

ICES WGMRE REPORT 2016

SCICOM STEERING GROUP ON ECOSYSTEM PRESSURES AND IMPACTS

ICES CM 2016/SSGEPI:04

REF. SCICOM

Report of the Working Group on Marine Renewable Energy (WGMRE)

12–15 April 2016

Cork, Ireland



ICES
CIEM

International Council for
the Exploration of the Sea

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. 2016. Report of the Working Group on Marine Renewable Energy (WGMRE), 12–15 April 2016, Cork, Ireland. ICES CM 2016/SSGEPI:04. 17 pp.

For permission to reproduce material from this publication, please apply to the General Secretary.

The document is a report of an Expert Group under the auspices of the International Council for the Exploration of the Sea and does not necessarily represent the views of the Council.

© 2016 International Council for the Exploration of the Sea

<https://doi.org/10.17895/ices.pub.8539>

Contents

Executive summary	2
1 Administrative details	3
2 Terms of Reference a) – z)	3
3 Summary of Work plan	4
4 Summary of Achievements of the WG during 3-year term	5
5 Final report on ToRs, workplan and Science Implementation Plan	6
6 Cooperation	8
7 Summary of Working Group self-evaluation and conclusions	8
Annex 1: List of participants.....	9
Annex 2: Recommendations.....	10
Annex 3: WGMRE draft resolution 2017–2019	11
Annex 4: WGMRE Self-Evaluation	14

Executive summary

The third meeting of the ICES Working Group on Marine Renewable Energy (WGMRE) took place from 12 to 15 April 2016 and was hosted by University College Cork, Ireland. There were 11 attendees. New members attended from Belgium and the Netherlands. The main focus of the meeting was updates and reporting on relevant work in respective countries against ToRs.

The meeting consolidated the main products from the 3-year cycle, identified strategic research topics associated with the potential impacts of marine renewable energy of interest to the wider ICES community, including agreement on a template for provision of annual country updates. A metadata base of information on web based information on research into potential impacts of marine renewable energy was finalised.

The group gave consideration to risk-based policy approaches that can be used by regulators to reduce scientific uncertainties associated with the environmental impacts of human activities such as marine renewable energy (MRE). This included the deliverables from a Horizon 2020 funded project called RICORE whose focus in the adoption of risk-based decision making as a basis for assessing potential impacts of MRE, and Adaptive Management as an overarching approach to reducing scientific uncertainties. Coordination with WGMRED was provided by Raeanne Miller who attended both meetings.

1 Administrative details

Working Group name

Working Group Marine Renewable Energy (WGMRE)

Year of Appointment within the current cycle

2014

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

3

Chair(s)

Finlay Bennet, UK

Meeting venue and dates

1–3 April 2014, San Sebastian, Spain; 6 participants

14–17 April 2015, Swansea, United Kingdom; 9 participants

12–15 April 2016, Cork, Ireland; 11 participants

2 Terms of Reference a) – z)

ToR a) Provide summaries of the state of development of the marine renewable energy sector, covering offshore wind energy, in-stream tidal energy, wave energy and tidal barrages, updated on an ongoing basis, and including ‘horizon scanning’ to identify future issues for marine environmental management.

Background:

- Science Requirements: the marine renewable energy sector is rapidly emerging as a new user of marine space. There is a need for up-to-date, spatially explicit information on developments and on current research activities to determine potential interactions with ecosystems and other sea users.
- Advisory Requirements:
- Advice to OSPAR and other customers requires access to latest research outcomes and experience of developments in this emerging science area.
- Requirements from other EGs: marine renewable energy developments will impact or interact with topics considered by other EGs, for example marine mammals, seabirds, benthos.

Deliverable: Live documents, on marine renewable energy developments and associated research, updated and extended annually.

ToR b) Report on developments in consenting procedures for marine renewable energy.

Background: As for ToR a) above.

Deliverable: Live document, updated and extended annually.

ToR c) Report on the development of decision-support and management tools for planning and regulation of marine renewable energy developments, considering the relevance to new technology, cumulative effects and the application of risk-based ecosystem approaches to management.

Background: As for ToR a) above.

Deliverable: Live document, updated and extended annually.

ToR d) Identify cross-sectoral issues involving marine renewable energy, for example opportunities for co-location, interactions with fishing, aquaculture, fisheries and Marine Conservation Zones.

Background: As for ToR a) above.

Deliverable: Individual fact sheets on expected interactions and issues by sector, for use by other EGs and ICES customers. Produced in year 2.

ToR e) Foster strong collaborative working relationships with other ICES Expert Groups, integrating recommendations across topic areas and identifying priority issues and science applications for thematic ICES Workshops based on regulatory and planning needs in relation to marine renewable energy.

Background: As for ToR a) above.

Deliverable: Links established during year 1, Workshops held during years 2 and 3, CRRs produced as Workshop outputs.

3 Summary of Work plan

- Agree the form of report, database and GIS outputs for ToR a, integrating information collated by SGWTE on development and research activities.
- Draft summary reports on consenting processes and decision support tools by country (ToRs b & c).
- Invite chairs and members of other EGs to participate in the WG meeting and otherwise identify cross-cutting issues; review relevant material in other EG reports.
- Propose the first topic-based Workshop, jointly with one or more other EGs.
- Review multi-annual ToRs for years 2 and 3 and adjust as appropriate.
- Update and extend reports on ToRs a, b & c.
- Based on collaborations with other EGs, develop fact sheets on cross-sectoral

interactions.

- Plan and hold the first topic-based Workshop, with the outcome reported as a CRR.
- Propose the second topic-based Workshop, jointly with one or more other EGs.
- Review progress against multi-annual ToRs and adjust as appropriate for year 3.
- Complete meta-database analysis, and national reports on ToRs a, b & c.
- Further develop integrated and collaborative approaches across expert WG's to efficiently progress scientific and advisory aspects of topic based issues
- Identify science, advisory and other EG needs for continuation of WGMRE activities and formulate multi-annual ToRs as appropriate.

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

- Three meetings of the WG.
- Participation is dominated by ICES nations that are actively developing marine renewable energy. A distinction can be drawn between issues associated with potential environmental impacts of nascent technologies and issues relating to cumulative impacts of commercial scale offshore wind, particularly in the North Sea region. The UK is particularly well represented in relation to both aspects. Sharing information on assessment methods, monitoring approaches and associated policy approaches that support good practice are considered to be valuable. The national reports collated by WGMRE indicate that decision makers/regulators within the ICES community to use cumulative assessment methods to focus on single species population impacts. There are a large number of scientific uncertainties associated with potential impacts e.g. collision and displacement risks to seabird populations and the consequences of impulsive noise on marine mammal populations. Consequently the priority is reducing scientific uncertainties to provide greater confidence to decision makers in existing modelling frameworks, and balancing the need for appropriate mitigation with the need for risk-based decision making that enables robust monitoring of the mechanisms of potential effect. The rate of transition to full ecosystem based assessments that meaningfully inform decision making regarding MRE is likely to be more gradual and contingent upon an improving evidence base.
- A template for annual country updates agreed and implemented.
- The most effective means of achieving collaboration across ICES groups, between member countries, and more widely was also considered in detail. An output from the meeting is a set of topics/questions that can form the basis of further cross-sectoral interactions.

Changes/ Edits/ Additions to ToR

Year 3 changes to the work plan reflect what the group consider to be achievable in the short term. A key focus of the next meeting will be revision of ToRs.

5 Final report on ToRs, workplan and Science Implementation Plan

Progress and fulfilment by ToR

Each ToR was reviewed and progress against delivery is reported below. The utility and practicality of each ToR was also considered with a view to agreeing changes should ICES approve a further 3 year work plan.

- ToR a) Provide summaries of the state of development of the marine renewable energy sector, covering offshore wind energy, in-stream tidal energy, wave energy and tidal barrages, updated on an ongoing basis, and including 'horizon scanning' to identify future issues for marine environmental management. The expected deliverables identified: live documents, database system and GIS outputs on marine renewable energy developments and associated research, updated and extended annually.

Progress: Working Group developed a new template based on the previous work of SGWTE, and is using it to provide annual updates of: the scale and type of marine renewable energy developments that are operational and planned, environmental research into the effects of marine renewables, and best available techniques for assessment – particularly in the context of regulatory requirements. Working Group sub-group collated meta-data on web-based knowledge and information of relevance to understanding the environmental impacts of marine renewable energy, and this has been provided to Tethys website.

- ToR b) Report on developments in consenting procedures for marine renewable energy. Live document, updated and extended annually.

Progress: The template agreed for annual updates includes a section that delivers against this ToR.

- ToR c) Report on the development of decision-support and management tools for planning and regulation of marine renewable energy developments, considering the relevance to new technology, cumulative effects and the application of risk-based ecosystem approaches to management. Live document, updated and extended annually.

Progress: As with the previous ToRs the country updates provide information on the development of decision-support and management tools within the planning and regulatory systems. In addition, several Working Group members (Netherlands, Spain, Portugal, Ireland and UK) contributed to the work of the [RiCORE](#) to better understand the policy options associated with development of risk-based decision making frameworks, especially for newer and smaller scale technologies. The RiCORE project is funded by Horizon 2020 and supported by several of the institutions represented in WGMRE. RiCORE

deliverables considered the science aspects of risk-based decision making and the recommendations of the project form the basis for further development and application of risk-based decision-support tools capable of an Adaptive Management approach that seeks to reduce scientific uncertainty associated with the interactions of environmental receptors with marine renewable devices in order to improve decision making over time.

- ToR d) Identify cross-sectoral issues involving marine renewable energy, for example opportunities for co-location, interactions with fishing, aquaculture, fisheries and Marine Conservation Zones. Individual fact sheets on expected interactions and issues by sector, for use by other EGs and ICES customers. Produced in year 2.

Progress: Working Group did not address this ToR.

- ToR e) Foster strong collaborative working relationships with other ICES Expert Groups, integrating recommendations across topic areas and identifying priority issues and science applications for thematic ICES Workshops based on regulatory and planning needs in relation to marine renewable energy. Links established during year 1, Workshops held during years 2 and 3, CRRs produced as Workshop outputs.

Progress: WGMRE members will continue to seek to establish and retain an overview of ICES advice on impacts of marine renewable energy, and seek to ensure co-ordination and consistency across working groups. The focus will be on topic based issues that can provide impetus for fostering collaborative working across disciplines within the ICES community. The strongest links are with WGMRED and have been maintained during the 3-year cycle by cross-attendance by group members in all 3 years. Aspects of this work are likely to be applicable to other receptor groups (e.g. populations of predator species).

Science Highlights

- WGMRE supported OSPAR to progress a review of the environmental effects of wave and tidal energy. Cefas (Daniel Wood and colleagues) lead on a similar review as part of the EU funded project MaRVEN. The MaRVEN project (which focuses on Environmental Impacts of Noise, Vibrations and Electromagnetic Emissions from Marine Renewables) includes a review of the environmental effects of offshore renewable energy devices.
- Direct involvement of several of WGMRE members in the RiCORE Horizon 2020 project is providing new opportunities for policy makers to make use of scientific advice in the context of risk-based decision making and assessment of marine renewables.
- Strong links between the international group called WREN (working to resolve environmental conflicts of wind energy) has been established and is funding is provided by U.S. Department of Energy for Secretariat function of WREN.

- Strong links with PNNL who host Tethys website which acts as a hub for new evidence of environmental impacts of marine renewable energy. More information on WREN and Tethys here: <http://tethys.pnnl.gov/>
- The 2015 WGMRE group attended a seminar on the work funded by the UK's National Environmental Research Council's (NERC's) knowledge exchange programme.
<http://www.nerc.ac.uk/innovation/activities/infrastructure/offshore/>

6 Cooperation

Cooperation with other WG

- We have identified a number of other ICES working groups covering various aspects of the need to understand and manage the effects of marine renewable energy. The current focus of WGMRE is to prioritise topic based issues for collaborative working.
- WG on Marine Mammal Ecology, WG on Seabird Ecology and the Working Group on Marine Benthos and Renewable Energy have all given further consideration to the effects of marine renewable energy projects.
- Diadromous fish: these include the Working Group on Eel (WGEEL), WG on North Atlantic Salmon (WGNAS), WG on Baltic salmon and trout (WGBAST) and a new WG on Sea Trout. It is believed that all of these groups include some considerations of the effects of offshore renewable energy devices on the relevant fish groups.

Cooperation with Advisory structures & IO

Nothing noted.

7 Summary of Working Group self-evaluation and conclusions

A copy of the full Working Group self-evaluation is included in Annex 4.

Annex 1: List of participants

Name	Address	Email
Teresa Simas	WavEC - Offshore Renewables Lisboa, Portugal	teresa@wave-energy-centre.org
Mark Jessopp	University College Cork, Ireland	M.Jessopp@ucc.ie
Raeanne Miller	Scottish Association for Marine Science, UK	Raeanne.Miller@sams.ac.uk
Juan Bald	AZTI, Pasajes, Spain	jbald@azti.es
Ian Horsfall	Swansea University, UK	i.m.horsfall@swansea.ac.uk
Daniel Wood	CEFAS, Lowestoft, UK	Daniel.Wood@cefes.co.uk
Finlay Bennet	Marine Scotland Science, Aberdeen, UK	Finlay.bennet@scotland.gsi.gov.uk
Marijke Warnas	Rijkswaterstaat, Netherlands	marijke.warnas@rws.nl
Linus Hammar	Marine & Water Management Agency, Sweden	linus.hammar@havochvatten.se
Suzanne Beck	Agri-food & biosciences institute, Belfast, UK	Suzanne.Beck@afbini.gov.uk
Joop Bakker	Rijkswaterstaat, Netherlands	joop.bakker@rws.nl
Bob Rumes	Institute of Natural Science, Belgium	bob.rumes@naturalsciences.be

Annex 2: Recommendations

RECOMMENDATION	ADDRESSED TO
1. WGMRE recommends that the work of the group is continued for a further 3 year term. SCICOM is requested to consider and approve this request based on revised ToRs.	SCICOM

Annex 3: WGMRE draft resolution 2017–2019

The **Working Group on Marine Renewable Energy (WGMRE)**, chaired by Finlay Bennet, UK, will work on ToRs and generate deliverables as listed in the Table below.

	MEETING DATES	VENUE	REPORTING DETAILS	COMMENTS (CHANGE IN CHAIR, ETC.)
Year 2017	11–13 April	Lisbon, Portugal	Interim report by 30 June to SSGEPI	
Year 2018			Interim report by Date Month to SSGXXX	
Year 2019			Final report by Date Month to SSGXXX	

ToR descriptors

ToR	DESCRIPTION	BACKGROUND	SCIENCE PLAN TOPICS		EXPECTED DELIVERABLES
			ADDRESSED	DURATION	
a	Summarise and analyse the state of development of the marine renewable energy sector, covering offshore wind energy, in-stream tidal energy, wave energy and tidal barrages, updated on an ongoing basis, and including 'horizon scanning' to identify future issues for marine environmental management.	<ul style="list-style-type: none"> • Science Requirements: the marine renewable energy sector is rapidly emerging as a new user of marine space. There is a need for up-to-date, information on developments and on current research activities to determine potential interactions with ecosystems and other sea users. • Advisory Requirements: Advice to OSPAR and other customers requires access to latest research outcomes and experience of developments in this emerging science area. • Requirements from other EGs: marine renewable energy developments will impact or interact with topics considered by other EGs, for example marine mammals, seabirds, benthos. 	11,12, 13, 14, 23 & 27	Ongoing	National reports, on marine renewable energy developments and associated research, updated and extended annually. The product will be developed into a manuscript to be submitted to a peer-reviewed scientific journal.
b	Report on developments in consenting procedures	As for ToR a) above.	11,12, 13, 14, 23 & 27	Ongoing	As for ToR a) above.y.

	for marine renewable energy.				
c	Review the development of decision-support and management tools for planning and regulation of marine renewable energy developments, considering the relevance to new technology, cumulative effects and the application of risk-based ecosystem approaches to management.	As for ToR a) above	11,12, 13, 14, 23 & 27	Ongoing	As for ToR a) above..
d	Identify monitoring priorities associated with potential mechanisms of effects that are assumed within cumulative assessment frameworks, and how monitoring is integrated into the development of decision-support tools and regulatory requirements. Report on development and standardisation of post-consent monitoring methods that promote efficient use of resources within ICES community and can provide robust results at single MRE locations and through use of meta-analysis approaches at multiple locations.	As for ToR a) above.	11,12, 13, 14, 23 & 27	Ongoing	As for ToR a) above.
e	Foster strong collaborative working relationships with other ICES Expert Groups, ensuring integration across topic areas and identifying priority issues and science applications based on regulatory and	As for ToR a) above.	11,12, 13, 14, 23 & 27		As for ToR a) above.

planning needs in
relation to marine
renewable energy.

Summary of the Work Plan

Year 1	<ul style="list-style-type: none"> - Provide annual report against ToRs, revising format as necessary - Invite chairs and members of other EGs to participate in the WG meeting and identify cross-cutting issues; reviewing relevant material in other eg reports - Report on the development of tools and approaches that can be used to align Policy with Evidence in a manner that promotes risk-based decision making when addressing societal trade-offs between the upscaling of marine renewable energy with impacts to wildlife populations, habitats and ecosystem services - Report on research priorities and approaches to study design and standardisation of monitoring in order to meet the needs of risk-based decision making in an efficient and robust manner - Draft manuscript for publication in a peer reviewed journal based on the output of multi-annual ToRs - Based on collaborations with other EGs, develop advise e.g. scope proposals for topic based workshops as appropriate - Review multi-annual ToRs for years 2 and 3 and adjust as appropriate
Year 2	<ul style="list-style-type: none"> - Provide updates to annual report against ToRs - Submit manuscript to a peer reviewed journal - Review multi-annual ToRs for year 3 and adjust as appropriate
Year 3	<ul style="list-style-type: none"> - Provide updates to annual report against ToRs - Undertake outstanding work to ensure manuscript is accepted by peer reviewed journal e.g. addressing peer reviewers' comments

Supporting information

Priority	The current activities of this Group will lead ICES into issues related to the ecosystem effects of marine renewable energy, especially with regard to the application of the Precautionary Approach in the context of risk-based decision making and the need to reduce scientific uncertainty associated with the impacts of new and established marine renewable technologies. Consequently, these activities are considered to have a high priority.
Resource requirements	The research programmes which provide the source material for this group already exist or are 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 approximately 12 members and guests.
Secretariat facilities	None.
Financial	No financial implications.
Linkages to ACOM and groups under ACOM	There are no obvious direct linkages.
Linkages to other committees or groups	There is a very close working relationship with the Working Group on WGMRED, WGMME, WGSE and a range of other WGs who consider the impacts of marine renewable energy within their ToRs.
Linkages to other organizations	

Annex 4: WGMRE Self-Evaluation

- 1) Working Group on Marine Renewable Energy (WGMRE)
- 2) Year of appointment: 2014
- 3) Current Chairs: Finlay Bennet
- 4) Venues, dates and number of participants per meeting:
 - 1–3 April 2014, San Sebastian, Spain. 6 participants
 - 14–17 April 2015, Swansea, United Kingdom. 9 participants
 - 12–15 April 2016, Cork, Ireland. 11 participants

WG Evaluation

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

WGMRE sits under SSGEPI within the ICES SCICOM structure. The most relevant science plan objectives and priorities relate to ecosystem pressures and impacts. The objective to understand, quantify and mitigate multiple impacts of human activities on populations and ecosystems is the key priority area for WGMRE. The WG also contributes to the objective to support sustainable management of ecosystem goods and services. The key science plan priority areas are: 11 and 14.

- 6) In bullet form, highlight the main outcomes and achievements of the WG since their last evaluation. Outcomes including publications, advisory products, modelling outputs, methodological developments, etc.
 - Creation of a template for providing ongoing national level updates on the state of development of marine renewable energy sector, covering offshore wind energy, in-stream tidal energy, wave energy and tidal barrages, updated on an ongoing basis, and including 'horizon scanning' to identify future issues for marine environmental management.
 - Collating meta-data on web-based knowledge and information of relevance to understanding the environmental impacts of marine renewable energy, and this has been provided to Tethys website.
 - Working Group contributed to the work of the RiCORE to better understand the policy options associated with development of risk-based decision making frameworks, especially for newer and smaller scale technologies. The RiCORE project is funded by Horizon 2020 and supported by several of the institutions represented in WGMRE. RiCORE deliverables considered the science aspects of risk-based decision making and the recommendations of the project form the basis for further development and application of risk-based decision-support tools capable of an Adaptive Management approach that seeks to reduce scientific uncertainty associated with the interactions of

environmental receptors with marine renewable devices in order to improve decision making over time.

- WGMRE members established and retained an overview of ICES advice on impacts of marine renewable energy, and seek opportunities to ensure co-ordination and consistency across working groups. The focus on topic based issues that can provide impetus for fostering collaborative working across disciplines within the ICES community. The strongest links are with WGMRED and have been maintained during the 3-year cycle by cross-attendance by group members in all 3 years. Aspects of this work are likely to be applicable to other receptor groups (e.g. populations of predator species).
- 7) Has the WG contributed to Advisory needs? If so, please list when, to whom, and what was the essence of the advice.
- WGMRE supported OSPAR to progress a review of the environmental effects of wave and tidal energy. Cefas (Daniel Wood and colleagues) lead on a similar review as part of the EU funded project MaRVEN. The MaRVEN project (which focuses on Environmental Impacts of Noise, Vibrations and Electromagnetic Emissions from Marine Renewables) includes a review of the environmental effects of offshore renewable energy devices.
 - Direct involvement of several of WGMRE members in the RiCORE Horizon 2020 project is providing new opportunities for policy makers to make use of scientific advice in the context of risk-based decision making and assessment of marine renewables.
 - Strong links between the international group called WREN (working to resolve environmental conflicts of wind energy) has been established and is funding is provided by U.S. Department of Energy for Secretariat function of WREN.
 - Strong links with PNNL who host Tethys website which acts as a hub for new evidence of environmental impacts of marine renewable energy. More information on WREN and Tethys here: <http://tethys.pnnl.gov/>
 - The 2015 WGMRE group attended a seminar on the work funded by the UK's National Environmental Research Council's (NERC's) knowledge exchange programme.
<http://www.nerc.ac.uk/innovation/activities/infrastructure/offshore/>
- 8) Please list any specific outreach activities of the WG outside the ICES network (unless listed in question 6). For example, EC projects directly emanating from the WG discussions, representation of the WG in meetings of outside organizations, contributions to other agencies' activities.

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

As a new group, with members that are mostly new to the ICES community the main challenges have been in relation to establishing clear expectations of purpose, levels of ambition and objectives. Particularly in the context of resource constraints. The time taken to “find our feet” means that the group members consider that they have more to contribute in this topic area than has been achieved to date, and that ICES provides a helpful institutional context for taking forward the issues covered by the work plan.

Future plans

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

- Group members request that the term is extended for a further 3 years
- Collation of information associated with marine renewable energy technologies and risk-based approaches to assessing ecosystem impacts has been initiated but would benefit from a further 3 year term. The WG has provided advice that relates to population level consequences of cumulative effects from marine renewables. The impact of cumulative effects from all pressure sources combined, and the impact to ecosystem services are both issues that have been considered in less detail. The WG members consider that the demand from decision makers is not yet at a stage where they see value in more fully integrated assessments. In the first instance the priority remains reducing scientific uncertainty associated with potential effect mechanisms to species of conservation priority (e.g. collision risk, and displacement effects). The rate of transition towards full ecosystem assessments of marine renewable energy is potentially beyond the period of an additional 3 year term, but the WG still consider there is a role to provide advice that enables progress.
- This is a topic area where advances in scientific understanding are progressing rapidly and group members see value in continuing to share information as the evidence base evolves, even where new evidence is limited to population level assessments.
- The utility of risk-based policy approaches to decision making and to reducing scientific uncertainties is not yet fully considered but has been identified as a future priority. In particular, use of Adaptive Management as a tool to resolve conflicts relating to wind and wildlife where scientific uncertainties are a prominent issue is a topic the group wishes to provide further advice upon.
- Methods and approaches for undertaking cumulative impact assessments is another priority area with methodologies evolving in light of new evidence.
- Post-construction monitoring programmes remain *ad-hoc* with little consideration of standardisation or potential for application of meta-

analysis approaches to overcome challenges associated with low statistical power to detect change at single locations. A core issue is that current post-consent monitoring suffers from potentially high levels of Type II error rates (although these are seldom quantified), meaning studies are incapable of detecting those changes that are occurring. A knock-on consequence is that scientific uncertainties are not being reduced in a manner that provides iterative improvements to decision making. Progressing towards a more question driven approach with improved standardisation is considered a priority. The group also wishes to provide advice on approaches to risk-based decision making that more explicitly link tolerance thresholds, Type I & II error rates, statistical power and model structure to experimental design for the purpose of model (in)validation. Of relevance are spatial and temporal scales, and degrees of societal tolerance in relation to populations afforded statutory protection.

- The group believes it has started to collate baseline information would be suitable for publication in a peer reviewed journal, but would need a further term to progress this work.

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

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

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

Nothing specific is requested.

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