ICES WGMBRED REPORT 2013

SCICOM STEERING GROUP ON ECOSYSTEM FUNCTIONS (SSGEF)

ICES CM 2013/SSGEF:17

REF. SSGEF, SCICOM

Report of the Working Group on Marine Benthal and Renewable Energy Developments (WGMBRED)

19-22 March 2013

Caen, France

ICES International Council for the Exploration of the Sea

CIEM Conseil International pour l'Exploration de la Mer

International Council for the Exploration of the Sea
Conseil International pour l'Exploration de la Mer

H. C. Andersens Boulevard 44–46
DK-1553 Copenhagen V
Denmark
Telephone (+45) 33 38 67 00
Telefax (+45) 33 93 42 15
www.ices.dk
info@ices.dk

Recommended format for purposes of citation:

ICES. 2013. Report of the Working Group on Marine Benthal and Renewable Energy Developments (WGMBRED), 19-22 March 2013, Caen, France. ICES CM 2013/SSGEF:17. 23 pp.

Contents

Executive summary

The 2013 annual meeting of the working group 'Marine Benthal and Renewable Energy developments' was held on the 19-22 March at the laboratory of 'Continental and Coastal Morphodynamic' in Caen, France. The meeting was attended by 21 experts, representing nine countries (Belgium, Estonia, France, Germany, Ireland, Poland, Sweden, UK, Netherlands). The meeting was co-chaired by Jennifer Dannheim (Alfred Wegener Institute, Germany) and Andrew B. Gill (Cranfield University, UK). The terms of references were summarized in three thematic subgroups: (A) The 'knowledge group' (ToR A, E) will evaluate and review existing knowledge of the effects of offshore renewable constructions and related topics (e.g. artificial reefs). (B) The 'monitoring group' (ToR B, F) will review and evaluate sampling techniques the scientific efficiency of ongoing monitoring programmes of offshore renewable construction projects by identifying knowledge gaps and simplifying future standardized research. (C) The 'metadatabase group' (ToR C, D) will develop a database of metadata that will help to cross-foster research and target monitoring, as well as future modelling approaches.

The knowledge group will develop a set of hypothesis-driven pathways from a conceptual scheme of cause–effect relationships (outcome of the WKEOMB) and will evaluate how knowledge of related topics (e.g. artificial reefs) can contribute to the issue of effects of renewable energy constructions. The disentanglement of the conceptual scheme began with consideration of components of relevance to societal issues, i.e. the benthal being (1) a 'biogeochemical reactor', (2) a source of biodiversity and (3) a source of food resources for higher trophic levels. Schemes were simplified and text descriptors of the processes (i.e. the hypotheses) that link the remaining components were formulated. During subsequent meetings, prioritization of the most important cause–effect relationships and the description of the main pathways of cause–effect-chains will be done.

The monitoring group will review why monitoring is needed, what needs to be monitored and how best to achieve those needs. This requires reviewing existing guidance for monitoring for marine renewables and other relevant marine activities. It was identified that time and spatial scale was crucial to the determination of the need to monitor and consequently what data should be collected and the best methodologies. Also identification of the type and extent of change, in the context of determining any significance, compared to natural variability and other effectors of change to the benthal community. The next stage is to write a review paper concerning monitoring and the crucial issues that were identified by the group. This will then be linked into the activities of the other two groups.

The metadatabase group was suggested to link to the Téthys ANNEX IV knowledge-management system, which is a USA-led collaborative project to gather and share information on the environmental effects of ocean energy development (tidal, wave, and ocean current) under the auspices of the Ocean Energy Systems (OES). A metadatabase will improve information exchange and guidelines for sampling techniques on renewable energy construction monitoring techniques (linked back to the monitoring group) and will simplify collaboration in the research field of marine renewables effects on the benthal in the future.

1 Administrative details

Working Group name

Marine Benthal and Renewable Energy Developments (MBRED

Year of Appointment

2013

Reporting year within current cycle (1, 2 or 3)

1st year

Chair(s)

Jennifer Dannheim, Germany

Andrew B. Gill, UK

Meeting venue

Caen, France

Meeting dates

19 – 22 March 2013

2 Terms of Reference a) – f)

a) Critically evaluate current knowledge of the effects of offshore wind farms and other renewable energy constructions on benthal organisms (i.e. marine invertebrates, demersal fish and macroalgae) in the North Atlantic

b) Review and develop guidelines for sampling techniques on renewable energy con-struction monitoring techniques by providing an overview of existing guidelines, in order to standardize and simplify future research and monitoring

c) Develop a meta-database for cross fostering research to target monitoring and future potential modelling approaches

d) Populating and keeping the meta-database updated

e) Review existing knowledge from related topics (e.g. artificial reefs) and how these are applicable to cause–effect relationships in the benthal associated with renewable energy constructions

f) Evaluate scientific efficiency of ongoing monitoring programmes by identifying knowledge gaps and overlap in research

3 Summary of Work plan

Year 1 ToR – A, C, D, E

Year 2 ToR – A, B, D, E

Year 3 ToR – A, B, D, F

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

WGMBRED was only established 2.5 months before the annual meeting. Therefore there are no outcomes so far but several aspects were discussed by the WG and evaluated which will lead to publications, datasets, methodological developments and advisory products.

- Two main themes were identified during the meeting, Knowledge and Monitoring, which address the TORs A, B, E and F.
- Significant progress on both these topics was made particularly in relation to formulating position papers.

Knowledge: ToRs A and E

Current activity

- Development of a schematic presentation of cause–effect relationships
- Identification of priority cause–effect relationships

Expected output:

- Matrix of related topics with specific cause–effect relationships; to include assessment of level of uncertainty in understanding
- Basis for scientifically underpinning the identified cause–effect relationships, to be then used to identify and prioritize the known unknowns.

Expected output (year 3):

- Review paper
- Feasible and readable paper, relevant to managers, policy-makers, developers and academics
- Highlighting knowledge gaps and prioritization (cf. known unknowns)

Monitoring: ToRs B and F

Current activity

- Outline structure for paper laid out ready for addition of text by different partners.

Expected output (year1):

- Review paper -
    - Highlights the current issues related to benthic monitoring, particularly in relation to spatial and temporal scale and biologically relevant size of effect to be monitored
    - Case study to be used to illustrate concepts reviewed and presented in paper.
    - Highlights knowledge gaps and prioritization

The Metadatabase: ToRs C and D

Current status:

- Checking whether WGMBRED can usefully engage and contribute to an already existing global database (Téthys, Annex IV, US DoE) that will

bring together projects, experiments, research and scientists that relate to the effects of marine renewables on the benthal.

Expected output (year1):

- Submission of metadata details for marine benthal monitoring related to MRED.

5 Progress report on TORs and workplan

5.1 Evolution and current status of the new working group on marine benthal and renewable energy developments

The working group on marine benthal and renewable energy developments was established only 2.5 month before the first annual meeting. At the start of the inaugural meeting, Jennifer Dannheim (co-chair) gave a brief introduction on the ICES structure and function, the aims of ICES in general and the official structure of an ICES working group. Further it was highlighted that WGMBRED is thematically linked to several other ICES groups (Figure 1). All members of the group agreed that there is a need to mutually inform and work together with ICES groups that are closely related.

Fig 1. ICES groups closely linked to WGMBRED

Following the introduction, Jennifer Dannheim gave a brief presentation on the evolution of the working group. The WG is thematically a continuation of the ICES workshop "Effects of offshore wind farms on marine benthos" (WKEOMB, see ICES 2012). Several intersessional activities were carried out and organized by members of WGMBRED in between the WKEOMB and the first annual meeting of WGMBRED:

- Theme session at ICES Annual Science Conference (ASC) 2012, Session O: How does renewable energy production affect aquatic life? convened by Erwin Winter (Netherlands), Alistair Maltby (UK), Jennifer Dannheim (Germany) and Steven Degraer (Belgium)
- Oral presentation at ICES ASC 2012, ICES CM 2012/O:07
- A call for hypotheses-based benthos research in offshore wind farm environmental impact studies

  Dannheim J, Degraer S, Gutow L, Birchenough S, Boon A, Brey T, Coates D, Dauvin J-C, de Roton G, Derweduwen J, Gill AB, Janas U, Kerckhof F, Krone R, Lozach S, Martin G, Mohn C, Reichert K, Reubens J, Robertson M, Rostin L, Steen H, Wilhelmsson D
- Poster presentation at ICES ASC 2012, ICES CM 2012/O:22:
- Target monitoring in offshore wind farms – the need to understand cause–effect relationships in the marine benthos

  Degraer S, Dannheim J, Gutow L, Birchenough S, Boon A, Brey T, Coates D, Dauvin J-C, de Roton G, Derweduwen J, Gill AB, Janas U, Kerckhof F, Krone R, Lozach S, Martin G, Mohn C, Reichert K, Reubens J, Robertson M, Rostin L, Steen H, Wilhelmsson D
- Viewpoint review article "Offshore renewable energy installations and their ecological impacts: A call for hypothesis-based and collaborative monitoring and research programmes" (working title), status presented by Steven Degraer

As a second part of the introduction Andrew B. Gill (co-chair) introduced the terms of references to the group which were summarized in three thematic subgroups:

a) The 'knowledge group' (referring to ToR A and E) will evaluate and review existing knowledge of the effects of offshore renewable constructions and related topics (e.g. artificial reefs) which might provide information on effects comparable to those of offshore renewables

b) 'monitoring group' (referring to ToR B and F) will review, evaluate and develop sampling techniques and scientific efficiency of ongoing monitoring programmes of offshore renewable construction projects by identifying knowledge gaps and simplify future standardized research

c) 'metadatabase group' (referring to ToR C and D) will develop a database of metadata that will help to improve cross fostering research and target monitoring, as well as future modelling approaches

An important question that came up in the group was how to sell the viewpoint article to industry, authorities, and consultancies, as well as the importance of effective knowledge exchange and thus the necessity of inclusion for standardization of methods.

The group should be an active long-term network producing valuable outputs, such as publications.

Participants agreed to become proactive and come up with non-solicited advice so as to demonstrate the added value of this working group to ICES.

It was noticed that critical scientific gaps might be missed by the interlinked ICES expert group and therefore must be considered in this group (e.g. migratory fish). Scientists from Canada and the USA are more active in some research fields e.g. electromagnetic field studies, than European scientists. This highlighted the importance of trying to get US and Canadian scientists to be involved in this group.

Further it was mentioned by the group that sampling effort needs to be considered when monitoring strategies and methodologies should be standardized and that experiences from ongoing initiatives on metadatabases might constitute a valuable benefit for WGMBRED.

Literature cited:

ICES. 2012. Report of the Workshop on Effects of Offshore Windfarms on Marine Benthos - Facilitating a closer international collaboration throughout the North Atlantic Region (WKEOMB), 27–30 March 2012, Bremerhaven, Germany. ICES CM 2012/SSGEF:13. 57 pp.

5.2 National updates

Belgium

Pilot study aiming to determine the acute lethal effect and the chronic impact of impulse noise on the development of sea bass (Dicentrarchus labrax) larvae.

Contact: Elisabeth Debusschere, University of Ghent.

Scotland – (three reports)

(1) Project licencing research with main focus for informing offshore energy project plans and project licencing being marine mammals, seabirds, fish and fisheries; no research specifically targeting benthic ecology at this time.

Contact: Mike Robertson, Marine Scotland Science, Aberdeen.

(2) Studies on effects of tidal flow on benthic species, habitats and on intertidal biofilms. Theoretical and numerical studies of the probability of interactions between migratory fish and structures for marine renewable energy.

Contact: Angus Jackson, Environmental Research Institute, North Highland College – UHI, University of the Highlands and Islands, Thurso.

(3) Summary on current research on the effects of offshore renewable energy on benthos carried out at SAMS: four PhD thesis, several publication (in prep.) and two large projects are currently undertaken (NERC, EU).

Contact: Tom Wilding, SAMS, Scottish Marine Institute

UK – (two reports)

Ongoing mesocosm study analysis of fish response to EMF and pile driving noise. New development at field site installing modular wave power device for multiple benthic related research projects. Also tidal device development at field site in South of England.

Contact: Andrew Gill, Cranfield University.

Presentation on the development and application of a 'flying array' with HD video camera from Plymouth University

Contact: Emma Sheehan, Plymouth University

The Netherlands

Current experimental research is focusing on the effects of underwater sound of offshore wind farm development on fish larvae and juveniles and on behavioural aspects of marine mammals. Field monitoring is currently limited to a monitoring programs at Amalia Wind Farm.

Contact: Arjen Boon, Deltares Research Institute

Estonia

Status of planned offshore wind farm projects in Estonian waters. All projects at an early developmental stage and EIA programmes are not officially adopted yet. Studies on possible impact on benthos in connection with EIA investigations: disturbance of benthic sessile communities on limestone substratum, sensitivity of certain depth intervals to disturbances, colonization patterns of artificial substrata.

Contact: Georg Martin and Liis Rostin, Estonian Marine Institute, University of Tartu.

France

In the case of the future assessment of the implementation of offshore wind farms on marine soft-bottom communities along the French Atlantic and English Channel coasts, as for granulate extraction and other anthropogenic impacts, we propose to promote for the future a unique sampling strategy at a local spatial scale, i.e. five replicates with mini-Hamon (0.1 m^{-2}) grab and sieving on 1 mm, and the designation of some share un-impacted control stations in the framework of a BACI (Before After Control Impact) approach. This approach can be encouraged for the cumulative impact study of anthropogenic activities on the benthal compartment at a regional scale.

Contact: Jean-Claude Dauvin, Université de Caen Basse-Normandie. UMR CNRS 6143 Morphodynamique continentale et côtière.

Poland

No offshore wind farms in the Polish marine sea areas yet but four selected regions (sandy, mixed sediments) for future investments (~2018). Large-scale studies on soft-bottom benthos were carried out in the past but current Polish monitoring stations are not situated near the planned wind farms. Natural hard-substrata is uncommon and thus hardly ever investigated, e.g. by monitoring. Succession studies of fouling communities on artificial substratum were done in the Gulf of Gdańsk. In 2012 short term studies on the colonization of artificial substratum were carried out in the southern part of the Baltic Sea.

Contact: Urszula Janas, Institute of Oceanography, Gdańsk University, Gdynia

5.3 Knowledge group (Tor A and E)

The knowledge group will develop a set of hypothesis-driven pathways based on the schematic presentations of cause–effect-relationships (see ICES 2012) to subsequently provide a list of prioritized hypotheses (ToR A) and will evaluate what and how much knowledge related topics (e.g. artificial reefs) can contribute to the issue of effects of renewable energy constructions (ToR E). The group will further contribute to a meta database on existing datasets of relevance to benthic resesarch and offshore renewables (Tor C).

The work of the subgroup started with a summary of the work done at the workshop in 2012. The basis of the work was the conceptual presentation of cause–effect-relationships of offshore renewables on the benthal (see ICES 2012). To simplify and clarify this scheme, the group decided on a structure to address societally important questions. Thereby the scheme should not aim at being comprehensive but rather identify cause–effect relationships relevant to major societal issues. These societal relevant issues were determined as the benthal being (1) a 'biogeochemical reactor', (2) a source of biodiversity and (3) a source of food resources for higher trophic levels. Biodiversity was defined in its broadest sense, i.e. the compositional aspect of biodiversity as e.g. number of species, community composition, etc.

The original diagram from 2012 (see ICES 2012) would be simplified by extracting only the components relevant to each of these issues. As a second step, gaps in knowledge and priority issues would need to be identified within these components and the way of presenting issues from the scheme would need to be developed by a broad audience. The expected output of this workgroup will be a review paper (finished in three years, working title: 'Benthic effects of offshore renewables: prioritizing the known unknowns') that is relevant to managers, policy-makers and developers of offshore renewables, highlighting current knowledge gaps and suggest prioritization of the known unknowns. Introductory material would include justification of reasons for selecting three key issues. Subdivision of tasks among the group and identification of inter-sessional work is needed.

Disentangling the conceptual presentation was the aim of this year's annual meeting. In order to achieve this aim, the disentanglement began with consideration of components of relevance to the named societal issues. The diagram was greatly simplified and brief text descriptors provided for the processes that link the remaining components. Here, the simplified scheme of 'biogeochemical reactor' with the description of each arrow is shown as an example (see Figure2).

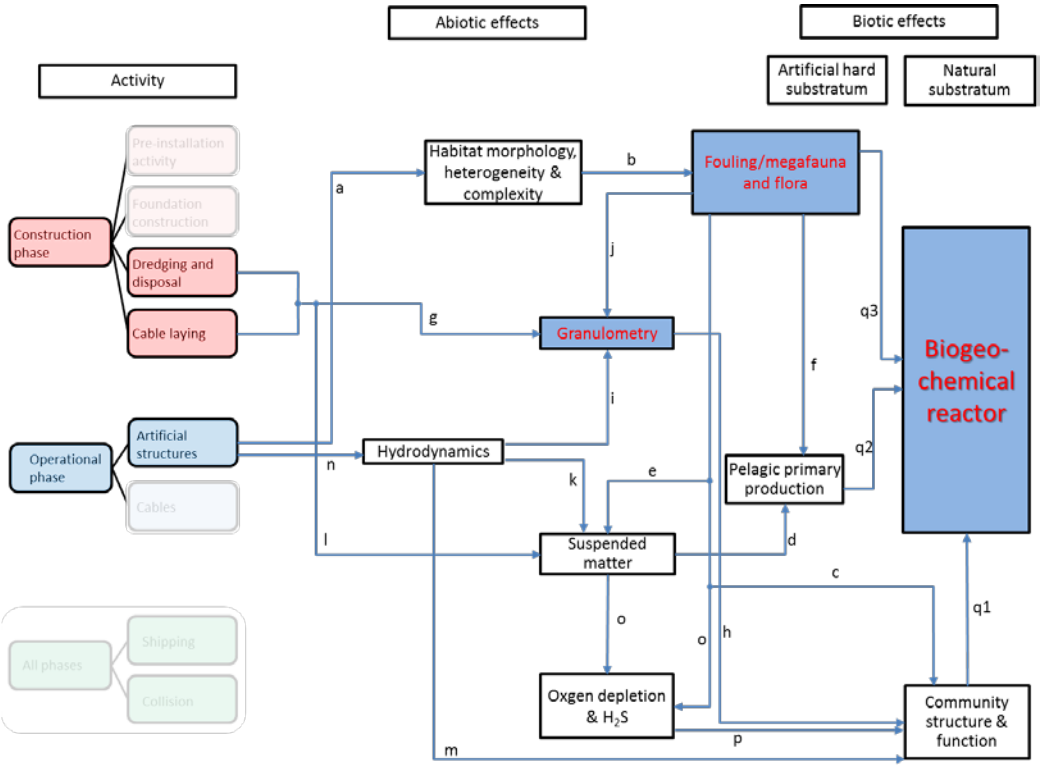

Fig 2. Conceptual presentation of the abiotic and biotic processes linked to biogeochemical reactions in the benthal, altered by activities and the resulting activity pressures during the construction and operational phase of offshore renewable energy constructions. Hypotheses are indicated by different letters (see text below). Note: Cause–effect relationships linked to cessation and displacement of fisheries are not considered here.

The MBRED working group identified the following specific hypotheses related to the effects on biogeochemical reactions in the benthic system:

a) The addition of artificial hard structures will change the morphology and increase the complexity of benthic habitats.

b) A specific hard bottom assemblage consisting of fouling organisms (fauna and flora) and associated mobile megafauna will colonize the new and complex artificial habitat.

c) Export of organic matter released by the fouling and megafauna community on the artificial structure provides food for benthic communities in the nearby natural sediments.

d) Turbidity caused by suspended matter reduces light penetration into the water column thereby reducing the primary production of photosynthetically active phytoplankton.

e) Suspension-feeding fouling organisms extract plankton and suspended matter from the water column and thereby decreasing turbidity.

f) Suspension-feeding fouling organisms on the artificial hard structure consume planktonic microalgae. This might affect the pelagic primary production at least on a local scale.

g) Disturbance of the seabed by dredging, disposal of extracted sediment and cable laying will change the granulometry of local sediments and thus benthic habitats.

h) Benthic species are sensitive to sediment conditions and thus community structure and function will change in response to the altered habitat.

i) Changes in can lead to turbulences that cause resuspension of fine sediment fractions. The export of fine sediments will cause scour and select for coarse sediment in the surrounding of the artificial structures.

j) Deposition of particles from fouling assemblages such as shell debris alters granulometry of nearby sediments.

k) Changes in the current conditions resuspend fine inorganic and organic sediment fractions in the water column.

l) Sediment disturbance such as dredging and cable laying during the construction phase will resuspend formerly deposited organic matter from the sediment.

m) Modified currents will determine settlement success of benthic species in nearby natural sediments.

n) Three-dimensional artificial structures which extend through the entire water column will affect local hydrodynamic conditions such as tidal and wind induced currents.

o) Released organic material from the water column and the accumulated fouling community on the artificial structure become deposited in the nearby sediments. Bacteria decomposition is accompanied by oxygen depletion and release of toxic H2S in the structures surrounding.

p) Anaerobic and/or toxic (H2S) conditions in the surrounding sediment of the structure cause mortality of organisms in adjacent natural habitats.

q) 1. Important functions of the benthos such as bioturbation and decomposition may change due to the altered benthic assemblage structure. This may substantially affect biogeochemical processes crucial to the functioning of the local marine ecosystem.

2. Pelagic primary production supports benthic biogeochemical processes. Accordingly, altered rates of primary production may affect biogeochemical turnover rates of benthic species. This may substantially affect biogeochemical processes crucial to the functioning of the local marine ecosystem.

3. The addition of 'new players' (i.e. fouling community on artificial hard sustrata) and their specific metabolic activities may substantially affect biogeochemical processes crucial to the functioning of the local marine ecosystem.

All three conceptual figures (one for each of the three components of relevance to societal issues) will be finalized by intersessional work before the next meeting. The group identified some issues that have to be considered in general, if the cause–effect relationships of offshore renewable energy constructions on benthos are to be evaluated:

- certainty: how to quantify it and how could variability be addressed
- scale issues (spatial and temporal): are the effects ecological relevant to the benthic system, i.e. if impacts upscale from a single wind farm to larger areas are impacts still relevant?
- habitat-specificity: what is the significance of regional variability?
- Fishery cessation and displacement will be dealt with as context-setting not as a direct impact from offshore renewables

- The relevance of the construction phase compared with operation phase to be tackled in the discussion

Next steps are to finalize the biogeochemical reactor, biodiversity and food resource scheme, as well as identify and describe the main pathways for these. It was suggested that the arrows are labelled during the meeting while the meaning of the arrows will be discussed intersessionally. Further work on the three themes will be disseminated within the 'knowledge' subgroup for approval before being considered by the full working group.

During the next meetings, prioritization of the most important cause–effect relationships should take place first after which the main pathways of cause–effect-chains can be described. The activity of the group identified the areas of importance under three broad themes, we now need to formalize this by finding the studies and literature (scientific justification) that demonstrate this and identify the gaps, the known unknowns.

Literature cited:

ICES. 2012. Report of the Workshop on Effects of Offshore Windfarms on Marine Benthos - Facilitating a closer international collaboration throughout the North Atlantic Region (WKEOMB), 27–30 March 2012, Bremerhaven, Germany. ICES CM 2012/SSGEF:13. 57 pp.

5.4 Monitoring group (ToR B and F)

There were three main sessions that took place with the Monitoring subgroup. A number of questions were raised in the first session to ensure that the subgroup thought clearly about aspects such as:

First session

1) Why are we monitoring? Evaluate efficiency (ToR F)

2) Which affects need to be assessed?

3) The need for a review of guidelines for monitoring (ToR B)

4) ToRs for monitoring is pointless, because time and space context are not taken into account. But what then is the efficiency of a monitoring program?

5) We don't know what the effect is; we have no normative concept of what a bad or good effect is.

6) We have to know what the variability of the environment is, to be able to assess the effect of the specific measure. In Germany they have found potential OWF effects, but identified it as a seasonal 'normal' effect (collecting all data are important)

A number of issues were identified that have to be taken into account:

- Scale is a very important issue. Both in time and space.
- Commercial/non-commercial species
- The concept of possibly focusing on "key" species (that perform important roles in Ecosystem)
- Methods of remote assessment – good for epibenthic species, but are they really necessary/important?
- Should the species be clearly connected to ecosystem services and ecosystem functioning

- Relate local effect to regional sea – hydrodynamic connected areas (connectivity) to understand effects; but can we do that? Can we escape the 'mindless monitoring' process?
- Regulators might be happy with support on how to monitor effects; but there are currently no benchmarks
- We say: it's a waste of money just to go out and monitor, you could do much more with the money (but what is the question?)

Opinion on Current Practice:

An overview was taken of current guidance and any issues that have arisen using experience from different countries.

Poland - a written guide for developers exists: it states that samples should be taken before (T0) and after (T1) the OWF is constructed (Stryjecki et al. 2011). These guidelines should be improved upon (e.g. there is a lack of reference stations).

Long-term data: 50 years of collecting data are not a popular approach. So, what can be delivered and what should the approach be?

Netherlands and Belgium - monitoring programs are set up based on making an inventory of knowledge and knowledge gaps. This should be used in prioritizing research needed to get this knowledge and then improve understanding of the cause-and-effect chain. Hypothesis-driven approach could be part of that.

Developers need to do the research but scientist have to aid them to fulfil their obligation to monitor possible effects focusing on ecosystem aspects (resistance/resilience; local v regional impact; and how are things connected in the foodweb)

Important to consider:

- Starting with a proper definition of the type and extent of change that is of interest (e.g. ecosystem service change).
- Determine what monitoring design is needed for what question. Consider, if a difference is found then what?
- Also when is a significant effect significant?
- Furthermore there is a need to look at how monitoring is organized by regulatory frameworks? National and international legislation and policy.
- Hypotheses-based research/monitoring should be promoted to try to determine how likely a specific effect is to occur.

Second session

The outcome of the discussions was to agree on the format, structure and content of a scientific paper concerning monitoring. The goal of the paper needs to cover:

1) Defining the current monitoring goals?

2) Highlight that currently monitoring is not effective: if there is any change, it is difficult to detect it against other factors and natural variability. There will be a focus on benthos, but other effects that take place such as, scour, fouling; secondary production, fish aggregation (and release from fishing pressure) need to be mentioned.

3) What kind of local changes are then being expected, and how can they be detected, filling the unknowns (cause–effect changes – link to knowledge

subgroup), find the right 'indicator'. An integrated approach is required (e.g. fouling community is benthic as well). Connect diversity-process-production (3 services). They need to be parameterized for this small scale.

4) The fundamental aspects of benthic ecosystem that need to be taken in to account for monitoring.

5) It is necessary to look at possible cumulative (system) effects due to scaling up and what research/monitoring/modelling is needed to assess these changes. Also important to consider how to judge them (e.g. ecosystem-based management, adaptive management), the interaction with other users (e.g. fisheries exclusion/displacement).

Third session

The point of this session was to further discuss the structure and content of the monitoring paper.

The main aspects to make clear were:

1) Existing monitoring is limited to local scales, it tells us nothing about the broader environment, this is seen as a result of being constrained by local drivers and being legally obliged to put some sort of monitoring in place.

2) Monitoring is not fit for purpose; more gap filling is needed with targeting monitoring dictated by developers and scientists.

3) Some developers will just do the minimum as they have limited budgets and they don't see the value or reason for monitoring.

4) Lack of a framework to follow.

The group agreed that there needs to be a demonstration of the requirement and use of monitoring if done effectively and provide a framework.

Issues with scale were also discussed and the following points were raised:

i) Scale of impact needs to be identified/ sampling universe/ relevant water body and relevant environmental factors (depth/habitat type etc).

ii) Need to be able to identify causes of impact in order to be able to scale up.

iii) We should include reference to upscaling (perhaps in paper title).

iv) Consider ecological scales at which organisms are operating

v) Potential link to ecosystem based models to scale up effects

vi) Need to consider at what point does number of turbines become relevant.... 1-10, 10- 100 ,.... 1000s? Hence how might monitoring be designed.

vii) Potential need for a threshold/threshold range to determine an effect and to determine sampling design. It was discussed that if the design needed to identify an effect was too costly, it was better to not do it at all rather than spend money on a survey that could not detect an effect

Output from the three sessions was a strategy for the paper writing:

The group decided to focus the paper on stating that monitoring is currently not effective and to focus on measuring the impacts on the three outlined ecosystem services and ask the questions:

- What are current monitoring goals and guidance?
- What would be needed to detect these changes?

- How to judge any effects... ask the right question?
- What local impacts are likely to be detected?
- What are likely cumulative effects?
- How to judge these regional changes?

The Group decided that offshore wind, with its deploy and monitor approach, could be used as an example, of what not to do, and that wave and tidal industry could learn from.

It was also important to learn from existing monitoring of benthic environments and monitoring methodologies (e.g. Schmitt et al 1996 – Detecting Ecological Impacts, which discusses appropriate monitoring strategies in monitoring coastal ecosystems).

The study effect size must be defined in conjunction with a definition of the goals of the monitoring.

Indicators of change were discussed as there is a need to identify good indicators of change.

Paper Writing Strategy summary

Ditch current monitoring (diplomatically) and call for something else that is more targeted. Use data obtained from such studies to feed into models to understand regional scale impacts. Measure trophic pathways that are occurring as a result of deploying structures in the sea by e.g. biogeochemical function alteration, use to populate models that will look at effects at the ecosystem level.

Literature cited:

Schmitt, R.J., Osenberg, C.W. (Eds.), Detecting Ecological Impacts- concepts and applications in coastal habitats. Academic Press, San Diego. 401 pages. ISBN 0-12-627255-7

Stryjecki M, Mieleńczuk K., Biegaj J., 2011, Przewodnik po procedurach lokalizacyjnych i środowiskowych dla farm wiatrowych na polskich obszarach porskich, Fundacja na Rzecz Energetyki Zrównoważonej, Warszawa, 156 str.

5.5 Metadatabase group (Tor C and D)

The group agreed that a metadatabase will improve information exchange and guidelines for sampling techniques on renewable energy construction monitoring techniques and will thus simplify collaboration in the future.

The group discussed the scope and the format of the database which is directly connected to the users and their needs of the database. As a start the group discussed whether a WGMBRED metadatabase should be developed or if an existing one should be used. A suggestion was to link to the data to the Téthys knowledge-management system (http://mhk.pnnl.gov/wiki/index.php/Tethys_Home). The Téthys ANNEX IV is a collaborative project to gather and share information on the environmental effects of ocean energy development (tidal, wave, and ocean current) under the auspices of the Ocean Energy Systems (OES). The project aims at collecting information on current research efforts that investigate environmental effects of ocean energy projects (principally tidal, wave, and ocean current energy), i.e. information on research projects and experiments that investigate potential environmental effects of ocean energy devices, mooring systems, anchors, and power cables on marine animals, habitats, and ecosystem processes. In order to avoid duplication of metadatabases dealing with the effects of marine energy renewable constructions on

the benthal, the participants agreed on linking metadatabase information to the ANNEX IV database.

5.6 Identified important cross-cutting themes

Following on from the WKEOMB and discussions prior to the inaugural WGMBRED a number of relevant cross-cutting themes came to light. These are outlined below and were introduced to the group to indicate how the activities within the group could be developed and applied:

a) Comparability of techniques / methodology in offshore wind park/marine renewable energy monitoring sampling (Steven Degraer); this topic will partly be covered by the monitoring group

   1) Towards hard bottom benthic community observations: long-term survey of hard-bottom benthic communities from marine renewable energy developments to establish an European observatory link to climatic changes, opportunity to promote a common sampling design to observe changes of offshore intertidal and subtidal fauna and flora (autochthonous and exotic species) at the scale of the northeastern Atlantic continental shelf. (Jean-Claude Dauvin)

b) Working on the hypothesis of devices and subsurface structures being surrogates for natural hard substrata. (Steven Degraer), i.e. if natural and artificial hard substratum ecosystems are different, analysis of structure, function and ecosystem services; this topic will partly be covered by the knowledge group

   1) Assessment of how the type of environment that the marine renewable technology is deployed within will have implications for benthal ecosystem. (Andrew B Gill)

c) Definitions of effects vs. impacts (Andrew B Gill), consideration of the definition of effects (i.e. something that is happening to the organisms, or a response) vs. impacts (i.e something where an effect causes significant change to either a species population or a community and the dynamics and whether it is regarded as positive or negative); this topic will partly be covered by the knowledge group.

d) Determining methods to address the question of whether these new renewable energy structures in the environment can be regarded as positive or negative ecologically (Andrew B Gill), including the spatial scale issue to consider the relevant scale of benthic ecological functioning (species, community, ecosystem) vs. the societal magnitude of the impact (cf. context setting); this topic will partly be covered by the knowledge group.

e) The source-sink hypothesis. (Andrew B Gill)

f) Cumulative impacts of anthropogenic activities, such as offshore wind farms, granulate extraction, deposit of sediments, fishing on the functioning of marine area (ecosystem), i.e. ecosystem based-management approach. (Jean-Claude Dauvin)

g) Changes in ecological functioning, as exemplified by biological traits, focus on changes in biological traits dependent on the distance to the wind farm constructions. Similar to fishery impact studies, changes biological traits might be more significant than changes in species composition, e.g. transnational analysis of benthos in different wind farms. (Jennifer Dannheim)

6 Revisions to the work plan and justification

There is no revision of the work plan necessary.

7 Next meetings

The group agreed upon that the meeting in 2014 will take place 25.03. – 28.03.2014 in Tallinn, Estonia.

Delft (Netherlands), Galway (Ireland) and Oban (Scotland) were suggested as venues for 2015. The potential hosts will confirm their offer in Tallinn where the final decision will be made on the date and venue for 2015.

Annex 1: List of participants

Name	Address	Phone/Fax	E-mail
Alexandrine Baffreau	Université de Caen Basse-Normandie. UMR CNRS 6143 Morphodynamique continentale et côtière.		alexandrine.baffreau@etu.unicaen.fr
Arjen Boon	Deltares Research Institute Unit of Coastal and Marine Science PO Box 177 2600 MH Delft The Netherlands	Phone: + 31 88 3358003 Fax: + 31 88 3358582 Mobile: + 31 6 51635449	arjen.boon@deltares.nl skype: arjenrboon
Jennifer Dannheim (co-Chair)	Alfred Wegener Institute for Polar and Marine Research PO Box 120161 27570 Bremerhaven Germany	Phone: +49 471 4831 1734 Fax: +49 471 4831 1425	Jennifer.Dannheim@awi.de
Jean-Claude Dauvin	Université de Caen Basse-Normandie. UMR CNRS 6143 Morphodynamique continentale et côtière.	Phone: +33 2 31 56 57 22 Fax: +33 2 31 56 57 57	jean-claude.dauvin@unicaen.fr
Ilse de Mesel	RBINS-MUMM 3e en 23e linieregimentsplein 8400 Oostende Belgium	Phone: +32 59 24 20 51 Fax: +32 59 70 49 35	Ilse.demesel@mumm.ac.be
Steven Degraer	RBINS-MUMM Gulledelle 100 B-1200 Brussels Belgium	Phone: +32 2 773 2103	steven.degraer@mumm.ac.be
Jozefien Derweduwen	Institute for Agricultural and Fisheries Research (ILVO) Ankerstraat 1 8400 Oostende	Phone: +32 59 56 98 18	jozefien.derweduwen@ilvo.vlaanderen.be
Andrew B. Gill (co-Chair)	Cranfield University Cranfield, Bedfordshire MK43 0AL UK	Phone: +44 (0)1234750111 x2711	a.b.gill@cranfield.ac.uk

Lars Gutow	Alfred Wegener Institute for Polar and Marine Research PO Box 120161 27570 Bremerhaven Germany	Phone: +49 471 4831 1708 Fax: +49 471 4831 1425	Lars.Gutow@awi.de
Zoe Hutchison	Scottish Association for Marine Science, Oban, Argyll, Scotland PA34 1QA	+44 1631 559000	Zoe.hutchison@sams.ac.uk
Angus Jackson	Environmental Research Institute, North Highland College UHI, University of the Highlands and Islands, Ormlie Road, Thurso, Caithness, KW12 7EE, UK.	+44 1847 889596	Angus.jackson@uhi.ac.uk
Urszula Janas	Institute of Oceanography University of Gdańsk Al. Marsz. J. Pilsudskiego 46 81-378 Gdynia Poland	Tel. +48 58 523 68 67	oceuj@univ.gda.pl
Georg Martin	Estonian Marine Institute, University of Tartu, Mäealuse 14, 12618, Tallinn Estonia	Phone: +3726178936 Fax: +3726718900	georg.martin@ut.ee
Maxime Navon	Université de Caen Basse-Normandie. UMR CNRS 6143 Morphodynamique continentale et côtière.		
Francis O'Beirn	Marine Institute, Rinville, Oranmore, Galway, IRELAND	Ph: +353-91-387250	fobeirn@marine.ie
Jean-Philippe Pezy	Université de Caen Basse-Normandie. UMR CNRS 6143 Morphodynamique continentale et côtière.		philippe.pezy@orange.fr
Mike Robertson	Marine Scotland Science, Marine Laboratory PO Box 101 375 Victoria Road Aberdeen. UK. AB11 9DB	Phone +44 (0) 1224 876544	mike.robertson@scotland.gsi.gov.uk

Liis Rostin	Estonian Marine Institute, University of Tartu, Mäealuse 14, 12618, Tallinn Estonia	Phone: +37253403778 Fax: +3726718900	liis.rostin@ut.ee
Emma Sheehan	Plymouth University Marine Institute Marine Building Drake Circus Plymouth, PL4 8AA UK	0044 1752 584699	emma.sheehan@plymouth.ac.uk
Tom Wilding	SAMS, Scottish Marine Institute Dunbeg Nr Oban Argyll, Scotland, UK,	+44(0)1631 559214	Tom.wilding@sams.ac.uk
Dan Wilhelmsson	Swedish Secretariat for Environmental Earth System Science (SSEESS) Royal Swedish Academy of Science Box 50005, 104 05 Stockholm, Sweden	+46 8 673 9500	Dan.wilhemsson@sseess.kva.se

Annex 2: Intersessional work and action points

Deadlines of intersessional work

Date	Topic
Knowledge group	
Mid May 2013	Finalizing the "biogeochemical reactor story"– Jennifer Dannheim (JD) and Lars Gutow (LG)
Mid May 2013	Finalizing the "biodiversity story" – Steven Degraer (SD) and Angus Jackson (AJ)
Mid May 2013	Finalizing the "food resource story" – LG and JD
June 2013	Drafting the first part of the paper, send to entire WGMBRED – SD
2014	Tallinn Meeting, Prioritization, i.e. consider the priority areas to address and any knowledge gaps
Monitoring group	
April 2013	Circulate general outline with bullet points to members of group for review and comment –Francis O'Beirn (FOB)
31. May 2013	Group to return outline to FOB and commence writing 1st drafts of relevant sections – leaders to coordinate input from other members
October 2013	1st drafts of sections complete and updates provided to FOB for compilation
Start Dec. 2013	Compiled draft put on sharepoint for group review (FOB, Andrew B. Gill (ABG), Tom Wilding (TW)), comment and editing
2014	Tallinn Meeting: final draft review to sigh off

Actions points

- Metadatabase: ABG will contact Téthys OR members of the group will fill in-to the metadatabase form → ABG and JD will build up an excel file, topic will be set on the workshop agenda next year (national updates)
- Funding opportunities: Participants agreed to look out for funding and becoming active if there is an opportunity!
- Cross-cutting theme "Surrogates" (B) → SD will do a literature research and put on the sharepoint
- Cross-cutting topic "effect-impact", positive-negative (C): dealt with within the subgroups until next meeting in Tallinn
- Cross-cutting topic "cumulative impacts" (F) → folder on the sharepoint, literature to be uploaded, topic will be on the agenda next year
- Cross-cutting topic "ecological functioning" (G) → JD: complile/put together biological-trait definition data sheet, all participants → upload documents, literature in the folder on the sharepoint, topic will be on the agenda next year