BEWG/SCICOM
3. To explore the integration of regular ICES-wide benthos surveys into the large-scale fish surveys, e.g. IBTS, to support the ICES Science Plan 2009-2013	BEWG
4. To establish a Study Group on Climate-Related Processes within the Benthos of the North Sea (see Annex 7)	BEWG/SCICOM
5. To organize a Theme Session at the ASC 2010 on ecological quality assessment in relation to the Marine Strategy Framework Directive. (See Annex 12)	BEWG/SCICOM

Actions:

BEWG subgroup "Long-term data series & Climate Change": To explore long-term data series on soft-sedimented benthos with special attention to ecological regime shifts (Lead: A. Schroeder; for responsibilities and timeline see 3.8)

BEWG (all): to check and update the metadata list on long-term data availability

S. Degraer : to take contact with MARBEF (LargeNet) to introduce our initiative on long-term data analysis in relation to climate change, as to avoid duplication of the work and attract attention to our initiatives (see Recommendation 1).

BEWG subgroup "Benthic Indicators": To prepare a viewpoint paper on lessons-learned from the use of benthic indicators within the Water Framework Directive in view of the Marine Strategy Framework Directive (Lead: G. Van Hoey; for responsibilities and time line see Annex 6)

BEWG subgroup "ICES Position Paper on Climate Change": To compile a draft position paper on the impacts of climate change to the benthos, taking the BEWG 2008 ToR a response as a starting point (Lead: S. Degraer; for responsibilities and time line see Annex 9)

S. Degraer : to ensure the authorship of the BEWG to the ICES Position Paper on Climate Change.

S. Degraer : to present the proposal of the BEWG subgroup "ICES Position Paper on Climate Change" to the SGCC and contact all BEWG contributors regarding the SGCC advices/suggestions and timeline for further progress.

S. Degraer : to invite the habitat suitability modelers from within the BEWG, WGMHM and outside both working groups to the BEWG 2010 meeting as to explore the possibilities to establish a Study Group on Habitat Suitability Modelling to be hosted by both the BEWG and WGMHM.

S. Degraer : to send the response to the Danish request on mussel fisheries and mussel eating bird populations to the ICES Secretariat

S. Degraer : to write a formal BEWG letter to SERC on the acceptance of their invitation to host the BEWG 2010 meeting

H. Reiss/S. Birchenough: (in case of approval of the BEWG proposal to establish a Study Group on Benthos-Related Processes in relation to Climate Change in the North Sea, SGCBNS) to organise a meeting of the Study Group on Climate-Related Processes within the Benthos of the North Sea early 2010 (prior to the BEWG 2010 meeting, 19-24/04/2010).

BEWG (all): update on exciting ongoing benthos research.

Annex 5: References

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Annex 6: The evolution from benthic indices, the way from the Water Framework Directive to the Marine Strategy Framework Directive

Authorship

Will be the contributors to this topic + potentially members of the following groups: BEWG members + Attendees of WKBEMET (optional) + wider (e.g. USA, Chili)

Introduction

(*I. Muxika/A. Borja*)

- Where do we come from? → Already done
    - Evolution within index development through time(incl. linkages between indices)
- Where are we at this moment? → Already done (ref Diaz *et al*, Borja *et al.*, Pinto *et al.*)
- Figure 1: Time line + spatial scale extend of indices

Summarize the current state and reviews and the framework it is used. → 1 page

Objectives

- Where should/could we go? To present guidelines for the future (e.g. lessons learned, advantages/disadvantages,…)
    - Intercalibration problems; what if you don't do that. Is it fine?
    - Reference sites/ choice problem → setting of thresholds
    - Indicators and the level of organization of the ecosystem: the organization is more complex, compared to the indicators.
    - Effort to assess your environment; handle of large water bodies (box strategy): effort dependency. Quality assurance? Every method needs his own sampling strategy and method. → Examples of certain countries (Germany, The Netherlands, Italy). Taxonomic level of your research (species or family (sometimes enough)).
    - To assess your environment, you need your experts.
    - Subjectivity/objectivity of indicators
- EMS
    - Ask points from the EMS; EMS; action points, can it be solved with the current indicators. Parameters used by the current indicators in a view point of EMS requirements
    - Offshore waters were different compared to inshore and estuaries.
- One indicator compared to different indicators.
- Examples to fund our lessons learned. (map)

View points

Lay-out per view point: introduction to the topic, providing arguments for the problem and possibly illustrated with an example. Half to one page maximal per topic. Examples or lessons learned have not to be restricted to Europe, but may considered worldwide.

- Intercalibration problems; what if you don't do that? (*G. Van Hoey*)
    - Examples for illustration

- o Message: intercalibration: "*All that glitters is not gold*"; yet it is necessary but currently not all problems are solved. Difference in level of intercalibration.

- Reference sites/ choice problem (*P. Magni + D. Fleischer + AZTI*)
  - o The setting of thresholds.
  - o Where you get it from?
  - o What is it?
  - o What to do if you not have pristine sites or historical data
  - o Subjectivity/objectivity selection of data (large datasets, along gradient, long-term)
  - o Knowing, the understanding of the ecosystem process
  - o Setting reference conditions in relation to climate change; continuing changing world triggered naturally and anthropogenically.

- Invasive species problem? (*S. Degraer*)
  - o Is it always bad as determined by the WFD?
  - o May it lower the ecological status?

- Effort to assess your environment; (*M. Zettler + G. Van Hoey*)
  - o Handling of large water bodies (box strategy): effort dependency.
  - o Every method needs its own sampling strategy and method.
  - o Examples from some countries (Germany, The Netherlands, Italy).

- Quality assurance? Experts? (*H. Rumohr? + P. Magni + others*)
  - o React on all level of the discussion.
  - o Taxonomic level of your research (species or family (sometimes enough)).
  - o Need for experts?
  - o How about assessing the status with one taxonomic group (e.g. polychaetes). Most dominant group is likely to react on pressures.

- Use of ecosystem approach (*I. Muxika to check what is known*)
  - o Indicators and the level of organization of the ecosystem: the organization is more complex, compared to the indicators.
  - o How to combine the quality components?
  - o One out all out? If it is a good way?

- Measuring anthropogenic versus natural impacts? (*H. Reiss, A. Schröder*)
  - o See paper

Conclusion; European marine strategy view point

(*G. Van Hoey, after finalizing the view points (1-2 page)*)

- How to improve

  Action points from the EMS; EMS; action points, can it be solved with the current indicators. Parameters used by the current indicators in a view point of EMS requirements

- Offshore waters were different compared to inshore and estuaries.

Process

- Writing of the text per leader: 2 months for first draft: end June
- Leader will distribute it in their group (feedback): 2 month: July-August

- Compilation by *G. Vanhoey*: September and feed back to BEWG
- Conclusions: 2 months to finalize: 1 November

Google docs as possible forum.

Annex 7: Draft Resolution for SGCBNS

A Study Group on Climate related Benthic processes in the North Sea [SGCBNS], chaired by S. Birchenough, UK, and H. Reiss, Germany, will be established and will meet at CEFAS Lowestoft, UK, 8–12 February 2010 to:

a) Review and consider a reduced spatial coverage (i.e. small-scale approach) for studying benthic processes outlined as during the Working group Climate related Benthic Processes in the North Sea (WKCBNS);

b) Develop a work plan within the timeframe of the Study Group for developing a comprehensive research proposal;

c) Initiate a benthos long-term series network in support of comparative studies on climate effects on the benthos across areas;

d) Initiate intercessional work by using case studies to explore wider patterns across benthic assemblages;

e) Explore collaborative opportunities with other ICES Expert Groups, for maximising the use of data sets.

SGCBNS will report by 15 April 2009 for the attention of the Science and Advisory Committee and the BEWG.

Supporting Information

Priority	The work of this Study Group (SG hereafter) will be in accordance to the recent ICES Science Plan in support of an Ecosystem Approach. Evidence-based science to advance our current knowledge with the facilitation of interdisciplinary research for assessing climate change processes for marine benthos and the integration of surveys to harmonise practices will be a valuable strategy to develop this work.
Scientific justification	Current public and scientific concerns on the climate-driven changes within marine ecosystems has stimulated much interest in how climate change might affect benthic organisms. Currently there is a lack of understanding in how benthic communities respond to climatic variation. The fact that marine benthic ecosystems are relatively complex and ecological processes, such as trophic and non-trophic interactions, benthic-pelagic coupling and species interaction, are only partly understood, emphasizes the need for enhanced research of climate influences on benthic communities and processes. Based on the work done in the BEWG and the SGNSBP on the assessment of effects of changes in hydrodynamics and sea temperature and changes of the distribution of benthic communities, respectively, this SG will address relevant open questions of climate related processes in benthic systems. During the WKCBNS meeting in 2008 several hypotheses on how climate change may affect benthic ecosystems were already developed. The aim of the Study Group "Climate related Benthic processes in the North Sea" [CBNS] will be build upon these discussions, with a view to outline and inititate relevant interdisciplinary research and strategies by using case studies to address hypotheses relevant for climate effects on benthic systems.
Resource requirements	No specific resource requirements beyond the need for members to prepare for and participate during the meetings.

Participants	These would include a wide range of scientists, whose disciplines could contribute to the topics developed in this SG (e.g. benthic ecology, fish ecology and ecological modelling). Additional participation will be sought from ICES countries and by scientists both from disciplines and scientific circles not normally represented at ICES when necessary.
	It has to be clear that - because of its high data availability - the North Sea is here selected as a case-study area, rather than the research focus, which is the impact of climate change to the benthos. Hence, any expert in this field of research – also from non-North Sea bordering countries might contribute to the SG.
Secretariat facilities	This group is likely to have demand on the computing resources of the Secretariat, but no additional software/hardware is anticipated beyond that which is currently available.
Financial	In principle it will be useful to explore within ICES financial support for this group (i.e. database usage and funds to support collaborative work). Additional, 'in kind' contribution will be provided by individual organisations covering travel and subsistence and time for the participants
Linkages to advisory committees	SCICOM and ACOM
Linkages to other committees or groups	A close working link with e.g. Benthos Ecology Working Group (BEWG), Steering Group On Climate Change (SGCC), Working Group on Modelling of Physical/Biological Interactions (WGPBI), ICES Regional Ecosystem Group for the North Sea (REGNS) and ICES Working Group on Zooplankton Ecology (WGZE).
Linkages to other organizations	ICES will seek wider participation for this group including contact with relevant academic and intergovernmental organisations for this SG.

Annex 8: Draft Resolution for a Fjord System Ecology Working Group

A draft resolution for a Fjord System Ecology Working Group will be submitted to ICES by mid-August 2009 pending approval by the Benthos Ecology Working Group.

Annex 9: Structure of and delegated responsibilities for the BEWG contribution to the ICES Position Paper on Climate Change

The BEWG contribution to the ICES Position Paper on Climate Change, as requested by the SGCC, will comprise the following headings. Delegated responsibilities can be found next to each of the hypotheses.

Distribution shift

Poleward shifts in the latitudinal distributions of species, with consequent changes in species composition and species richness at any given location
(I. Muxika/A. Borja)

Rising temperature could enable more human introduced species to invade and become established, replacing current native species
(S. Degraer/I. Muxika/A. Borja

Changing wind directions may lead to changing local surface currents resulting in changes in larval transport and, thus, species distribution.
(J. Craeymeersch)

Community changes including habitat forming species will result in altered habitats.
(C. Van Colen)

Anthropogenic impacts such as fisheries and pollution may have decreased the resilience of certain benthic species to changing climatic   conditions   endangering their population.
(NN)

Climatic induced changes in phytobenthic plant species composition and coverage will influence the associated faunal composition as well as animals seeking reproduction, nursery areas as well as food within the phytobenthic zone.
(H. Kautsky)

Reproduction and match/mismatch

Climate change might result in changes in the timing of reproduction. This might result in a temporal mismatch between the larval period and/or settlement and the availability of food, i.e. the plankton bloom.
(H. Reiss)

Stratification and spring blooms of plankton in our shelf seas will occur earlier in a warmer climate. This might result in a temporal mismatch as mentioned above.
(H. Reiss)

Climate change may influence terrestrial inputs of pollutants and the release of pollutants currently locked in seabed sediments with consequences for the benthos such as effects on reproduction (and local extinctions).
(B. Tunberg)

An increased distribution of parasites (such as trematodes) will lead to higher infection rates of benthic species with consequences on survival and reproduction.
(J. Craeymeersch)

Secondary production

Reduced mixing of the water column (increased stratification) may favour many Harmful Algae Blooms-causing species. This might have effects on the benthos food web relying on phytoplankton as primary food source.

(S. Parra)

Altered current conditions may lead to shifts in frontal areas and may change upwelling situation. This will influence primary production with consequences for the food supply to the benthos.

(S. Parra)

Changes in nutrient fluxes due to advection, vertical diffusion and mixing, river flows and atmospheric deposition, leading to changes in primary production with consequences for the secondary production and biomass of the. benthos.

(NN)

Changes in the production and biomass of benthic species will have implications for the food web dynamics.

(H. Reiss)

Other

Reduced mixing may also enhance the risk of oxygen depletion and result in altered pelagic-benthic coupling.

(C. Van Colen)

Changes in the frequency and intensity of storms will change the wave energy which will have an impact on the benthic environment.

(B. Tunberg)

Sea level rise may accelerate the loss of intertidal habitats also because of increased coastal defenses (e.g. hard structures, islands, beach nourishment).

(S. Degraer)

Changes of anthropogenic actions (e.g. fisheries, sand extraction) will have consequences for the benthic environment.

(S. Birchenough)

Future increases in ocean acidity will have major negative impacts on some shell/skeleton-forming organisms.

(A. Schroeder/J. Craeymeersch

Conclusions: diversity

Annex 10: JAMP Guidelines

JAMP Eutrophication Monitoring Guidelines:

Benthos Reviewed and amended by ICES BEWG April 2008 and 2009

JAMP Eutrophication Monitoring Guidelines: Benthos

1   Introduction

Benthic communities (including hard-bottom and soft-bottom macrophytobenthos and hard-bottom and soft-bottom macrozoobenthos) generally occur in recognisable states, depending on the substrate, depth, wave exposure and salinity *etc.* Macrobenthic communities are an appropriate target for monitoring since:

- an important component of benthic communities is that formed by species which are long-lived and which therefore integrate environmental change over long periods of time;

- they are relatively easy to sample quantitatively;
- they are well-studied scientifically, compared with other sediment-dwelling components (*e.g.* meiofauna and microfauna) and taxonomic keys are available for most groups;
- community structure responds in a predictable manner to a number of anthropogenic influences (thus, the results of change can be interpreted with a degree of confidence);
- there may be direct links with commercially valued resources, *e.g.* fish (via feeding) and edible molluscs.
- the floral part integrates long-term change of water quality (turbidity)

Nutrient enrichment/eutrophication may increase the food supply to the benthos and therefore may give rise to changes in species composition and numbers, increased biomass, a shift from k-selected to r-selected species, shifts in functional groups, changes in community structure and an impoverishment of benthic communities due to anoxia. These guidelines are intended to support the minimum monitoring requirements of the Monitoring Programme.[1]

Much information exists on methodology for benthos investigations. The most relevant reports are those by Rumohr (2009) which deals largely with methodology for the collection and treatment of the soft-bottom macrofauna, and by Rees *et al.* (1991) and Rees (2009) which focuses on the monitoring of benthic communities around point-source discharges and epibenthic studies, respectively. These accounts also deal more generally with the role of benthos studies in investigations of human impact, including guidance on the sampling of different substrate types. The HELCOM 'COMBINE' manual for monitoring in the Baltic Sea is another important reference source (see www.helcom.fi).

A range of other documents are of value in the planning and conduct of marine benthos sampling programmes. The most useful is that by Eleftheriou and McIntyre (2005) which is a standard reference for work of this type. Gray *et al.* (1992) report on approaches to marine pollution assessment and provide practical examples of applying the PRIMER ('Plymouth Routines in Multivariate Ecological Research') package for univariate, graphical and multivariate data analyses (see Clarke and Gorley, 2001 for further details). Kramer *et al.* (1994) have produced a manual for the sampling of tidal estuaries. An account of survey methods employed by a team of scientists undertaking a review of marine nature conservation in UK inshore waters together with a rationale for such work is given by Hiscock (1996), Davies *et al.* (2001) and Connor *et al.* (2004). A monitoring programme and monitoring guidelines have been prepared for the Wadden Sea 'Trilateral Monitoring and Assessment Programme' (TMAP, 2000). The last update of this document was mainly to harmonize it with the ISO 16665 International Standard guidelines on quantitative sampling and sample processing of marine soft-bottom macrofauna. (ISO, 2005). These ISO guidelines should be consulted when detailed questions on sampling and sample processing are to be cleared.

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[1] The Nutrient Monitoring Programme as adopted by OSPAR 1995 (OSPAR 95/15/1, Annex 12).

2   Purposes

The monitoring of benthic communities is carried out for, *inter alia*, the following purposes:

1) to monitor the spatial variability in species composition and biomass within the Maritime Area resulting from anthropogenic nutrient inputs;

2) to monitor temporal trends in species composition and biomass within the Maritime Area (at a timescale of years) in order to assess whether changes can be related to temporal trends in nutrient inputs;

3) to support the development and implementation of a common procedure for the identification of the status of the benthic communities;

4) to understand the relationship between nutrient concentrations and temporal trends in species/community characteristics.

3   Quantitative objectives

The patchy distribution of benthic communities together with the many taxa involved means monitoring programmes are very dependent on the design of the field programme. It is very difficult to formulate a general monitoring model suited to a wide variety of organisms, particularly for epilithic habitats. Furthermore, great care must be taken when transferring techniques developed in less complex systems (*e.g.* the Baltic Sea) to more complex systems (*e.g.* the North Sea). Taking into account these precautionary notes, the three primary objectives of benthic monitoring are as follows:

a) to test the hypothesis that eutrophication is responsible for changes in community composition and function, biomass and community structure;

b) to test the hypothesis that eutrophication is responsible for an increase in the abundance of ephemeral/annual algae such as *Cladophora*, *Enteromorpha* and *Ectocarpus* and a decrease in perennial algae such as *Laminaria* and *Fucus* and the angiosperm *Zostera marina* (eelgrass);

c) to test the hypothesis that changes in eutrophication levels are responsible for a decreased depth distribution of the macrophytes (*e.g.* due to increased turbidity).

Prior to monitoring, it is necessary to determine the number of sample replicates required to describe the species spectrum (this may be done using a species area curve or a comparable advanced technique. Alternate methods can be used when fixed frames or transects are utilized). Before sampling begins, levels of acceptable variability must be set and followed for all parameters measured. The effects of organic matter inputs on benthic communities are adequately described by the empirical "enrichment" model of Pearson and Rosenberg (1978) and examples of studies which have postulated links between changes in the benthos and eutrophication are given by ICES (1995). The model, which is equally applicable to trends in space and time, describes cyclical (*i.e.* non-linear) changes in numbers, densities and biomass of benthic species along an enrichment gradient. Multivariate analytical methods may be used to examine between-station differences and temporal trends in the data. Univariate measures amenable to statistical testing include:

- a count of species (coverage of plants and colonial animals included);
- a coverage of plant species and colonial forms;

- measurement of densities and biomass;
- quantification of species in terms of functional groups *e.g.* feeding types;
- categorisation into r-selected and k-selected species.

The natural patchiness of benthic communities must be accounted for in the analysis. Hierarchical statistical methods may be used. Sophisticated computer packages for the statistical analyses of benthic data are now widely available. Use should be made of at least one established diversity index and one multivariate analytical technique. A consideration of trends in the "primary" variables (*i.e.* numbers of individuals, taxa and biomass) should also be undertaken in relation to physical/chemical measures derived from sediment sub-samples. The statistics for these evaluations may be undertaken using appropriate software packages

4   Sampling strategy

Sample sites should be representative of the whole monitoring area and so characteristic habitat structures and substrates must be sampled. Prior to temporal trend analysis, checks must be made to ensure that sample sites are inhabited by a homogenous benthic community rather than non-comparable, heterogeneous benthic communities. It is important to establish the baseline community structure and variability at the site under consideration. Sample points must be spread out over the extent of the habitat studied to ensure an adequate consideration of spatial variation. It cannot be assumed that one point is representative of the habitat as a whole. When measuring anthropogenically-induced change control/reference sites (preferably at least two) are required for each test site. It is critical that similar habitats are selected for comparison. There are several sources of guidance on the design and implementation of field sampling programmes, including Elliot (1971), Cohen (1977), Green (1979), Andrew and Mapstone (1987), Skalski and Robson (1992), Rees *et al*. (1991 and 2009), Underwood (1997) and Underwood and Chapman (2005). An eutrophication-related monitoring programme would typically include a desk study and survey planning stage, followed by pilot, baseline and ongoing surveys.

The sampling strategy for macrophytobenthos and hard-bottom macrozoobenthos is described at Technical Annex 1. The sampling strategy for soft-bottom macrozoobenthos is described at Technical Annex 2. Rejection criteria for insufficient samples must be formulated and followed strictly. Al steps in the sampling and analytical procedure must be documented in written form.

5   Sampling equipment

The sampling equipment for macrophytobenthos and hard-bottom macrozoobenthos is described at Technical Annex 1. The sampling equipment for soft-bottom macrozoobenthos is described at Technical Annex 2. For all activities the health and safety rules requirements have to be enforced strictly.

6   Storage and pre-treatment of samples

The storage and pre-treatment of macrophytobenthos and hard-bottom macrozoobenthos samples is described at Technical Annex 1. The storage and pre-treatment of soft-bottom macrozoobenthos samples is described at Technical Annex 2.

7   Analytical procedures

Analytical procedures for macrophytobenthos and hard-bottom macrozoobenthos are described at Technical Annex 1. Analytical procedures for soft-bottom macrozoobenthos are described at Technical Annex 2.

The data generated will require storage in a database. The database should be of a type capable of storing and/or generating information of the following type:

a) the spatial distribution and size of epilithic communities, particularly concerning mats of green macroalgae, eelgrass meadows and mussel beds;

b) sketch illustrations showing the distribution of substrate types and the dominant species associated with the substrates;

c) the depth distribution of plant and animal biomass by species, functional group and any other arbitrary selection, as well as the relative quantities of the primary functional groups such as dominant, annual and perennial organisms;

d) temporal trends concerning changes in depth distribution, percentage cover, biomass, species composition and distribution *etc.*;

e) a statistical evaluation including explanatory power;

f) correlations of specific types of benthos data against supporting information (*e.g.* Secchi depth, salinity, oxygen, nutrients, pelagic primary production, other types of benthos data).

As a measure of grain size distribution for the upper 5 cm of the sediment the following sieves should be used: 63 µm, 125 µm, 250 µm, 500 µm, 1000 µm and 2000 µm together with weight loss on ignition (500°C–520°C), total organic carbon and pigments (recommended). Other more advanced methods such as Laser diffraction, sedimentation columns etc. may also be used. To measure nutrients (particulate N) in sediments samples should be dried at 60°C until constant weight (12–24h), treated with HCl, held for 24h in a desiccator, dried again at 60°C and analysed in a CHN analyser.

8   Analytical quality assurance

Effectively the quality assurance (QA) programme should ensure that the data are fit for the purpose for which they have been collected (see Rees, 2004). Appropriate QA schemes should be established before the onset of survey work. It is particularly important that adequate resources are allocated for these purposes when co-operative studies involving several institutes are to be conducted, or when the data are to be centrally archived. It is essential that the QA also includes the explanatory power and the experimental design. Thus, the QA must take into account as many steps of the analytical chain as possible in order to determine the contribution of each step to the total variation. Quality assurance methods are still under development for some activities, e.g., biomass determinations. If the abundance estimates are to be carried out by different workers, a calibration of their cover estimates must be performed. This can be done by comparing *in situ* survey data with digital and point sampling estimates of underwater photo documentation. Underwater photography and/or video may provide an additional means of obtaining cover estimates but these techniques are more appropriate where foliose phytobenthos does not obscure underlayers. Animals that can be counted often provide a better basis for estimates of cover than subjective assessments or point sampling. The latest taxonomic literature should be

used. Name changes and literature used must be recorded. Quality assurance for soft-bottom macrozoobenthos should take account of Rees (2004) and Rumohr (2009) (see also ICES 1994, 1996). Each Contracting Party which intends to deliver data to a common data pool should take part in regular quality control audits such as inter-calibration exercises, ring tests and associated taxonomic workshops. Voucher specimens should be deposited regularly at museums to make later taxonomic checks possible

9 Reporting requirements

[Reporting formats need to be developed which will allow the exchange and evaluation both of the raw data and of all relevant ancillary information. Such formats must be readily usable by both the data centres and the originators of the data. Data for the common pool will have to be submitted via the national data centres in order for them to keep in touch with progress of the work, including the availability of data from each Contracting Party. This procedure should help to guarantee data quality, since the national data centres will be ultimately responsible for the timely submission of completed data sets to the common pool. Reporting formats will develop with the programme. As a component of the 1997 ICES Work Programme, the Oslo and Paris Commissions have formally requested ICES to establish a databank for phytobenthos and zoobenthos]

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Technical Annex 1

Hard–bottom macrophytobenthos, soft–bottom macrophytobenthos and hard–bottom macrozoobenthos

Sampling strategy

An overview of the methods available for monitoring has been given by ICES (1996), Hiscock (1996), Davies *et al.* (2001), Eleftheriou and McIntyre (2005) and Rees (2009). Diver operated methods in shallow water and remote underwater photography in deeper areas, are the most suitable options.

Monitoring should take place annually at a particular time within the four summer months (June–September) for the first three years of the monitoring programme. Subsequent sampling frequency then depends on the expected rate of change in species composition. In areas where large changes are expected sampling should take place on an annual basis. In areas where little change is expected sampling every 5 to 10 years would be sufficient. Three main sampling techniques are available for hard-bottom and soft-bottom macrophytobenthos and for hard-bottom macrozoobenthos: aerial surveillance (in tidal areas), diving transects (in sub-tidal areas) and quantitative (destructive) sampling. Voucher specimens should be deposited regularily at museums to make later taxonomic checks possible

Aerial surveillance

Aerial surveillance can be used as an optional method to determine the size and distribution of epilithic communities, including mats of green macroalgae, eelgrass meadows and mussel beds. High-wing monoplanes flying at low altitude (150 m) are an appropriate platform for the relevant sensors. Positions should be located by means of satellite navigation (*i.e.* GPS). Aerial surveillance can cover large areas and results should always be calibrated by means of quantitative field inspections at selected locations (*cf.* section entitled "Quantitative sampling"). When applied, aerial surveillance of green algae should take place during May–October at four-week intervals during low tide. One flight should be carried out at the end of the winter for mapping the distribution of mussel beds.

Diving transects

Diving transects are used to provide a description of the depth distribution and abundance of the dominant plant and animal communities. The transects should extend to at least the maximum depth of the algae, but should not be deeper than 30 meters (for diver safety). Depth limits of kelp, dense foliose algae or the deeper foliose algae may be measured using digital instruments, recorded and corrected for tidal amplitude. Abundance and/or coverage should be determined at sites within the main assemblages or within sub-habitats, if these are distinct. The coverage should (Braun-Blanquet) be used for plants and animals in colonies or high abundance. Reconnaissance surveys, which may include remote sensing (see section entitled "sampling equipment") are also useful in helping to choose transect locations. Transects should be undertaken at the beginning of the monitoring programme and should be repeated regularly, for example every 5 to 10 years. As estimates of distribution and percentage cover are carried out *in situ*, a cord with meter marks should be placed along the transect. Progressing along this cord, divers should note the distribution

and type of substrate as well as the degree of cover for the main plant and animal species in a strip 5-10 m wide. Divers should estimate abundance using an appropriate scale (Hiscock, 1990; Kautsky,1993 in prep., Krause-Jensen *et al.*, 1994; Karlsson, 1995; Pedersen *et al.*, 1995,.). This may be time consuming under water, but gives a good estimate over the whole depth zone, which is much harder to achieve using frames. An alternative approach would be to apply the abundance estimation scale at fixed sites within the main zonal biotopes. Species/categories that are not immediately obvious may warrant the use of more time-consuming techniques such as quadrat counts (see section entitled "Quantitative sampling").

The following information should be recorded in the field:

a) the exact position of the transect (using for example a map, photography, a permanent mark on the shore, GPS

b) the distance from the shore (using a meter marked line along the transect);

c) the depth (according to a calibrated depth gauge and corrected for tidal amplitude);

d) substrate type (rock, boulders, stones, gravel, sand, mud, glacial clay, *etc.*);

e) the presence of loose sediment deposited on plants and substrate (in terms of "none", "little covered", "heavily covered");

f) an estimate of the abundance of different plant and animal species;

g) the maximum depth of dominant sub-littoral species and the lower limit of vegetation;

h) photographic and/or video documentation (video/photographic profiles of the transect, panoramic views and, at fixed marked sites if possible, stereo photographs);

i) the degree of wave exposure, Secchi disk depth (*i.e.* light transmission) and salinity (if possible).

j) The use of satellite image based software e.g GOOGLE Earth. is suggested to visualize the exact location of a diving transect.

Quantitative sampling

Depending on the time spent on the transect, direct observations by divers may over-emphasise the importance of particular eye-catching species. Quantitative sampling gives unbiased information about plant and animal communities but is extremely time-consuming. Quantitative samples, obtained via stratified random sampling, are required in order to determine species composition and biomass. At least three parallel quantitative samples of key species/communities should be collected at different pre-selected depth intervals. Sample locations at each depth are chosen by random placement of a quadrat, or by sampling at random distances along the transect from the shore. Tests should establish the number of parallel samples and the minimum sample area, and this will vary according to the type of community/species being sampled and its distributional characteristics (*cf.* Elliott, 1983). For example small but randomly distributed species may require large quadrats, whereas it may be possible to use relatively small quadrats for small but evenly distributed species. Rocky habitats are usually architecturally very complex and care is needed to specify slope, aspect and exposure. These methods follow recommendations by Anon. (1991) Dybern *et al.*, (1976), Hiscock (1987), Hiscock and Mitchell (1989), Jespersen *et al.* (1991), Kautsky (1993) and Davies *et al.* (2001).

The following data should be recorded in the field whenever possible:

a) the exact distance of the sample site from the shore;

b) water depth (according to a calibrated depth gauge and corrected for tidal amplitude);

c) a photographic image of the site;

d) the number of organisms of each species;

e) the biomass of plant species and animal species;

f) the size structure of some animals (mainly molluscs).

Biological material could also be collected as reference specimens for herbaria *etc.* and for algal toxins (in conjunction with other monitoring programmes).

Sampling equipment

Submarine video in combination with GPS is useful for choosing transects and for surveying large areas for approximate species composition and the depth distribution of the vegetation as a whole. Larger areas may be scanned using remote-sensing techniques (*e.g.* by satellite or aircraft), but only for communities close to the surface. For visual inspections during low tide in intertidal areas, manual mapping is sufficient. For aerial surveillance vertical images and video recordings are generally t cost-effective techniques.

Surveys estimating abundance should sample within a large area containing the same biotope in order to reduce edge-effects or effects resulting from irregular species distribution. Quadrangular frames with a side length of 0.10 m to 0.50 m are suggested for quantitative sampling (the smaller frames should be used in the littoral zone for small species such as barnacles).

Storage and pre-treatment of samples

Sampled material should be preserved by freezing (−20°C) or by using formaldehyde (2–4%). It should be emphasised that thawing may cause leakage and thus underestimate biomass, and that species may react differently depending on their morphology. The same also applies for preservation with formaldehyde. Fixation using formaldehyde should be avoided for samples which will be analysed for nutrients and for further genetic analysis. Samples for biomass determination must be free of overgrowth and rinsed with freshwater before drying. Sampled animal material should be stored in alcohol (70%) after biomass (wet weight) determination.

Analytical procedures

Macrozoobenthos measurements should comprise individual length, width, volume *etc.* Macrophytobenthos determinations should normally be accompanied by the co-monitoring of relevant macrozoobenthos and vice versa.

Samples obtained using quadrangular frames (see section entitled "Quantitative sampling") may be analysed to determine plant and animal species composition and biomass. In areas where species numbers are low biomass may be expressed per species. Biomass should be expressed as either "g dry weight" samples should be dried at 60°C until constant weight (this can be up to one week depending on volume of sample) or as "g ash-free weight per m²" (samples should be dried at 500°C until con-

stant weight (at least 6h)). Biomass expressed as volume (*e.g.* using water displacement) should be measured in the field whenever possible.

The degree of accuracy required for taxonomic sorting depends on the purpose of the monitoring programme. For the present programme it should be sufficient to identify organisms, whose taxonomic specification is difficult or time-consuming, to the generic level rather than to the specific level. (*e.g. Cladophora* spp., *Enteromorpha* spp.). Rare species should be determined to higher taxonomic levels. Functional groups should be kept intact as far as possible.

Biological material could also be collected as reference specimens for herbaria *etc.* and for algal toxins (in conjunction with other monitoring programmes). The use of fixation and preservation media has to be cleared the receiving institutes.

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Technical Annex 2

Soft-bottom macrozoobenthos

Sampling strategy

An initial spatially extensive "baseline" survey will facilitate the selection of representative stations within and adjacent to areas perceived to be vulnerable to the effects of eutrophication. It will be necessary to repeat the baseline survey periodically to check the continued validity of representative stations and to ensure that no unexpected effects are occurring beyond the region predicted to have been affected by eutrophication. Full use should be made of historical information in the planning of surveys.

Large-scale sampling of the macrozoobenthos community in offshore subtidal soft-bottoms should comprise many stations but with adeaquate replication per station. A large-scale sampling grid (preferably stratified random) covering the whole area of investigation should be sampled at intervals of 10 years and this should be sampled by a variety of methods in order to cover the full range of the species spectrum. This large-scale sampling every 10 years is necessary to confirm the representativity of annual temporal trend monitoring stations. For temporal trend monitoring, sampling at a frequency of once per year (at the same time of year) should be adequate, although locally severe effects of nutrient enrichment (such as hypoxia) may dictate a higher sampling frequency. If the sampling frequency is twice per year, then sampling should take place in late winter/early spring to establish the stable community conditions and in late summer/autumn with a view to detecting the possible effects of nutrient enrichment (such as hypoxia) on the macrozoobenthos.

The sampling strategy for macrozoobenthos communities in coastal soft-bottom areas needs site-specific adaptations of site selection, choice of sampler and sampling frequency (see, e.g., Trilateral Monitoring and Assessment Program, 2000). For example: estuaries should be sampled from the limnic to the marine area, backwaters and lagoons should be sampled twice a year at representative stations (a large-scale sampling programme should be performed every 5 years) and fjords should be sampled along a transect ending at the outer edge of the sill.

The following information should be recorded in the field:

a) whether or not the ship was anchored;

b) depth and position of each replicate; a GPS track plot would be desirable;

c) the time of day;

d) the weather conditions during sampling and sea state;

e) a description of the sediment, including:

    i) surface colour and colour change with depth (as a possible indicator of redox state);

    ii) smell (H_2S);

    iii) a description of sediment type, including important notes such as the occurrence of concretions, loose algae;

f) the type and specification of the sampler (weight and sampled area);

    mesh size of the sieve.

Near-bottom temperature, salinity and oxygen measurements are desirable. If more than one sample is taken at a station, the depth range of samples should be recorded. All samples must be treated separately, *i.e.* must not be pooled. An estimate of the volume of sediment retained should be made for all samples taken, as a measure of sampler efficiency and penetration depth. Criteria for rejection of samples collected by grabs are given by Rees *et al.* (1991), ICES (1994) and Rumohr (2009). Measurements of redox potential and shear-strength should be made on samples collected by a box corer rather than a grab sampler because grab samplers are likely to distort the sample.

Sampling equipment

Sampling equipment appropriate for soft-bottom macrozoobenthos is described in detail by Rumohr (2009) and Eleftheriou and McIntyre (2005). Coarse sediments which cannot be sampled using normal procedures may be sampled using either a Hamon grab or appropriate dredges (*e.g.* an anchor dredge). Sediment structure and bioturbation depth may be checked with sediment profile imagery (see below). A hand-operated corer should be used for Wadden Sea sediments (TMAP, 2000). It should be noted that more sophisticated gear, such as epibenthic sledges, might be required for sampling hyperbenthic or bentho-pelagic species. Such gear is particularly valuable for studies of species (especially crustaceans) which constitute an important component of the diet of fish. Epibenthic and hyperbenthic sledges (Rothlisberg, P. C. and Pearcy, W. C., 1977 dredge; see also Brattegard and Fosså, 1991; Sorbe sledge (Sorbe, 1983)) are useful for the small mobile crustaceans and boundary fauna. If automatic closing mechanisms and dredge distance recorders are added, then these instruments can be quantitative (cf. Gage deep sea epibenthic sledge). Special attention is drawn to the Triple-D dredge which was designed for the quantitative collection of the large and rare epifauna and infauna (Bergman and van Santbrink, 1994).

(see also Rees, 2009., for guidance on epibenthic sampling)

Photographic and video records are recommended as a complement to traditional sampling methods (Rumohr, 1995, Smith & Rumohr 2005). Sediment profile imaging (*cf.* Rhoads and Germano, 1982, Solan *et al*. 2003) may provide a useful means for rapid surveys and classification of soft sediment areas. Side-scan sonar images will provide information on bottom topography and substrate type, which can be useful in the planning of benthos monitoring programmes or in the interpretation of the data. These records should be 'ground-truthed' by underwater video recording and/or grab sampling of sediments.

Storage and pre-treatment of samples

Procedures for the storage and pre-treatment of soft-bottom macrozoobenthos samples are as at Sections 3.1-3.2 of Rumohr (2009).

Analytical procedures

Procedures for the sorting and biomass determination of soft-bottom macrozoobenthos samples are at sections 3.4 and 3.5 of Rumohr (2009).

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Annex 11: To be able to evaluate the interaction between the blue mussel fishery and the mussel eating bird populations in Natura 2000 sites in the Danish waters, ICES is requested to advise on methodologies for:

Estimation of the blue mussel stock and annual blue mussel production in the Danish part of the Wadden Sea and in other relevant Danish NATURA 2000 sites

Introduction

Blue mussels, *Mytilus edulis*, are sedentary bivalves. They attach to a firm substrate and each other using byssal threads, which are produced by the byssal organ of the muscular foot. Mussels frequently occur in large colonies, forming mussel beds.

Mytilus edulis is primarily an intertidal species, although sometimes abundant in the subtidal, particularly in sheltered, estuarine-type habitats. The lower limit of distribution is strongly influenced by predation. In the Wadden Sea subtidal mussel beds mainly occur in shallow areas between deeper channels. These 'subtidal flats' may host mussel beds of considerable size. Part of the beds in the western Dutch Wadden Sea occur in deeper channels north of the 'Afsluitdijk'. In Schleswig-Holstein, Germany, subtidal mussel beds below 2-3 m and down to 25 m depth below the low water level show much more variation in biomass and occurrence than the shallow subtidal beds, just below the low water line down to 1–2 m depth, mainly adjacent to intertidal beds. Extensive settlement in the deeper subtidal areas, mainly adjacent to the open sea, may in some years lead to the formation of large beds with high biomasses which, however, can be wiped out by the first strong gale.

A mussel bed may consist of a spatially well-defined irregular collection of more or less protruding smaller beds, which may be called patches, separated by open spaces. This description also includes young beds with a high abundance of small mussels. The described structure may not be so distinct in young beds or just settled beds (spatfall) (CWSS, 2002; Essink, 2005). The structure of intertidal and subtidal mussel beds, however, differ (Saier *et al*. 2002).

In conclusion, the patchy distribution of mussels both within the area studied as within the beds has important consequences for the sampling strategies applied.

Due to irregular spatfall, larger interannual fluctuations may occur on regional level which requires monitoring with – at least - an annual frequency (http://www.harbasins.org/fileadmin/inhoud/pdf/Final_Products/WP1/1.4/TMAP_Handbook_Mussel-beds__08-05-15_.pdf). Also within a year or region large fluctuations may occur due to spatfall, growth and mortality.

Sampling design

Because mussels are not distributed homogeneously in the subtidal Wadden Sea, stratified sampling will increase sampling efficiency. Stratification of the population into non-overlapping subpopulations is a common technique were auxiliary information can be used to improve efficiency if each stratum is homogeneous with respect to the variation of the studied variables. Hence, the within-stratum variation will be small, which is beneficial for efficiency (see e.g. Eurostat 2002, 2008). The surveyed

area could be divided into a number of strata according to prior knowledge of or expectation on the distribution and density of blue mussels. Thus, strata are more homogeneous than the population as a whole. The division could be based on former surveys, but nowadays acoustic methodology can provide relative fast detection of mussel distribution, mussel bed contours and bed structure over large areas at high spatial resolution, and the methodology for seabed mapping in general is still developing, see e.g. Kenny *et al*. (2003), Anderson *et al*. (2008), Rees *et al*. (2009) and the MESH guide to marine habitat mapping (www.searchmesh.net). It is beyond the scope of this advice to review all of them in the light of their usefulness for the study of subtidal mussel beds. In the Wadden Sea Side Scan Sonar images in combination with quantitative sampling recently proves to be very useful in the study of subtidal mussel beds (http://www.wageningenimares.wur.nl/NL/aquacultuur/Produs/natuur-waarden/)

Next question is how to distribute samples over the inventory areas, i.e. strata. Systematic sampling is usually superior in efficiency if the target population is spatially autocorrelated, that is, if nearby values of the variables inventoried tend to be more similar than distant ones, as is the case for blue mussels. Many times, the fieldwork is simpler to implement too. A major problem in systematic sampling is the difficulty of assessing the sampling error (Heikkinen, 2006). The most common approach, used in practice, is to ignore the effect of systematic sampling and apply the formulae that hold for the case of simple random sampling. Another approach is the generic notion of variance estimation via replication techniques (e.g. jackknife, bootstrap) (Eurostat, 2002). An assumption of randomness in a systematic survey can, however, lead to a significant variance overestimate, especially if a population is ordered or spatially autocorrelated (Nelson, 2005). An alternative might by a model-based approach. Matérn's estimators for example seem to be safe in the sense that they generally overestimate the sampling error (Heikkinen, 2006).

In conclusion, Stratified Systematic Sampling seems to be the optimal sampling design. The BEWG, however, recommend to ask the ICES Working Group on the Statistical Aspects of Environmental Monitoring (WGSAEM) for further advice.

Sampling devices

Rees *et al*. (2009) describe a range of devices for the collection of epibenthos. Conventional grab samplers are generally not suitable for larger and/or motile epibenthic surveys but blue mussels can be collected by grab sampling, as has been done in Danish waters in the past (Buschbaum and Saier, 2001). Grab samplers operate, however, on a very small spatial scale. Given the patchy distribution within a mussel bed, the probability of mussels being sampled might at least in some beds very low resulting in large standard errors of the measured variables. Sampling equipment designed to quantitatively collect larger samples of the seabed should be used, such as the triple-D (Bergman and van Santbrink, 1994, and modifications described by Rees *et al*. 2009). Annual data on the subtidal mussel stocks in the Dutch part of the Wadden Sea are mainly derived from samples taken with a similar trawled dredge (sampling area 10–15 m^2, the surface area depending on the length of the hauls) or with a modified hydraulic dredge (sampling area 20–30 m^2) (Smaal *et al*. 2001).

Parameters

The ICES Working Group on Seabird Ecology (WGSE) discussed the energetic requirements of blue mussels, *Mytilus edulis* for the eider, *Somateria mollissima* and other blue mussel eating bird species in Danish waters at their meeting in March 2009. The WGSE propose to follow a modelling approach to quantify consumption rates of shellfish. Input parameters related to mussel characteristics are a) shell length, b) density, c) fresh mass (both for flesh and shell) d) energy value of the flesh (as-free dry mass) and e) monthly variation in prey relative abundance. The necessary data on the first four parameters can easily be gathered from the quantitative samples taken yearly following the strategy described earlier covering the whole study area. The last parameter, however, needs frequent sampling. It is probably not feasible to include all beds, but restrict analysis to a few selected mussel beds. Including not only prey abundance estimates but also energy value measurements would allow to make secondary production estimates (see e.g. Craeymeersch *et al.*, 1986).

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Annex 12: Theme Session Proposal

The Benthos Ecology Working Group proposes a Theme Session on benthic indicators during the 2010 Annual Science Conference:

Title: Benthic indicators: responding to different human pressures and assessing integrative quality status

Conveners: Ángel Borja (Spain), Daniel Dauer (USA) and Antoine Grémare (France)

Description: Increasingly on a worldwide scale, legislation has been adopted to determine the ecological status of estuarine and coastal waters. One of the biological elements more used in such assessment is benthic communities. In recent times a plethora of methodologies with hundreds of indices, metrics and evaluation tools have been developed. An ecologically parsimonious approach dictates that investigators should place greater emphasis on evaluating the suitability of indices that already exist prior to developing new ones. Hence, the objective of this session is to compare the methodologies existing in various countries, for different systems, trying to improve the knowledge of the suitability of such approaches when using benthic communities under different human pressures.

Contributions are welcome on the following topics:

- Benthic indices for hard- and soft-bottom substrata, both in coastal and estuarine systems
- Setting reference conditions for coastal and estuarine waters, in a changing ocean
- Response of indices to different human pressures
- Comparison of different indices across different geographies
- Managing invasive species in benthic quality assessment
- Response of benthic indices to aquatic restoration
- Uncertainty in assessing quality status, using benthic indices
- Integrating benthic indices with other biological elements, when assessing ecological integrity of marine waters.

SUPPORTING INFORMATION

Priority:	Given its focus on benthic indicators, the proposed Theme Session supports the topic "Biodiversity and the health of marine ecosystems", being one of the 16 focal topics of the ICES Science Plan 2009-2013.
Scientific justification:	This theme session will provide the SoA regarding benthic indicators and further aims at outlining the future challenges of and potential solutions to the use of benthic indicators, e.g. reference condition, metrical and biogeographical intercalibration, uncertainty and integration. This next step in benthic indicator development and elaboration will be supportive for an efficient application of benthic metrics within e.g. the Marine Strategy Framework Directive.
Participants:	It is expected that responses to a call for contributions will reflect the wide interest and active research current in this subject area.

Linkages to advisory committees:	It is expected that responses to a call for contributions will reflect the wide interest and active research current in this subject area.
Linkages to other committees or groups:	SCICOM, ACOM, any quality assessment ICES EG
Linkages to other organizations:	–