ICES WGMS REPORT 2017

SCICOM STEERING GROUP ON ECOSYSTEM PRESSURES AND IMPACTS

ICES CM 2017/SSGEPI:08

REF. SCICOM, ACOM

Report of the Working Group on Marine Sediments in Relation to Pollution (WGMS)

6–10 March 2017

Ancona, Italy

International Council for the Exploration of the Sea

Conseil International pour l'Exploration de la Mer

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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. 2017. Report of the Working Group on Marine Sediments in Relation to Pollution (WGMS), 6–10 March 2017, Ancona, Italy. ICES CM 2017/SSGEPI:08. 54 pp.

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Executive summary

The Working Group on Marine Sediments in Relation to Pollution (WGMS) met on 6–10 March 2017, in Ancona, Italy. The meeting was chaired by Celine Tixier (France) and Craig Robinson (UK) and attended by 8 other members from 6 countries; additional contributions were received from five staff of the host institute (ISMAR CNR) and from two local experts who were invited to contribute to WGMS ToRs.

WGMS had six regular Terms of Reference due for completion in 2017. These require the Group to (1) respond to requests for advice; (2) work to promote the use of passive sampling in sediment contaminant monitoring; (3) report on the applicability of modelling to explain the distribution of sediment-associated contaminants in relation to potential sources; (4) to advise on deep sea sediment monitoring protocols; (5) investigate/review the potential for release of contaminants from marine renewable energy activities; (6) review emerging issues (e.g. microplastics, deep sea mining) as potential risks for environmental contamination by hazardous substances. Additionally, WGMS and Marine Chemistry Working Group (MCWG) jointly received a significant advisory ToR: (7) special request from OSPAR for advice on the selection /deselection of hazardous substances.

Terms of Reference 1 (requests), 3 (modelling), 4 (deep sea sampling protocols) and 6 (emerging issues) were completed during the meeting and are reported on here and in the previous interim reports. Work was jointly undertaken in virtual session with Marina Chemistry Working Group (MCWG) on ToR 5, but this subject is not finalised as the German research project behind it is just commencing. Sufficient work was undertaken to propose resolutions for three ICES publications arising from ToR 2 (passive sampling): one Cooperative Research Report reviewing passive sampling techniques and two TIMES papers, one on passive sampling of hydrophobic contaminants and one on passive sampling of metals. These documents remain on a proposed new ToR, for submission to ICES following a 2019 meeting.

Significant effort was made during the meeting, and subsequently, to address special ToR 7 (OSPAR request) along with experts from MCWG. An interim report on this ToR was submitted to ICES in March (for reporting to OSPAR in March) and a final report in October 2017.

As this was the final meeting of the three-year ToR, a self-evaluation was completed and a resolution proposed for a new three-year ToR, to be taken forward under new co-Chairs.

1 Administrative details

Working Group name

Working Group on Marine Sediments in Relation to Pollution (WGMS)

Year of Appointment within current cycle

2015

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

3

Chair(s)

Celine Tixier, France

Craig Robinson, UK

Meeting dates and venues

6–10 March 2017, Ancona, Italy (8 participants, plus 7 local contributors)

14–18 March 2016, Ostende, Belgium (10 participants, plus 5 local contributors)

2–6 March 2015, Koblenz, Germany (10 participants, plus 2 local contributors)

2 Terms of Reference

1	**Respond to requests for advice from Regional Seas Conventions** (e.g. OSPAR, EU) as required (See ToR 7 below).
2	**Passive sampling (PS) in sediment** 2a - Review of existing methods dealing with PS in sediment 2b - Complete Guidelines for monitoring with PS in sediments for hydrophobic organic contaminants / produce guidelines for PS of metals 2c - Improve the understanding of the relation between data obtained by passive sampling in sediment and environmental quality (biota data, toxicity data, EACs) 2d - Review on on-going or future projects with PS
3	**Explore the suitability / possibility of modelling to explain spatial distribution patterns of contaminants in sediment and inform on sources and hence possible MSFD measures**
4	**Deep sea sediment monitoring** To provide advice on sediment monitoring in the wider oceans as required for MSFD
5	**Impact of renewable energy devices (e.g. wind mill,…)** To explore the potential risk impact in terms of release of contaminants (corrosion, anti-corrosion agents…)
6	**Emerging issues:** To assess the relevance and the potential risk impact of these issues and follow up outcomes of other expert groups working in areas of interest to WGMS 6a - Microplastics in sediment 6b - Deep sea mining

	6c - "new" priority substances to be considered under the MSFD 6d - Emerging contaminants (flame retardants, pharmaceuticals, etc.)
7	**OSPAR request**: WGMS and MCWG are requested to report on the selection and de-selection of hazardous substances of concern to coastal and marine waters in the OSPAR maritime area. Reporting should: 1) Identify and collate information on projects, activities and sources of information for new and emerging substances; as well as 2) Review the information to identify new and emerging substances, identify information gaps and recommend what further work is needed.

3 Summary of Work plan

Year 1	Repond to requests under ToR 1 Complete review of techniques for passive sampling of marine sedments (ToR 2a) Progress work towards completion of the remaining ToRs
Year 2	Repond to requests under ToR 1 Progress work towards completion of the remaining ToRs
Year 3	Repond to requests under ToR 1 Interim report for ToR 7 by 10 March 2017 Report on ToRs 2-6

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

- Advice for ICES to provide to OSPAR on Contaminants of Emerging Concern was produced during 2017. Co-chair attended ICES Advice Drafting Group on HAZardous substances to produce this in November 2017.
- Significant progress was made on documents relating to Passive Sampling that will be finalised for publication in 2019 (resolutions proposed with this report):
    - Draft Cooperative Research Report reviewing **Passive sampling for the monitoring of contaminants in sediments**, edited by members of WGMS. This document presents the background, existing methods and best practices of passive sampling in marine sediments for monitoring purposes (based on the outcome of the SETAC Technical Workshop held November 2012 in Costa Mesa, California, USA and on a recent review produced by WGMS member F. Smedes). The estimated number of pages is 50–60. The authors agree to submit the final draft of the proposed publication by 31 March 2019.
    - Draft TIMES paper on **passive sampling for the determination of hydrophobic organic contaminants in sediments**, written and edited by members of WGMS. This document describes a protocol for the sampling, chemical analysis, and data processing steps required to determine freely dissolved concentrations of hydrophobic organic contaminants in sediment pore waters. It will complement an existing TIMES paper on the

passive sampling of water for hydrophobic organic contaminants (Smedes & Booij, 2012, ICES TIMES number 52), and simultaneously proposed documents reviewing passive sampling approaches to monitoring contaminants in sediments (an ICES CRR) and describing a protocol for passive sampling of metals in sediments (an ICES TIMES). The estimated number of pages is 30. The authors agree to submit the final draft of the proposed publication by 31 March 2019.

  - Draft TIMES paper on **passive sampling for the determination of metals in sediments**, written and edited by members of WGMS. This document describes the sampling, chemical analysis, and data processing steps required to determine freely dissolved concentrations of trace elemental contaminants in sediment pore waters. It will complement an existing TIMES paper on the passive sampling of water for hydrophobic organic contaminants (Smedes & Booij, 2012, ICES TIMES number 52), and simultaneously proposed documents reviewing passive sampling approaches to monitoring contaminants in sediments (ICES CRR) and describing guidelines for passive sampling of hydrophobic organic contaminants in sediments (ICES TIMES). The estimated number of pages is 25. The authors agree to submit the final draft of the proposed publication by 31 March 2019.
- The findings of reviews and discussions amongst Group members and other invited experts on deep sea mining are reported to ICES.
- The findings of reviews and discussions amongst Group members and other invited experts on the applicability of modelling to explain sediment contaminant distribution patterns on (sub-)regional scales are reported to ICES.
- OSPAR Guidelines on sediment monitoring were reviewed as to their applicability to the deep sea and minor changes recommended.

5 Final report on ToRs, workplan and Science Implementation Plan

5.1 ToR 2: Passive sampling

5.1.1 ToR 2a

2a - Review of existing methods dealing with PS in sediment	Follow-up on the work of ICES WKPSPD	Year 3	Recommendation based on current status

A review of existing passive sampling methods (PSDs) to measure metals and organotins in sediments has been carried out. Limitations and advantages of the methods for passive sampling for metals in sediments are highlighted in the draft review. The PS approach can provide excellent information on the bioavailability and potential toxicity of metals in sediments. However, the development of usage guidelines, appropriate assessment criteria and proficiency testing schemes are also required before the approach can be used for monitoring and assessments such as are required by the Regional Seas Conventions or European Directives (i.e. WFD and MSFD).

WGMS were presented with a Dutch document (Smedes, 2014) on passive sampling of hydrophobic organic contaminants (HOCs) in sediments that was offered for use by the group in developing its review on passive sampling of hydrophobic organic contaminants, once the work had been more widely published in the scientific literature. WGMS updated the current draft of its review of passive sampling techniques for HOCs.

Due to the OSPAR special request, limited time was available for the group to work in sub-groups to finalise the drafts. It is anticipated intercessional work will be carried out during the year in order to produce two complete drafts, one on metals and one on organics, to be merged into a single document during the next meeting. A resolution is proposed for these reviews to be published as an ICES Cooperative Research Report in 2019.

Reference

Smedes, F. 2014. *Monitoring Environmental Quality of Marine Sediment. A Quest for the Best.* Deltares report 1209377-004-ZKS-0001; Deltares, Utrecht, The Netherlands. 57pp.

5.1.2 ToR 2b

2b - Complete Guidelines for monitoring with PS in sediments for hydrophobic organic contaminants / produce guidelines for PS of metals	Guidelines required for technique to be acceptable for monitoring purposes.	3 years	Working with MCWG experts, produce TIMES paper(s) on the use of PS in sediments

Following the near-completion of the review on passive sampling of metals in sediment undertaken as part of ToR 2a, experts have made good progress with the development of a guideline document.

WGMS worked on the development on a guideline paper on passive sampling of hydrophobic organic contaminants (HOCs) in sediments, to complement the existing TIMES paper on passive sampling of HOCs in water (ICES TIMES no. 52). This document is based on a previous draft of a guideline document on passive sampling of sediments using silicone rubber prepared in 2007 by WGMS.

Due to the OSPAR special request, limited time was available for the group to work in sub-groups to finalise the drafts. It is anticipated intercessional work will be carried out during the year in order to produce two complete guidelines, one on metals and one on organics during the next meeting.

A resolution is proposed for the publication of an ICES TIMES paper following the 2019 meeting.

5.1.3 ToR 2c

2c - Improve the understanding of the relation between data obtained by passive sampling in sediment and environmental quality (biota data, toxicity data, EACs)	Assessment criteria suitable to assess GES in sediments are lacking / require improvement. WGMS will work with WGBEC to attempt to close this knowledge gap.	3 years	Dataset and advice to OSPAR on progress as passive sampling, which ICES WKPSPD have recommended the approach go on the pre-CEMP.

In order to progress towards generating a dataset suitable for use in deriving assessment criteria, a database of papers had been established on the web-based citation manager http://www.mendeley.com/. Some papers suitable for use in establishing Environmental

Assessment Criteria have been being added to this. However, time constraints mean that the task has not progressed further.

Several members of WGMS were involved in developing a successful bid to the INTERREG Atlantic Area Partnership; the project (MONITOOL) includes the aim of developing EQSs suitable for assessing data derived from passive sampling of metals. The project will start in autumn 2017.

5.1.4 ToR 2d

2d - Review on-going or future projects with Passive sampling	Each year	Report to ICES

This ToR was extensively addressed in the 2015 and 2016 Working Group reports; no further reports were received in 2017.

5.2 ToR 3: Modelling

Explore the suitability / possibility of modelling to explain spatial distribution patterns of contaminants in sediment and inform on sources and hence possible MSFD measures	3 years	Report to OSPAR via ACOM

Significant work was reported on this ToR in both the 2015 and 2016 interim WGMS reports. These included details of multivariate statistical approaches to interpreting the distribution of conservative tracer elements and thus concurrent anthropogenic contaminants (Spagnoli *et al.*, 2014), the use of stable lead isotopes as tracers of pollution (Mil Homens *et al.*, 2013) and hydrodynamic modelling of particle transport (Baetens, 2016; Fricke and Weilbeer, 2012; Heyer & Schottke, 2013; Seiffert *et al.*, 2014).

At present, according to the WGMS meeting participant knowledge, the suitability and possibility to explain spatial distribution patterns of contaminants in sediment are quite robust, while the determination of the sources deduced by modelling, even if is still under development, provides promising potential. The participants at 2015-2017 WGMS meetings gave some inputs. Federico Spagnoli described how conservative tracers such as aluminium and rare earth elements could be used in multivariate statistical modelling (Davis, 1986) to explain the sea bottom distribution of contaminants resulting from punctual sources (Spagnoli *et al.*, 2014). In particular the method been successfully applied in the Adriatic Sea bottom sediments and revealed a main contaminant source in the River Po mouths. An exhaustive introduction of this method, with a discussion of the general principles and a contextual history of the approach, is provided by Pisias *et al.* (2013). These authors, in the same paper, provide also the sources to download the scripts for the application of the statistical method and the guidelines for their use. This statistical approach (Q-mode factor analysis) allows the determination of contamination sources but requires a lot of real sample data and a good knowledge of the marine processes acting in the area to produce good results. Taking a different approach, Mário Mil-Homens showed how the use of stable lead isotopes and ratios of Pb/Al concentrations inform on the extent of anthropogenic Pb input from the River Tagus to the deeper areas of the Portuguese Atlantic Margin (Mil-Homens *et al.*, 2013). In a recent study, Mil-Homens *et al.* (in press) used the stable Pb isotopes to identify the sources of Pb enrichments in a 5 m sediment core off the southern Iberian shelf. The dominant source of Pb are the Iberian

Pyrite Belt deposits located in terminal part of the River Guadiana (Iberian Peninsula) that were exploited in two periods of mining activities: the old associated with the Roman period and the second more intense and recent related to the intense mining activity happened since the 1850s until the 1960s. The multivariate statistical and chemical approaches described above present some limitations because they are subject to a certain degree of interpretation based on the scientific knowledge of the environmental settings (e.g. hydrodynamics, known sources, sedimentary processes, etc.). Birgit Schubert and Nicole Brennholt reported on the use of hydrodynamic and morphodynamic modelling to produce sediment transport models of the German Bight and German North Sea estuaries (BAW 2013; Heyer and Schott, 2013), including the Elbe (Seiffert *et al.*, 2014; Fricke, 2012). Back-modelling to source has provided support to a theory that pathogenic bacteria observed in the German Bight in 2010 originated from an outbreak in the Ems estuary. These studies suggest that modelling may be able to inform on sources of marine contaminants, and thus inform on measures under the MSFD and WFD. Katrijn Baetens (RINBS, OD-Nature, Belgium) presented a new ecological shelf seas model; it integrated an existing open source hydrodynamic module (COHERENS), a sediment transport module (Lagrangian particle model), a pollutant physical-chemical behaviour module and a biological (plankton) module. She considered that it might be possible for this to be developed and applied to identify the source of the sediment contamination by back-modelling analysis. Katrijn noted that in some circumstances backtracking of atmospheric tracers had been achieved to a point source using Eulerian models (Hourdin and Talagrand, 2006), but the situation was more complex in the marine environment, particularly if attempting to back-track non-conservative contaminants with multiple point sources or diffuse inputs. At the 2017 WGMS meeting Christian Ferrarin (ISMAR-CNR of Venice, Italy) presented a modelling framework (SHYFEM) based on unstructured method able to describe water and sediment dynamics in morphological complex coastal systems (north Adriatic lagoons). In the opinion of C. Ferrarin such numerical tool could be also used to track and back-track pollutants in the marine system with the aim of identify the area of influence of each source and also to identify the origin of pollutants present in the sea bottom.

The 2015–2017 WGMS meeting members and participants considered that back-tracking is possible in determined conditions. In particular, major limitations are imposed by the site specific characteristic time window of the transport which needs to be known in advance. Under these constraints this methodology can be used also in case of multiple sources.

In any case, high quantity and quality of multi-parameter (chemical, hydrographical, morphological and sedimentological) datasets are needed for setting initial boundary conditions, forcing conditions and for validating every model to reach satisfactory results.

References

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5.3 ToR 4: Deep Sea Monitoring

To provide advice on sediment monitoring in the wider oceans as required for MSFD	Monitoring of the deep sea is required for the MSFD. Technically this is more difficult than for shallow seas and advice should be developed	3 years	Advice to OSPAR via ACOM on deep sea sediment monitoring

The 2015–2017 WGMS meeting members point out that sampling procedures/techniques in the deep sea are similar to those developed for shallow marine sediments that are well described in the OSPAR JAMP Guidelines for Monitoring Contaminants in Sediments, originally developed by OSPAR Working Groups on Monitoring and on Trends and Effects of Substances in the Marine Environment (MIME) and currently available on the OSPAR Hazardous Substances and Eutrophication Committee (HASEC) website (http://www.ospar.org/work-areas/hasec). However, major differences exist between the deep sea and shallower marine environments and that needs to be pointed out. These differences are related to the relatively low sediment accumulation rates, absence of direct pollution sources (excepting in the cases of aggregates, mining and oil / gas extractions) and the dominance of diffusive contamination sources (e.g., atmosphere, oceanographic transport) in the deep sea areas. Other differences are the technical conditions of sample recoveries in the deep sea that are critical and have specific requirements (e.g., pressure resistant equipment, larger vessels, corers, winches and cables), and also the time necessary for collecting each sediment sample in deep waters. Therefore, the financial costs associated with each sample collection increases significantly in deep seas, even where these are relatively near-shore. Different indications regards the limit between the shallow and deep sea environments in case of the mining activity: following the most diffused opinions and the suggestions of Marzia Rovere (member of the Legal and Technical Commission of the International Seabed Authority (2015/2016) and that attended the WGMS 2017 meeting) this limit should be put between 100 and 200 m depth. For minimizing the costs of a bottom sea sampling strategy, in deep sea environments, a good knowledge of bottom morphology and sedimentological processes occurring in the survey area is needed. Additionally, it will be recommended to use a risk-based monitoring strategy based on the identification of the targets (issues) to be studied before, during and after the operation. Based on this, it will be possible to choose each station as representative of the widest area. In this way, the description of the sea-bottom can be carried out with the minimum number of samples. In order to optimize the sampling strategy in deep sea environments it is then recommended to:

- Compile an accurate bibliographic information regarding the area, concerning: bottom sediment features and hydrodynamic knowledge, other available geochemical/sedimentological data;
- Characterize the morphology and sedimentology of the bottom sea through the use of geophysical surveys (e.g., side-scan sonar, multi-beam and seismic surveys).

Furthermore, the areal and depth sampling frequency need to be decided on the basis of knowledge of sedimentation rates, mixing rates and the aims of the monitoring program. Given the cost of obtaining deep sea samples, considerations should be given to archiving and storage of samples for future use (e.g. analyses of emerging contaminants, determination of baselines).

The existing OSPAR guidelines on monitoring contaminants in sediments were considered by WGMS 2015–2017 member meetings to be adequate for deep sea monitoring. In addition the WGMS members present at the 2015–2017 meeting added other topics to assure both a good control on the sampled area and also the collection of the water-sediment interface. Due to the small accumulation rates of the deep sea area, this interface (e.g., first 0.5 cm) is integrating the signal of last decades. Thus, the WGMS members present at the meetings recommend the:

- use of a digital system (video or camera) coupled to the sampling device (BOX or MULTI-CORER) to recover the image of the sea-bottom where the sediment samples are collected;
- preferential use of multi-corer system in order to assure the collection of enough undisturbed surface samples and also a better preservation of the sediment-water interface respect to the box-corer. The subsampled uppermost surface layer (representing the most recent sediments) should be as thin as possible. It is also important to assure the verticality of the liner during the handling and the sub-sampling of the core and that the core is extruded by a piston from the bottom. Furthermore, because of the high costs of the deep sea sampling, the multi-corer is preferable because it allows getting enough material that can be preserved and used for complementary and future studies. Moreover, the use of a multi-corer allows determination of the contaminant heterogeneity of the surface sediment through the sub-sampling of several cores.
- In case of need of knowledge deeper in the sediment, the use of a gravity corer or piston corer coupled with multi-corer should be adopted so that both sediment-water interface and in depth sediment knowledge can be obtained.

In addition, an error pertaining to sediment preparation and storage was identified in the existing JAMP Guidelines for Monitoring Contaminants in Sediments. Section 5.3 of the guidelines, describing drying, states that samples for mercury analysis should not be freeze dried, but can be oven dried at < 105° C. This is incorrect, samples for Hg can be freeze dried and should not be oven dried above 60° C (Loring and Rantala, 1992).

Recommendation: WGMS recommends that for the existing JAMP Guidelines for Monitoring Contaminants in Sediments to be used for deep sea monitoring (as may be needed for the MSFD) they require modifications to include details of geophysical surveys, multi-corer sampling, digital imaging, and that an error in Section 5.3 should be corrected.

Reference

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In relation to ToR 4 (deep sea monitorig) and to ToR 6 (emerging issues), Prof Roberto Danovaro (Stazione Zoologica Anton Dohrn, Naples, and Polytechnic University of Marche, Ancona, Italy) gave a presentation to WGMS and staff of the host institute on the role of the MSFD with respect to the deep sea. He addressed each of the 11 qualitative descriptors in turn, highlighting areas where the MSFD applied and where research / monitoring of the deep sea is required for the MSFD. He noted that point 22 of the introductory text of the MSFD highlighted that there is need to take account of the high biodiversity and the potential for research in the deep sea, which accounts for 65% of the world's surface and 95% of the biosphere, but that relatively little work for the MSFD has been undertaken in the deep sea so far. Under D1 and D4 he noted that it is essential to identify keystone species and that deep sea species tend to be slow growing and long lived, meaning they are susceptible to human impacts and this is leading to a reduciton in deep sea biodiversity. Under D3, Prof Danovaro noted that trawling depths are increasing and that increasing fishing pressure/behaviour results in a spread of Anisakidae parasites and introduction of non-native species (D2); climate change also contributes to species invasions as some may move into deeper waters to avoid surface warming. Eutrophication (D5) may not be thought of as a problem for the deep sea, but these areas are often oligotrophic and eutrophication in overlying waters can result in high organic loads to the deep sea below, resulting in oxygen depletion. Trawling reduces the heterogeneity of the seabed (D6), resulting in reduced biodiversity and changes to ecosystem services and to fluxes between sediments and the overlying water. There are episodic deep sea events (e.g. deep shelf water cascades, turbidity currents) that transport sediment (and contaminants) into the deep sea at very much greater rates than usual, examples occur in the canyons off the Portuguese coast (D7). In addition to biological and sedimentary fluxes into the deep sea, there are many shipwrecks that contain toxic cargos, and deliberately dumped wastes (e.g. munitions) that are corroding and that will release contaminants (D8 & D9). Deep sea fish often contain very high concentrations of persistent organic pollutants as they are high trophic level and long lived. There is also evidence of high concentrations in gonads, indicating maternal transfer to the next generations. A recent G7 science Ministers' meeting highlighted that marine litter (especially microplastics) is a priority and it is known that marine snow carries microplastics (especially fibres) in to the deeper sea (D10). Prof Danovaro also highlighted the increasing role of autonomous and remotely operated vehicles in monitoring and researching deep sea areas that are difficult to access via traditional methods. Finally, Prof. Danovaro introduced a new project (**IDEM** - Implementation of the MSFD to the Deep Mediterranean Sea; starting in 2017) that aims to produce a coherent, coordinated and consistent initial environmental assessment for the Mediterranean deep Sea and to develop outputs of direct use to Member States in implementing the MSFD in these areas.

5.4 ToR 5: Impacts of marine renewable energy devices

To explore the potential risk impact in terms of release of contaminants (corrosion, anti-corrosion agents…)	Many hundreds of renewable energy devices are being placed in the marine environment. Resultant changes in hydrodynamics may release sediment-bound contaminants, there may be inputs of contaminants from their installation, operation and decommissioning.	3 years	Report to ICES (with recommendations, as appropriate)

This ToR was requested by a member who has not been able to attend WGMS meetings during this 3 year period; however, one of his colleagues has now joined the group and co-authored two presentations that were presented during a joint virtual session with ICES Marine Chemistry Working Group, held via video conference during this meeting. The following abstract was provided.

Emissions from corrosion protection systems of offshore wind farms

Torben Kirchgeorg, Ingo Weinberg, Berit Brockmeyer

The marine environment is a highly corrosive environment for steel constructions such as offshore wind turbines. Corrosion affects all parts of offshore wind turbines, especially in the submerged and in the tidal- and wave effect zones. These zones are protected with different systems against corrosion processes, often the combination of different techniques. Amongst those are (organic) coatings (e.g. epoxy resins), thicker steel to compensate the loss through corrosion, and galvanic anode cathodic protection systems (GACP, the so called "sacrificial anodes") or impressed current cationic protection systems (ICCP) for the submerged zones of foundations. All techniques have different potentials of chemical emissions, e.g. sacrificial anodes emitting high amounts of aluminium, zinc and other metals during their consumption, or the leaching of organic substances from organic coatings. Here a short overview about the emissions of corrosion protection systems was given and the potential impact to the marine environment was discussed

5.5 ToR 6: Emerging Issues

To assess the relevance and the potential risk impact of emerging issues Follow up of outcomes of other expert groups		3 years	Report to ICES
6a) Microplastics in sediment	Microplastics are of emerging concern and may be a vector for contaminant transfer to sediments, or from sediments to biota		Develop link-ups to relevent expert groups on marine litter
6b) Deep sea mining	Mineral mining is a likely future source of anthropogenic disturbance to the deep sea and could result in the release of contaminants into otherwise relatively pristine environments		Link-up with WGEXT who have a ToR to report to produce a summary paper concerning deep sea mining (What is being mined, where this is occurring, techniques being developed etc).
6c) Other emerging issues			

5.5.1 ToR 6a: Microplastics

A presentation on microplastics was received from NO and IT, with the following abstract. A second presentation was received from SP concerning both microplastics and substances of emerging concern; the abstract for the latter appears under ToR 6c.

Microplastics in marine sediments: Occurrence, characterization, distribution and environmental management

Alessio Gomiero (IRIS, NO and CNR-ISMAR, IT), Guido Bruno (CNR-ISMAR, IT)

Due to the useful properties of polymers that have led to numerous technological and societal advances, the production of plastic items has significantly increased in the last decades achieving a pivotal status in our modern society. However, limited and inappropriate waste management practices of plastics and irresponsible human behaviour have incremented the load of plastic items i.e., bottles, plastic bags, sacks, and wraps in the environment. Although most of the plastic litter is persistent and do not biodegrade easily, under the influence of solar UV radiations wave and air friction, do degrade and fragment into small particles. Plastic litter fragmented to size < 5mm in diameter is classified as secondary microplastics may eventually spread in all the environments. In contrast, primary microplastics are purposefully manufactured polymers to be of microscopic size for industrial (paintings, anti-foam additives, etc.,) and heath care products (scrubbers and toothpaste). Our oceans ultimately serve as a sink for these small plastic particles and in one estimate, it is thought that 200 000 microplastics per km2 of the ocean's surface commonly exist. Research examining the occurrence of microplastics in the marine environment has substantially increased. Field and laboratory work regularly provide new evidence on plastic debris occurrence and distribution. This debris has been observed in every marine habitat. MPs are commonly studied in relation to plankton samples, sandy and muddy sediments, vertebrate and invertebrate ingestion, and chemical pollutant interactions. More recently, it was reported that MPs have reached the most remote of marine environments: the deep sea. Plastic particles sized in the micrometre range were found in deep-sea sediments collected at various locations representing different deep-sea habitats. Microplastics include different debris that may vary in terms of colour, size, shape, composition, specific density, chemical composition and other characteristics. Over the last years scientific community has focused the attention on the development of sampling and analyzing operative procedures as well as to understand the environmental fate and the possible negative effects on biota. To date, different methods have been suggested to estimate the abundance, distribution and composition of microplastic in the marine environment. Nevertheless, the lack of standard operation protocols for microplastics sampling and detection in different environmental compartments results in the generation of data of extremely different quality and resolution hampering the development of an effective environmental risks assessment. Some large research initiatives have been granted at EU level to implement a common framework to assess the occurrence, distribution and biological effects of microplastics in the aquatic ecosystem named JPI-Baseman, JPI-Plastox, JPI-Ephemare.

For a future perspective, standardized sampling procedures which permit a spatiotemporal comparison of microplastic abundance across marine environment are prioritized. Furthermore, there is the need of novel monitoring approaches to support legislators and environmental planners to an effective ecosystem management action. These require a multi-tiered approach which integrates the best available technology with effective cost- and time-saving procedures.

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Van Cauwenberghe, L., Devriese, L., Galgani F., Robbens, J., Janssen C.R. 2015. Microplastics in sediments: A review of techniques, occurrence and effects. *Marine Environmental Research*, **111,** 5-17.

Vianello, A., Boldrin, A., Guerriero, P., Moschino, V., Rella, R., Sturaro, A., Da Ros, L. 2013. Microplastic particles in sediments of Lagoon of Venice, Italy: First observations on occurrence, spatial patterns and identification. *Estuarine, Coastal and Shelf Science*, **130,** 54-61.

Two recent reviews on microplastics in the marine environment were brought to the 2016 WGMS meeting:

- Van Cauwenberghe, L., Devriese, L., Galgani F., Robbens, J., Janssen C.R. 2015. Microplastics in sediments: A review of techniques, occurrence and effects. *Marine Environmental Research*, **111,** 5-17.
- a book on "Marine Anthropogenic Litter" (2015; Eds. Bergmann M., Gutow L., Klages M.; available under open access from Springer (https://doi.org/10.1007/978-3-319-16510-3) and divided in five sections: A historical synopsis of marine litter research, abiotic aspects of litter pollution, biological and ecological implications of marine litter and microplastics.

However, due to the time dedicated to ToR2 and ToR 6b, WGMS could not consider these for deeper review. IPMA (Portugal) is one of the research institutions involved in two research projects focused on the topic of microplastics (MP):

- BASEMAN (JPI_Ocean) is an interdisciplinary and international collaborative research project that aims to overcome the problem of the establishment of standard operation protocols for microplastics sampling, extraction, purification and identification.
- PLASTICGLOBAL project (European Structural Funds) aims at assessing the MP-mediated chemicals transfer in marine food webs and its effects on the biota under climate change scenarios.

Three other research projects investigating the impact of plastic particles on the marine environment have been recently selected for funding from ten member countries of the JPI Oceans:

- EPHEMARE - Ecotoxicological effects of microplastics in marine ecosystems
- PLASTOX - Direct and indirect ecotoxicological impacts of microplastics on marine organisms
- WEATHER-MIC - How microplastic weathering changes its transport, fate and toxicity in the marine environment

5.5.2 ToR 6b: Deep sea mining

In 2016 WGMS meeting Brigitte Lauwaert (OD-Nature, Belgium) of the ICES Working Group on the Effects of Extraction of Marine Sediments on the Marine Ecosystem (WGEXT) was invited to the session on deep sea mining. In this session the participants exchanged information between WGMS and WGEXT on progress and scope of each other's ToR, and received a presentation on a major Deep Sea Mining project (JPI-Oceans) from Lieven Naudits (OD-Nature). The WGEXT ToR concentrates on physical impacts of deep sea mining (DSM), whereas WGMS interest is contaminants. Brigitte Lauwaert suggested that WGMS could contribute to a joint position paper that covers both aspects.

The scarcity of mineral resources on land deposits, together with the continuous and growing demand for metals and rare earth elements, motivates a future exploitation of these resources in deep sea areas. Certain target areas, such as hydrothermal vent fields, cobalt-rich crusts and poly-metallic deposits are good examples of possible exploitation sites. Mining activities threaten to disturb wide areas of deep-sea environments that until now have been maintained untouched by human activities and where resilience time is very low. The exploitation of these resources can affect extensive areas of the deep seafloor (including areas far away from the exploitation sites) and the overlying water column (e.g. by releasing primary and secondary plumes of material).

The environmental costs of the exploitation of the deep sea environment and the ecosystem services can be extremely high so that an urgent identification and assessment of the potential impacts of these activities is needed.

Before commencing resource exploitation it is necessary to proceed to a correct evaluation of the potential mineral resources and also to develop environmental characterization of these sensitive environments in order to avoid the risk of irreversible deep-sea environment destruction. Therefore, the absence of scientific knowledge of these sensitive environments would imply the development of more extensive scientific research studies (e.g., species identification, ecology of the benthic communities, distribution of species, genetics, life histories, settlement patterns, resilience to disturbance, and continuous time series of observations (for instance during a period of 10 years) to understand the population dynamics of proposed mining sites overtime). Also, the technology to be used at the deep-sea areas needs to have significant advancements both to minimize the environmental impacts and to optimize the resources' exploitation.

At the 2017 meeting Marzia Rovere (member of the Legal and Technical Commission of the International Seabed Authority (2015/2016) gave a presentation about the present state of the art of the deep sea mining as regard the main elements, minerals, and bottom sea areas that can be under the attention of private and public institutions for the exploitations, both within and beyond national jurisdiction. M. Rovere, in particular, focused on the current global economic situation that makes the deep sea mining, in areas beyond national jurisdiction at ultra-deep water depths (4-6000 m), difficult to pursue, because of slowing demand of metals (notably from China), ongoing supply increases, renewed dollar strength, and still-high stocks of a number of metals from land supply. In reason of the economic conjuncture, evolving since 2007 and concerning the prices of metals, deep sea mining will be more likely carried out within national jurisdiction, in areas belonging to the continental shelf and upper slope, at water depths 10-1000 m, while the exploitation of mineral deposits of the seabed beyond national jurisdiction, in ultra-deep waters, will remain very unlikely during the next decade.

The European Commission and other countries funded research projects dealing with the deep sea mining, such as MIDAS (http://eu-midas.net/), BLUEMINING (www.bluemining.eu), JPI-Oceans (www.jpi-oceans.eu) and its research project 'MiningImpact', TREASURE (Towards Responsible ExtrAction of SUbmarine mineral Resources, a Dutch funded project) and more recently BLUE NODULES ((www.blue-nodules.eu/). BLUEMINING and BLUE NODULES projects are mainly concentrating on the technological challenges of mineral exploitation in extreme conditions, such as those existing in deep-sea environments, other than aiming to study biogeochemical processes and environmental impacts of mineral extraction from deep sea environments, the latter, instead, are the main aims of the other projects (MIDAS, MiningImpact and TREASURE.

On request of the French Ministry of Ecology and of the Scientific Council on Natural Heritage and Biodiversity (CSPNB), the environmental risks of deep sea mining were investigated in an Expertise report (Dyment *et al.*, 2014.). This report, elaborated by French expert researchers, presents the available knowledge on marine mineral resources, their exploration, and possible exploitation techniques to provide a consistent approach of their impacts. The report also identifies a set of knowledge gaps and how these can be addressed, stressing the importance of acquiring fundamental scientific knowledge that requires great investment in human (researchers) and technical resources as well as long-term financing.

Inside the ICES, the expert group with interest in deep sea mining is the ICES/NAFO Joint Working Group on Deep-water Ecology (WGDEC). WGDEC identified the different types of deep sea mining as outlined above and identified a number of potential impacts, including removal of substrate / loss of habitat, introduction of energy (noise, light), introduction of non-native species, smothering by sediment plumes, nutrient (Fe) enrichment altering plankton communities, and toxicity from introduced contaminants released incidentally (e.g. oil spills, sewage, flocculants) or as by-products of mining activities (e.g. release of toxic metals & radionuclides). The location of all exploration areas is available at the International Seabed Authority (ISA; www.isa.org.jm).

Another ICES Working Group on Effects of Extraction of Marine Sediments on the Marine Ecosystem (WGEXT) has a ToR to study the implications of deep sea mining (legislative/environmental/geological). In their 2014 report, WGEXT summarized the main types of potential mining interests and indicated that commercial development of these resources is not likely in the near to medium term. WGEXT also identified that the ocean floor in **Areas Beyond National Juridiction** (ABNJ) are regulated by the International Seabed Authority (ISA; www.isa.org.jm) which has regulations for prospecting and exploration, whilst its code for exploitation of deep sea mineral resources is under development. About that, the ISA, on the 2015 draft regulation, recommends the implementation and approval of a reliable environmental plan of work for exploration before starting the exploitation. This plan includes, among others, the Impact Statement (EIS), the Environmental Management Plan (EMP) and Social Impact Assessment (SIA). According to ISA, all these documents should be made in accordance with Good Mining Practices and verified by independent environmental consulting firms.

The main requirements of EIS among others are the:

1) existence of an Environmental Impact Assessment (EIA) where are established the baseline of environmental conditions;

2) assessment of project related significant effects and impacts (including cumulative impacts).

The EMP main requirements are:

1) the description of the methodologies to be employed on sampling and archiving, the location of monitoring stations, the measurable criteria and threshold indicators;

2) reflecting the parameters for and functionality of Preservation Reference Zones (PRZs) and Impact Reference Zones (IRZs);

3) defining the measures /plans for monitoring, management, conservation, remediation, restoration /rehabilitation and control including those to avoid, minimize, mitigate, rehabilitate and offset, where appropriate, impacts on biological diversity within the impacted area and plans to prevent, minimize, mitigate impacts to water column.

4) to be supported by an approved environmental management system, subject to inspection regime and frequent independent audit.

Despite the remoteness of the majority of exploitation activities locations, no immediate communities or individuals potentially significantly affected by operations, the SIA consider important contributions of other users (public or private organizations) of the marine environment.

As regarded above, the participants at the WGMS 20016 meeting highlighted that each exploitation project should carry out all activities following the good mining industry practices correctly adapted to the marine environment to reduce and control the pollution as well as other hazards, in particular the protection and the conservation of the marine fauna and flora should be assured.

Lieven Naudts (RBINS-OD Nature, Belgium) was invited by WGMS to present the preliminary results of the JPI-Oceans project "*Ecological aspects of deep-sea mining*" (Coord: M. Haeckel, GEOMAR, Helmholtz Centre for Ocean Research, Kiel, Germany; https://jpio-miningimpact.geomar.de/home). The main goal of this four year multi-parametric project is to assess the impact of potential commercial mining activities on deep-sea ecosystems in two areas of the Pacific (the DISCOL Experimental Area, SE Pacific, and the Clarion-Clipperton Zone, NE Pacific). This project involved six work packages responsible for generating great amount of data that are still in processing:

- WP1 Hydroacoustic and visual habitat mapping
- WP2 Benthic diversity and recolonization potential
- WP3 Biogeochemistry and ecosystem functioning of nodule fields
- WP4 Sediment plume dilution and dispersion
- WP5 Communication with stakeholders, policy makers, offshore mining industry
- WP6 Data and sample management

Preliminary results were presented for the various WPs. The 37-years-old mining track is still visible and the nematode community inhabiting this track presents lower density and diversity than the reference site. WP3 focuses on biogeochemical and geochemical conditions and processes in sediments including solute and contaminant fluxes. Modified oxygen fluxes were observed where disturbance removed the surface sediment layer. Trophic interactions, energy flows and bioaccumulation of metals in the benthic food web are also considered in this WP. Ecotoxicological experiments were carried out *in situ* to assess the bioaccumulation of Cu^{2+} by megafauna exposed to an artificial sediment plume as well as various biochemical responses. Concerning WP4, this WP aims at collecting all information on sediment plume dilution and dispersion required for the implementation of adapted deep-sea 3D coupled ocean circulation sediment transport models. For this, artificial plumes were created. Plumes could be successfully observed by both acoustic and optical methods; however further work is required for quantifying the process.

During the discussion other questions were raised regarding the deep-sea mining activity that are:

1) what is happening for the concessions located in the national waters? Some doubts could be related to the development of correct EIA and to who should evaluate them;
2) If the national legislation actually covers the environmental requirements for attributing the exploration licenses and who as well as how is controlling the application of this requirement;
3) If the mandatory deliverables (e.g. EIA, EIS) are also accounting the requirements of a cost-benefit analysis (CBA), i.e. the estimation between the net benefits of the mining activities against its net impacts. Furthermore, it is necessary to evaluate the baseline situation allowing the estimation of benefits and impacts;
4) If it is correct to compare terrestrial mining with marine mining because marine and terrestrial environments are distinct ecosystems. In fact, the potential impacts on land are well known contrary to the deep-sea environment;
5) The evaluation of EIS and EMP must be assured by international board composed by researchers / managers under the auspices of ISA or other independent and non-profit international authorities with recognized knowledge in these topics.

Following on from what was written before, some indication can be given associated with the disturbances in the deep sea caused by mining activities. The main factors affecting the surface sediments and the pathways of contaminants during deep sea mining can be attributed to resuspension of sediment particulate matter (SPM) during the operation of the mining vehicles on the seafloor as well as the SPM which are released during loading of the slurry into the riser, these together cause the primary plume close to the seafloor. A secondary plume is caused after separation of the nodules and dewatering of the slurry on board the mining vessel, when large amounts of sediments are pumped back into the sea through long vertical pipes. This SPM plume is located higher up in the water column and can spread out long distances in any direction depending on the prevailing current conditions.

The sediment surface in the nodule fields is in many cases oxic from the surface down to few centimetres only (Stummeyer and Marchig, 2001) below which it is suboxic. Nodule mining will dig into the suboxic layer which will release such sediment that will be immediately oxidized in the water column, partly releasing elements into the water phase. The sediments of the nodule fields are known to contain high concentrations of heavy metals (Stummeyer and Marchig, 2001) which will thus be released and transported by currents into large areas around the mining area, where they will accumulate. Another question is the physical blanketing of the seafloor by the SPM from the plumes. The results of the Midas project (finishing in the end of 2016) together with the results obtained for other projects, such as JPI-Oceans and TREASURE, will contribute to improve the knowledge of this remote and sensitive deep-sea environment towards to ensure their Good Environmental Status. They could also provide the background, to optimize the strategy for correctly implementing the EIA/EIS/EMP/SIA and also the planning of activities in the deep-sea marine environment. Based on the main findings and conclusions of these (and other) projects, it will be possible to complement the recommendations/warnings of this ToR to the stakeholders, policymakers (ISA, national governments, EC), industrial companies and scientists.

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5.5.3 ToR 6c: Other emerging issues (e.g. "new" priority substances, pharmaceuticals, novel flame retardants, etc.)

The WFD list of Priority Substances was recently expanded with the publication of the revised Environmental Quality Standards Directive (2013/39/EU). These substances have to be assessed under the new round of River Basin Management Plans and the Marine Strategy Framework Directive is relying on the WFD to provide much of its information on contaminants under Descriptor 8 (because the WFD requires Good Chemical Status in territorial waters, i.e. to 12 nm offshore). However, marine monitoring of the "new" substances appears to be very limited in most States for which information were available at the meeting (Table 1). Belgian members present considered that it was likely Belgium would monitor all substances ("if we have to do it, then we will do it"), but could provide no information regarding sampling matrix, distance, or frequency. Germany, Portugal, Spain, France and the UK have included some of the additional substances, particularly those (such as DDT) that were previously required under the Shellfish Waters Directive (2006/113/EC) or Dangerous Substances Directive (2006/11/EC); both Directives were repealed in 2013. For the UK, most "new" substances are being monitored in a very limited number of locations and the programme will be reviewed based upon the occurrence and concentrations determined in 2016. No other information was available from the remaining member states. It is notable that there will be considerable variation of spatial and temporal coverage between Member States, and that no country will monitor for aclonifen, bifenox and cybutryne in marine environments.

Table 1. Marine monitoring plans for the Priority Substances newly listed under 2013/39/EU. Information was only available for France, Germany, Portugal, Spain, UK; if the country is not listed then it is not monitoring that substance. * E = estuarine; C = coastal (<1 nm); T = territorial (1-12 nm); O = offshore (>12 nm)

	New Substance	Member State	Matrix	Sampling distance*	Sampling frequency	
6a	Carbon tetrachloride	UK	Water	E	Not provided	1 site
		FR	Mussels, Sediment	E, C	Once / 6 years	
9a	Cyclodiene pesticides: Aldrin, Dieldrin, Endrin, Isodrin	UK	Water Mussels Sediment *(Dieldrin only)*	E, C E, C O	Monthly Annually Annually	
		DE	Water	O	Annual	
		SP	Water Sediment *(not endrin)*	E, C, T E, C, T	Monthly or annually Annually	
		FR	Mussels, Sediment	E, C	Once / 6 years	
9b	DDT (total); *p,p'*-DDT	UK	Water Mussels Sediment	E, C E, C O	Monthly Annually Annually	
		DE	Sediment *(p,p'-DDT)* Water	O	Annually	
		PT	Sediment, Water, Fish muscle and mussels	E, C, T, O	Not provided	
		SP	Water Sediment	E, C, T E, C, T	Monthly or annually Annual	
		FR	Mussels, Sediment	E, C	Once / 6 years	
29a	Tetrachloroethylene	UK	Water	E	Not provided	1 site
		FR	Mussels, Sediment	E, C	Once / 6 years	
29b	Trichloroethylene	UK	Water	E	Not provided	1 site
		FR	Mussels, Sediment	E, C	Once / 6 years	

34	Dicofol	UK	Water Mussels	E, C E, C	Monthly Annually	Review after 2016
35	Perfluorooctane sulfonic acid and its derivatives (PFOS)	UK DE FR	Water Mussels Sediment and biota (fish liver) Water Mussels Fish Sediment	E, C E, C O O E,C T,O E,C,T	Monthly Annually Annually Annually Twice / 6 years Twice / 6 years Once / 6 years	Review after 2016
36	Quinoxyfen	UK	Water Mussels	E, C E, C	Monthly Annually	Review after 2016
37	Dioxins and dioxin-like compounds	UK PT FR	Mussels (Fish for D9) Sediment Sediment and fish muscle *(PCB105, PCB118)* Mussels Fish	E, C T, O O E, C, T, O E,C T,O	Annually 2014 only 2015 only Not provided Annually	Review after 2016 Link to D9
38	Aclonifen					
39	Bifenox					
40	Cybutryne					
41	Cypermethrin	UK	Water	E	Not provided	1 site
42	Dichlorvos	UK DE	Water Water	E O	Not provided Annually	1 site
43	Hexabromocyclododecane (HBCDD)	UK FR	Water Mussels Sediment and biota (fish liver) Mussels Sediment	E, C E, C O E, C T, O	Monthly Annually Annually Twice / 6 years Twice / 6 years	Review after 2016
44	Heptachlor and heptachlor epoxide	UK	Water Mussels Sediment	E, C E, C O	Monthly Annually Annually	

45	Terbutryn	UK DE	Water Water	E O	Not provided Annually	1 site

Some members reported on their country's past/current work undertaken on "emerging contaminants" (e.g. pharmaceuticals, novel flame retardants, new antifoulants, rare earth elements, etc.), these included:

- The IMPACTA project from Spain (c.f. presentation abstract from V. Léon below) aims to characterize the distribution of regulated and emerging contaminants (pharmaceuticals, perfluorinated compounds, organophosphorus pesticides, triazines, dioxin-like compounds, personal care products, nonylphenols and alkylated PAHs) and microplastics in marine sediments, in two Spanish areas (Atlantic and Mediterranean) and to evaluate the biological effects that they can cause (sublethal embryotoxicity tests, endocrine disruption and biomarkers). Sensitive and selective analytical methods are being developed and validated and they will be implemented in marine monitoring programs. Thus, relevant pollutants present in coastal and offshore areas are identified.
- A study from Moreno-González *et al.* (2015) showed that 20 pharmaceuticals in seawater and 14 in sediments were found at concentrations from low ng L^{-1} up to 168 ng L^{-1} (azithromycin) in seawater and from low ng g^{-1} up to 50.3 ng g^{-1} (xylazine) in sediments. Therefore their bioaccumulation was also determined in some representative organisms (Moreno-González *et al.*, 2016). On the other hand the occurrence, distribution and bioaccumulation of five endocrine disrupting compounds (4-*tert*-octylphenol, 4-*n*-octylphenol, 4-*n*-nonylphenol, nonylphenol and bisphenol A) in water, sediment and biota (*Corbicula fluminea*) collected along the Minho River estuary (NW Iberian Peninsula) were examined (Salgueiro-González *et al.*, 2015). The presence of linear isomers (4-*n*-octylphenol and 4-*n*-nonylphenol) was scarcely observed whereas branched isomers (4-*tert*-octylphenol and nonylphenol) were measured in almost all samples.
- The UK (Cefas) studied the occurrence of flame retardants (FRs) in the UK marine environment where over 20 halogenated flame retardants plus 16 PBDEs have been analysed in marine mammals and sediments. Preliminary results show that some FRs such as DBHCTD (HCDBCO), PBEB, PBT, 2,2',4,4',5,5'-hexabromobiphenyl (BB153) and DDC-CO (DPs) are present in UK samples, currently at much lower concentrations than PBDEs. Over half of the non-BDE halogenated flame retardants analysed for were not detected in any samples
- The UK (Cefas) collaborated with the Helmholtz-Zentrum Geesthacht, Centre for Materials and Coastal Research, Institute of Coastal Research in Germany to look at the fingerprint analysis of brominated flame retardants and Dechloranes in North Sea sediments: 53 brominated and chlorinated flame retardants were investigated in sediment samples from the German rivers Elbe and Weser, the German Bight, Jadebusen, East Frisian Coast as well as the UK East coast. The aim of the presented study was to investigate the prevalence of different halogenated flame retardant groups as contaminants in North Sea sediments, identify determining factors for the distribution and levels as well as to

identify area specific fingerprints that could help identify sources. A fast and effective ASE extraction method with an on-line clean-up was developed as well as a GC-EI-MSMS and LC-ESI-MSMS method to analyse PBDEs, MeOBDEs, alternate BFRs, Dechloranes as well as TBBPA and HBCDD. A fingerprinting method was adopted to identify representative area-specific patterns based on detection frequency as well as concentrations of individual compounds. Concentrations in general were low, with<1 ng g^{-1} dw for most compounds. Exceptions were the comparably high concentrations of BDE-209 with up to 7 ng g^{-1} dw in selected samples and TBBPA in UK samples with 2.7±1.5 ng g^{-1} dw. Apart from BDE-209 and TBBPA, alternate BFRs and Dechloranes were predominant in all analysed samples, displaying the increasing relevance of these compounds as environmental contaminants.

- Since 2009, France (Ifremer) has been carrying out a monitoring project (Veille-POP, Watch for new POPs in marine shellfish) on emerging contaminants using shellfish (mussels and oysters) as bioindicators of contamination. The samples were obtained from specimens collected within the French Monitoring Network (Réseau national d'Observation de la Contamination CHimique - ROCCH) operated by Ifremer. The studied contaminants included dioxins/furans (Munschy *et al.* 2008), brominated flame retardants (PBDEs, HBCDDs, BTBPE, DBDPE, HBB, BB-153) and perfluorinated compounds (PFCs) (Munschy *et al.*, 2013 and 2015). All studied contaminants exhibited low concentration ranges (< 1 ng/g wet weight- ww). Overall, non-PBDE BFRs revealed concentrations between 3 and 59 times lower than those of PBDEs. Although penta-BDE technical mixture has been withdrawn from the European market since 2003, BDE-47 (the predominant congener in the samples) was found at similar concentrations as those of α-HBCDD (predominant isomer), a still-used BFR employed in higher quantities than PBDEs in the past. Among PFCs, PFOS was the most detected compound and was predominant in samples from the English Channel and the Atlantic. In samples from the Mediterranean coast, the observed pattern was different, with the predominance of long-chain PFCAs (perfluorocarboxylic acids), suggesting the presence of alternative sources on the Mediterranean coast. Recently, this list of contaminants was extended to four synthetic muscs (galaxolide, tonalide, musk xylene and musk ketone). The two polycyclic musks (galaxolide and tonalide) were the predominant synthetic musks identified in all samples at levels reaching 9.4 and 1.4 ng g^{-1} ww (median value: 0.6 and 0.1 ng g^{-1} ww) respectively in the Seine Bay (English Channel). The contamination levels observed for the two nitro musks (musk xylene and musk ketone) were significantly lower (median value: 0.006 and 0.008 ng g^{-1} ww).

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Impact of Regulated and Emerging Pollutants and Microplastics in Marine Ecosystems (IMPACTA, CTM2013-48194-C3)

Victor León

The IMPACTA project characterizes the distribution of regulated and emerging contaminants (pharmaceuticals, perfluorinated compounds, phthalates, plastic additives, personal care products, alkylphenols, alkylated PAHs and organophosphorus, triazines and other current-use pesticides) and microplastics in marine sediments and seawater and evaluates the biological effects that they can cause (sublethal embryotoxicity tests, endocrine disruption and biomarkers) in two Spanish coastal areas (Vigo Ria and Mar Menor lagoon). Samples were taken in spring and autumn of 2015 to study seasonal variations on the pollutant distribution. Sensitive and selective analytical methods have been developed and validated for both matrices. The distribution of emerging organic pollutants in coastal areas was heterogeneous depending on the sources distance, hydrodynamic currents, dilution capacity, suspended solids sedimentation, etc. Significant seasonal variations of the current-use pesticides, pharmaceuticals and other pollutants concentrations (Moreno-González *et al.* 2015; 2017) were found in coastal sediments, as consequence of variations of sources discharges, temperature, sun irradiation, etc. These analyses are going to be also applied to Atlantic and Mediterranean continental shelf sediment samples in order to identify which emerging pollutants can access to deeper sediment areas and provoke adverse effects to marine organisms.

A presentation was received from local researcher Gian Marco Luna highlighting that sediment microbial communities are responsive to contaminant pressure, that sediments may act as a reservoir of faecal bacterial contamination and that antimicrobial resistance genes should be considered to be an environmental contaminant.

Sediment microbes in the coastal sea: a tale of pathogens, pollutants and community response to pollution

Gian Marco Luna, Elena Manini, *et al.*

Microbes can serve as a proxy for chemical pollution, which causes changes to microbial communities and functioning. DNA-based surveys of sediment bacterial diversity demonstrated that increased PCB and PAH concentrations in sediments from the Mar Piccolo, Tarrantino and the delta of the River Po were associated with reduced microbial biodiversity (Quero *et al.*, 2015); different pollutant profiles at different locations were associated with different community composition and a shift to PCB-degrading bacteria in the Mar Piccolo indicates selection pressures here. Bacterial community composition of R. Po delta sediments was also shown to change following flood events that altered contaminant pressure. Significant numbers of faecal bacteria were found in sediments, even when the overlying water was "clean", and were found to harbour virulence genes and genes that increased the resistance of *E. coli* to antibiotics. A paper indicating that chemical pollutant gradients can be mirrored in the presence of microbial genes that act as markers of antimicrobial resistance (AMR), hydrocarbon degredation and resistance to metals is in preparation.

Reference

Quero, G.M., Cassin, D., Botter, M., Perini, L. and Luna, G.M. 2015. Patterns of benthic bacterial diversity in coastal areas contaminated by heavy metals, polycyclic aromatic hydrocarbons (PAHs) and polychlorinated biphenyls (PCBs). Frontiers in Microbiology, https://doi.org/10.3389/fmicb.2015.01053.

5.6 ToR 7: OSPAR Special Request

WGMS and MCWG are requested to report on the selection and de-selection of hazardous substances of concern to coastal and marine waters in the OSPAR maritime area. Reporting should: 1) Identify and collate information on projects, activities and sources of information for new and emerging substances; as well as 2) Review the information to identify new and emerging substances, identify information gaps and recommend what further work is needed	Reporting should be done to ensure that in the new and emerging hazardous substances in the marine environment (of the OSPAR maritime area) that are of general concern to coastal and marine waters are identified, so that appropriate action can be taken by OSPAR. The work by MCWG and WGMS should build on and be coordinated with the already established EU WFD Watch List process and the relevant OSPAR List. Reporting should also take into account other research programmes that screen substances in the marine environment, e.g. through passive sampling, tissue analysis, sediment sampling etc.	WGMS and MCWG are requested to provide an intermediate report on progress of work by 10 March 2017 for the attention of ACOM. Based on feedback to the ICES Secretariat from OSPAR HASEC, update and finalize their work by 12 October 2017 and report to ACOM.

WGMS worked on this ToR in (virtual) plenary discussion with ICES Marine Chemistry Working Group who were meeting simultaneously in Hamburg. An interim report was provided to ICES at the end of the March meetings (Annex 5). Further intercessional work was undertaken during the summer, and a final report submitted to ICES in October 2017 (Annex 6).

6 Cooperation

- **Cooperation with other WG**

WGMS works closely with the other two ICES expert groups working on contaminants. We have worked with ICES Marine Chemistry Working Group (MCWG) to produce interim and final reports for OSPAR in response to their special request for advice relating to Contaminants of Emerging Concern and WGMS co-Chair Craig Robinson attended the ICES Working Group on Biological Effects of Contaminants (WGBEC) and contributed to their ToR (k) "Review the use of passive samplers and dosing in marine ecotoxicity studies". Exchanges have been set up with ICES Working Group on the Effects of Extraction of Marine Sediments on the Marine Ecosystem (WGEXT) regarding both groups' ToRs on deep sea mining. A member of WGEXT gave a presentation to WGMS 2016 and joined our discussions during the session on Deep Sea Mining.

- **Cooperation with Advisory structures**

The special request from OSPAR to ICES for information for use in prioritising contaminants of emergining concern was addressed in plenary and intercessionally by WGMS and MCWG to produce interim and final reports to ICES. Production of these reports involved WGMS members in a number of teleconferences with ICES secretariat and the Advice Drafting Group Chair. The joint Working Group report was subject to an ICES Review Group and WGMS co-Chair Craig Robinson then attended (along with the MCWG Chair) the ICES Advice Drafting Group on Hazardous Substances (ADGHAZ) to help produce the final advisory document for sending to OSPAR.

- **Cooperation with other IGOs**

Production of the report in response to OSPAR Special Request for information for use in prioritising contaminants of emergining concern involved the cooperation of WGMS/MCWG members who worked on the production of major report on Contaminants of Emerging Concern by the Arctic Monitoring and Assessment Programme (AMAP).

Members of WGMS who are also members of the OSPAR Working Group on Monitoring & on Trends and Effects of Substances in the Marine Environment (MIME) contribute to information sharing on related activities between the two groups.

Attendees from other IGOs were involved in our discussions and in developing our report under the deep sea mining ToR. These included invited experts from the International Seabed Authority and from two research consortia: the EU-funded MIDAS (Managing Impacts of Deep-seA reSource exploitation) project and the JPI Oceans funded MiningImpact project.

Some members of WGMS are also members of the JRC-led MSFD Expert Network on Contaminants. This network supported the development (with respect to MSFD Descriptors 8 and 9) of the latest Commission Decision laying down criteria and methodological standards on good environmental status of marine waters and specifications and standardised methods for monitoring and assessment (2017/484/EU); the network is currently involved in making the MSFD reporting formats practical for both Member States and the Commission.

WGMS maintains an active relationship with the NORMAN network of reference laboratories, research centres and related organisations for monitoring of emerging environmental substances, particularly with respect to the development and application of passive sampling techniques, which form a key part of WGMS's Terms of Reference.

7 Summary of Working Group self-evaluation and conclusions

A copy of the full Working Group evaluation is included as Annex 4 of this report.

Significant contribution to ICES SSGEPI Science Plan Priorities

WGMS has worked on ICES SSGEPI Science Plan Priorities 1, 7, 9, 11, 13, 16, 25, 27, 28 and 31, as indicated in the following table:

Science Plan priority	**How WGMS addresses this issue**
1. Assess the physical, chemical and biological state of regional seas and investigate the predominant climatic, hydrological and biological features and processes that characterise regional ecosystems	Under ToR 1, 2, 3, 4, 5, 6 and 7, WGMS provided information on monitoring and assessment of contaminants in sediments. Including providing advice to OSPAR on the design of sediment monitoring programs, drafting ICES publications (TIMES papers and CRR), reporting on modelling ecosystem pressures from contaminants in sediments, deep sea monitoring protocols, the impact of new renewable energy devices in the sea, and emerging issues such as deep sea mining.
7. Develop end to end modelling capability to fully integrate natural and anthropogenic forcing factors affecting ecosystem functioning	WGMS has addressed this issue under ToR 3, and has reported on possible use of hydrodynamic modelling to explain spatial distribution patterns of contaminants in sediment and inform on sources and hence possible MSFD measures
9. Identify indicators of ecosystem state and function for use in the assessment and management of ecosystem goods and services	WGMS has addressed this issue under ToRs 1, 2 and 7 and acts to report and provide advice on monitoring and assessment of contaminants in sediments; understanding of the relationship between human activities and marine ecosystems (estimation of pressure and impact, …)
11. Develop methods to quantify multiple direct and indirect impacts from fisheries as well as from mineral extraction, energy generation, aquaculture and other anthroponegic activities and estimate the vulnerability of ecosystems to such impacts.	WGMS has addressed this issue under ToRs 5 and 6b. Exploring the potential risk impact of mineral extraction and energy generation in terms of release of contaminants from/to sediments
13. Develop indicators of pressure on populations and ecosystems from human	WGMS has addressed this issue under ToR 2 and has reported to ICES on improving the understanding of the relation between data obtained by passive sampling in

activities such as eutrophication, contaminants and litter release, introduction of alien species and generation of underwater noise.	sediment and environmental quality (link with WGBEC for the development of sediment EACs); determination of background assessment concentrations (BAC) in sediment.
16. Quantify and map biological, ecological and environmental values with an aim to optimize ecosystem use and minimize environmental impacts in relation to ecosystem carrying capacity	Advice on monitoring and assessment of contaminants in sediments (e.g. by passive sampling (ToR 2) and by improved statistical design of sediment sampling programs (WGMS 2013 report; ICES advice 1.6.6.2, May 2014); understanding of the relationship between human activities and marine ecosystems (estimation of pressure and impact, …); spatial transport modelling of sediment-related contamination
25. Identify monitoring requirements for science and advisory needs in collaboration with data product users, including a description of variable and data products, spatial and temporal resolution needs, and the desired quality of data and estimates	WGMS addressed this issue under ToR 4, reviewing and providing feedback to OSPAR MIME on how their sediment sampling guidelines could be adapted for use in sediment monitoring of the deep seas, as may be required for MSFD. Furthermore, The draft passive sampling TIMES and CRR publications (ToR 2) provide guidance on required Quality control protocols for passive sampling of contaminants in sediment.
27. Identify knowledge and methodological monitoring gaps and develop strategies to fill these gaps	WGMS reported on key issues and methodologies regarding the monitoring of contaminants in deep sea sediments (ToR 2).
28. Promote new technologies and opportunities for observation and monitoring and assess their capabilities in the ICES context	Handling key issues on Monitoring and assessment of contaminants in sediments. Production of TIMES paper or guidelines for the use of passive sampling in monitoring programs. Organisation of a trial survey on PS in 2007 (link with MCWG). Workshop on Passive Sampling and Passive Dosing (WKPSPD) in 2013
31. Ensure the development of best practice through establishment of guidelines and quality standards for (a) surveys and other sampling and data collection systems; (b) external peer reviews of data collection programmes and (c) training and capacity building opportunities for monitoring activities	Monitoring and assessment of contaminants in sediments: Production of TIMES paper or Guidelines (Analyses of various contaminants in sediments; Use of passive sampling); update of the OSPAR JAMP Monitoring guidelines; CRR on the use of passive sampling currently being produced; Advices/Recommendations to OSPAR

Difficulties encountered in achieving the work plan

ToR 5 (contaminants related to offshore renewable energy schemes) was hardly worked on during the current cycle. However the WGMS member from the German institute, Bundesamt fur Seeschiffahrt und Hydrographie (BSH), are keen to take this topic further in the next cycle as a new research project behind it is just commencing.

Future plans

WGMS proposed to pursue his work on the development of best practice through the update of the OSPAR JAMP sediment monitoring guidelines regarding existing BACs/

EACs and recommendations regarding the management of dredging activities and the monitoring of disposal sites.

WGMS will also report on emerging issues such as occurrence of substances of emerging concern in sediments (including platinum group and rare earth elements, as well as organic contaminants), microbiological contamination and potential risk impact of new renewable energy devices in the sea.

WGMS will bring further his work on passive sampling of sediments by finalizing TIMES paper or Guidelines documents and by reporting to ICES on improving the understanding of the relation between data obtained by passive sampling in sediment and environmental quality. As a number of group members with expertise on passive sampling have recently left, or will be leaving the group shortly, additional expertise in this area may be needed to continue this work.

Annex 1: List of participants

NAME	ADDRESS	EMAIL
Elvio Amato	University of Antwerp Systemic Physiological and Ecotoxicological Research (SPHERE) Campus Groenenborger Groenenborgerlaan 171 2020 Antwerpen Belgium	elvio.amato@uantwerpen.be
Guido Bruno (guest)	ISMAR-CNR Largo Fiera della Pesca 60125 Ancona Italy	guidobruno87@yahoo.com
Maria J. Belzunce	AZTI-Foundation Herrera Kaia Portualde z/g 20110 Pasaia (Gipuzkoa) Spain	jbelzunce@pas.azti.es
Thi Bolam	Centre for Environment, Fisheries and Aquaculture Science (Cefas) Pakefield Road Lowestoft Suffolk NR33 0HT United Kingdom	thi.bolam@cefas.co.uk
Roberto Danovaro (guest)	Stazione Zoologica Anton Dohrn, Naples, Italy; and Polytechnic University of Marche, Ancona, Italy	r.danovaro@univpm.it
Christian Ferrarin (guest)	ISMAR-CNR Castello 2737/F Venice, Italy	c.ferrarin@ismar.cnr.it
Gianna Fabi (guest)	ISMAR-CNR Largo Fiera della Pesca 60125 Ancona Italy	g.fabi@ismar.cnr.it
Ana Gama	Instituto Hidrografico Rua das Trinas 49 PT1249-093 Lisbon Portugal	ana.gama@hidrografico.pt
Alessio Gomiero (guest)	International Research Institute of Stavanger (IRIS) Postboks 8046 4068 Stavanger Norway	alessio.gomiero@iris.no

Victor León	Instituto Español de Oceanografía Centro Oceanográfico de Murcia C/ Varadero 1, San Pedro del Pinatar, 30740 Murcia Spain	victor.leon@mu.ieo.es
Gian Marco Luna (guest)	ISMAR-CNR Largo Fiera della Pesca 60125 Ancona Italy	gianmarco.luna@ve.ismar.cnr.it
Marzia Rovere (guest)	ISMAR-CNR Via Gobetti 101 Bologna Italy	m.revere@ismar.cnr.it
Craig Robinson (co-chair)	Marine Scotland Science Marine Laboratory 375, Victoria Road Aberdeen AB11 9DB United Kingdom	craig.robinson@gov.scot
Federico Spagnoli	ISMAR-CNR Largo Fiera della Pesca 60125 Ancona Italy	f.spagnoli@ismar.cnr.it
Celine Tixier (co-chair)	Ifremer RBE-BE-LBCO Rue de l'île d'Yeu P.O. Box 21105 44311 Nantes Cédex 03 France	celine.tixier@ifremer.fr

Annex 2: Recommendations

Recommendation	Addressed to
1. Advice is requested on what organisms are suitable for ecotoxicological assessments of sediments (including dredged materials) in deeper waters	WGBEC
2. WGMS recommends to OSPAR MIME that for the existing JAMP Guidelines for Monitoring Contaminants in Sediments to be used for deep sea monitoring (as may be needed for the MSFD) they require modifications to include details of geophysical surveys, multi-corer sampling, digital imaging, and that an error in Section 5.3 should be corrected.	OSPAR Working Group on Monitoring and on Trends and Effects of Substances in the Marine Environment (MIME)

Annex 3: WGMS resolution 2018-2020

The **Working Group on Marine Sediments with respect to pollution** (WGMS), chaired by Els Monteyne*, Belgium, and Maria Belzunce*, Spain, will work on ToRs and generate deliverables as listed in the Table below.

	Meeting dates	Venue	Reporting details	Comments (change in Chair, etc.)
Year 2018	12–16 March	San Pedro del Pinatar, Murcia, Spain	Interim report by 1 June to EPISG	
Year 2019			Interim report by Date	
Year 2020			Final report by Date	

ToR descriptors

ToR	Description	Background	Science Plan topics addressed	Duration	Expected Deliverables
A	Respond to potential requests for advice as required.			3 years	Advice
B	Dredging activities 1) Review the regulated substances and thresholds used in management of dredging activities 2) Review and recommend monitoring approaches to disposal sites	A major source of contaminants in marine sediments, the substances considered, their thresholds and management approaches are different in each country.	1, 11, 13, 25, 27	3 years 3 years	Review document & recommendation, if required Review document & recommendation, if required
C	Sediment Quality Guidelines Review recent publications that may contain data to refine existing sediment assessment criteria	More data may be available to refine existing BACs / EACs; there are no existing criteria for some prioirity substances (e.g. PBDEs) for use in MSFD / OSPAR status assesments.	1, 13, 25, 27, 31	3 years	Annual updates and final report.
D	Plastic litter: To assess the relevance and the potential risk impact of (micro-) plastics in sediments and follow up of outcomes of other expert groups	(Micro-)plastics are included in MSFD Descriptor 10, are of emerging concern and can be a vector for contaminant transfer to	1, 11, 13, 25, 27	3 years	Annual updates and final report.

		sediments, or from sediments to biota			
E	Emerging issues 1. To review and inform on the occurrence of substances of emerging concern in sediments, including platinum group and rare earth elements, as well as organic contaminants 2. To consider other forms of pollution, e.g. microbiological	Sediments are a sink for many of these pollutants, but may also be a source.	1, 13, 25, 27	3 years	Annual updates and final report.
F	Impact of renewable energy devices To explore the potential risk impact in terms of inputs (corrosion, anti-corrosion agents…) and release of contaminants due to sediment scouring	Changes in hydrodynamics may release sediment-bound contaminants; there may be inputs of contaminants during installation, operation and decommissioning. This is under active research by a member of the group.	1, 11, 13, 25, 27	3 years	Report (with recommendations, as appropriate)
G	Passive sampling 1) To publish guidelines on passive sampling of sediments	Documents are in advanced drafts and will be completed	28, 31	1 year	Two ICES TIMES papers
	2) To publish a review on passive sampling techniques	A review document is at an advanced stage of drafting and will be completed	28, 31	1 year	Cooperative Research Report
	3) Review and update on developments	Passive sampling is an advancing area of research that could improve on existing monitoring techniques	28	3 years	Annual updates and final report.
	4) continue to develop a database to provide information of use in developing assessment criteria for passive sampling techniques		28, 31	3 years	Dataset and advice to OSPAR on progress

Summary of the Work Plan

Year 1	Completion of the different draft documents on Passive Sampling (PS) and submission as two ICES TIMES papers (Guidelines on PS in sedimens) and one Cooperative Research Report on the techniques for passive sampling of marine sedments. Progress work towards completion of the remaining ToRs
Year 2	Progress work towards completion of the remaining ToRs
Year 3	Final Report

Supporting information

Priority	This Group handles key issues regarding monitoring and assessment of contaminants in sediments. The current activities of this Group will lead ICES into issues related to the understanding of the relationship between human activties and marine ecosystems (estimation of pressure and impact, …). Consequently, these activities are considered to have a high priority.
Resource requirements	The research programmes which provide the main input to this group are already underway, and resources are already committed. The additional resource required to undertake additional activities in the framework of this group is negligible.
Participants	The Group is normally attended by some 10-15 members and guests.
Secretariat facilities	The normal secretarial support to an ICES Expert Group is required.
Financial	No financial implications.
Linkages to ACOM and groups under ACOM	There are no obvious direct linkages.
Linkages to other committees or groups	There are close working relationships with Marine Chemistry Working Group (MCWG) and Working Group on Biological Effects of Contaminants (WGBEC); some members of WGMS are also members of these. The work of WGMS is also relevant to the Working Group on the Effects of Extraction of Marine Sediments on the Marine Ecosystem (WGEXT) and to the OSPAR Intersessional Correspondence Group on Marine Litter (ICG ML).
Linkages to other organizations	OSPAR, HELCOM, MEDPOL, EU/JRC Expert Network on Contaminants.

Annex 4: Copy of Working Group evaluation

1) Working Group name: Working Group on Marine Sediments in relation to pollution (WGMS).

2) Year of appointment: 2015.

3) Current Chairs: Céline Tixier (FR) & Craig Robinson (UK).

4) Venues, dates and number of participants per meeting:

02–06 March 2015, Koblenz, Germany (10 members + 2 local contributors)

14–18 March 2016, Ostende, Belgium (10 members + 5 local contributors)

06–10 March 2017, Ancona, Italy (8 members + 7 local contributors)

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.

Science Plan Priority #1: Assess the physical, chemical and biological state of regional seas and investigate the predominant climatic, hydrological and biological features and processes that characterise regional ecosystems

WGMS provide advice on monitoring and assessment of contaminants in sediments. In 2017 we are working with MCWG to provide advice on which Contaminants of Emerging Concern OSPAR should be considering for prioritisation. Previously we have provided advice that ICES ADG supplied to OSPAR on the spatial design of sediment monitoring programmes.

Science Plan Priority #7: Develop end to end modelling capability to fully integrate natural and anthropogenic forcing factors affecting ecosystem functioning.

WGMS have reported (2015-2017) on the possible use of multivariate statistical modelling and of hydrodynamic modelling to explain spatial distribution patterns of contaminants in sediment in order to inform on sources and hence possible measures to prevent and control their release.

Science Plan Priority #9: Identify indicators of ecosystem state and function for use in the assessment and management of ecosystem goods and services

As noted under Priorities 1 and 7, WGMS provide advice on the monitoring and assessment of contaminants in sediments and thereby contribute to understanding the relationship between human activities and marine ecosystems (estimation of pressure and impact, …)

Science Plan Priority #11: Develop methods to quantify multiple direct and indirect impacts from fisheries as well as from mineral extraction, energy generation, aquaculture and other anthropogenic activities and estimate the vulnerability of ecosystems to such impacts.

WGMS have reported (2015-17) on the potential risk impact of mineral extraction, energy generation and other anthropogenic activity in terms of release of contaminants from/to sediments

Science Plan Priority #13: Develop indicators of pressure on populations and ecosystems from human activities such as eutrophication, contaminants and litter release, introduction of alien species and generation of underwater noise.

WGMS have provided advice on contaminants of emerging concern, reported on monitoring and assessment of contaminants in sediments, including on improved methods (e.g. passive sampling). WGMS work aims to improve the understanding of the relation between data obtained by passive sampling in sediment and environmental quality, and to develop assessment criteria Environmental Assessment Criteria & Background Assessment Concentrations (EACs & BACs) for use with passive sampling data. We have reported on a ToR regarding litter in sediments and propose to take this subject further in the future.

Science Plan Priority #16: Quantify and map biological, ecological and environmental values with an aim to optimize ecosystem use and minimize environmental impacts in relation to ecosystem carrying capacity

WGMS have advised and reported on monitoring and assessment of contaminants in sediments; understanding of the relationship between human activities and marine ecosystems (estimation of pressure and impact, …); spatial transport modelling of sediment-related contamination.

Science Plan Priority #25: Identify monitoring requirements for science and advisory needs in collaboration with data product users, including a description of variable and data products, spatial and temporal resolution needs, and the desired quality of data and estimates

WGMS are working with MCWG to provide advice on Contaminants of Emerging Concern to OSPAR. We have previously provided advice (via the ICES ADG) to OSPAR regarding spatial sampling design for sediment contaminant monitoring and reported on monitoring requirements within the deeper oceans to meet MSFD needs.

Science Plan Priority #27: Identify knowledge and methodological monitoring gaps and develop strategies to fill these gaps

As noted above, WGMS identified that the MSFD requires assessment of the status of the deep sea and has reported on key issues and methodologies regarding the monitoring of contaminants in deep sea sediments.

Science Plan Priority #28: Promote new technologies and opportunities for observation and monitoring and assess their capabilities in the ICES context

WGMS is working to produce TIMES paper/s or guidelines for the use of passive sampling in monitoring programs. In the past we have been involved with MCWG in organising a trial survey for the use of passive sampling in measuring contaminants in sediment and water and an ICES Workshop on passive sampling and passive dosing (WKPSPD) in 2013.

Science Plan Priority #31: Ensure the development of best practice through establishment of guidelines and quality standards for (a) surveys and other sampling and data collection systems; (b) external peer reviews of data collection programmes and © training and capacity building opportunities for monitoring activities

As noted under Priority 28, WGMS has advised OSPAR on various aspects of monitoring and assessment of contaminants in sediments. We have been involved in producing/reviewing/updating TIMES paper/s and OSPAR Guidelines on the analyses of various contaminants in sediments and on the use of passive sampling in marine monitoring programmes.

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

- Advice for ICES to provide to OSPAR on Contaminants of Emerging Concern is being finalised during 2017
- Significant progress was made on documents relating to Passive Sampling that will be submitted for peer review in 2018 (resolutions proposed with this report)
- Findings of reviews and discussions on deep sea mining and the applicability of modelling to explain sediment contaminant distribution patterns on (sub-)regional scales were reported to ICES
- OSPAR Guidelines on sediment monitoring were reviewed as to their applicability to the deep sea and minor changes recommended

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

In 2017 the group is working (with the Marine Chemistry Working Group) to produce advice on contaminants of emerging concern to the marine environment. This advice is due to be presented to the ICES ADG in October 2017.

In 2011-2014 the group worked on a special request from OSPAR for advice on designing a programme for monitoring the spatial distribution of contaminants in marine sediments. This was completed in 2014 and submitted to OSPAR via the ICES ADG.

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.

One member of WGMS took the lead role in developing a bid to the INTERREG Atlantic Area Partnership, with the involvement of other members of the group and outside parties. The bid was successful in securing funding for the MONITOOL project which is being led by Dublin City University (and has the involvement of Maria Belzunce, Thi Bolam, Jean Louis Gonzalez) and Craig Robinson of WGMS); the project will develop & trial the use of Environmental Quality Standards in assessing coastal water quality with respect to metal concentrations determined via passive sampling.

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

ToR 5 (contaminants related to offshore renewable energy schemes) was hardly worked on during the current cycle as the person who proposed the work moved jobs; however, there is renewed interest in the topic, which was discussed in joint (virtual) session between MCWG and WGMS in 2017. There is enthusiasm from the German institute to take this topic further in the next cycle.

Future plans

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

Yes. Members of the group have proposed a number of ToRs which they wish to see taken forward into the future. These ToRs fit into the ICES Science Plan as indicated in Annex 3, and are considering to have high environmental science and policy priority.

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?

An number of group members with expertise on passive sampling have recently left, or will be leaving the group shortly, and additional expertise in this area may be needed to bring forward the work already underway on passive sampling of sediments

Development of further links with experts (e.g. in WGBEC) who can assist with the development of ecotoxicologically based assessment criteria fr passive sampling data

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

WGMS had proposed that the potential impacts of contaminants released during deep sea mining operations could be a suitable topic for an ICES Viewpoint document. However, having a better understanding of what ICES requires for a Viewpoint, the WG concluded that there is currently insufficient scientific evidence to be able to formulate advice in such a document and, furthermore, the specific expert does not currently have the capacity to produce such a document.

Annex 5: OSPAR Special Request to WGMS and MCWG: Interim Report, March 2017

Joint interim report to ACOM from WGMS and MCWG on progress with the 2017 Special Request from OSPAR on the selection and de-selection of hazardous substances of concern to coastal and marine waters in the OSPAR maritime area

Prior to the March meetings of the ICES Working Group on Marine Sediment (WGMS) and Marine Chemistry Working Group (WGMS), the Chairs of the two groups were notified that ICES had received this Special Request from OSPAR. The Chairs recognised the importance of this task but noted that the timing of the task may be problematic, since a report had to be prepared by the last day of the meeting week in order to meet the timetable of OSPAR HASEC. The request was amended to presenting an interim report by 10 March 2017 and a final report by 12 October 2017. The Chairs still considered that this timetable remained a risk to the successful completion of the task as they had an expectation that members of both groups would have limited time available for substantive inter-sessional work. The groups consider that the correct term to be applied with respect to "emerging substances", and that will be used hereafter, is "substances of emerging concern". The text of the request was is given in Annex 1.

Part 1: ICES is requested to identify and collate information on projects, activities and sources of information for new and emerging substances

During their 2017 meetings, the WGMS and MCWG have collated a list of projects and other sources of information known to those present. Neither group had access to bibiliographic search engines (e.g. SCOPUS) during their March meetings and the list principally contains projects that group members present were aware of, plus some important references. The document therefore requires further additions and amendment. This "sources of information" list has been prepared as an Excel spread sheet that is available from the "working documents" folder of the MCWG 2017 SharePoint site. Information relevant to part 2 of the current request (e.g. project name, contact person, substances studied, matrices studied, substances actually detected in the marine environment, publication details) has been extracted from the spread sheet and is presented below as Annex 2. One of the most valuable exercises on marine substances of emerging concern is the work of Tornero and Hanke (2016). They provided a review on substances that might be released from sea-based sources and established a list of 276 substances including 22 antifouling biocides, 32 aquaculture medical products and 34 warfare agents. They also provided an overview of those substances which have already been considered in European regulations. For the recent review of the Water Framework Directive (WFD) list of priority substances, a prioritization process was conducted by JRC, starting with more than 11 000 compounds and ending with a short list of 17. OSPAR should consider this list and approach JRC to check whether marine aspects have been adequately considered. Adaptations to the list may be needed based on marine monitoring data and information on substances released from sea-based sources. During their 2016 meeting, MCWG considered the following substance groups of emerging concern: dechlorane+, alternative brominated flame retardants, phosphorous flame retardants, antifoulants, per- and polyfluorinated substances (not PFOS, PFOA), benzotriazoles, siloxanes, radioactive substances, anticorrosion agents.

Part 2: Review the information to identify new and emerging substances, identify information gaps and recommend what further work is needed

In order to identify new substances of emerging concern the groups have identified which substances are already listed as Priority Substances by OSPAR or the European Commission (under the Water Framework Directive); these are NOT considered to be substances of emerging concern. Other substances have been identified as being of potential concern by OSPAR, or by the WFD Watch List and JRC prioritisation process and these have been identified in Annex 3

The list of projects & sources of information in Annex 2 requires to be completed, and the projects/sources of information should be evaluated and prioritized to allow the extraction of a list of substances that should be reviewed as to their environmental significance. To do so, OSPAR will need to obtain additional information for each substance, including toxicity, hazard properties, chemical and physical properties, production volumes and use patterns. However, the availability of this information is expected to be incomplete and a significant knowledge gap for the vast majority of the compounds. Although the REACH regulation is in place, toxicological information to predict the impact of chemicals on the marine environment is limited. Prioritization of the substances would be easier if from the beginning a more in depth investigation was obligatory.

Annex 1: Text of the OSPAR request to ICES

OSPAR is keen to ensure that new and emerging hazardous substances in the marine environment that are of general concern to coastal and marine waters are identified, so that appropriate action can be taken.

HASEC is aware that a similar exercise is already established under the WFD through the Watch List process and therefore the work for the marine environment would need to build on and be coordinated with this process.

Currently there are research programmes that screen substances in the marine environment, e.g. through passive sampling, tissue analysis, sediment sampling etc.

HASEC's request is in stages:

1. ICES is requested to identify and collate information on projects, activities and sources of information for new and emerging substances;
2. Review the information to identify new and emerging substances, identify information gaps and recommend what further work is needed;
3. Report back to HASEC on the findings of the exercise

HASEC 2017 should be updated on the progress on stage 1 (interim update (summary report as a meeting document to HASEC and presentation of progress, not advice); Stage 2 and the full advice reported to HASEC 2018

Annex 2: List of projects/ sources of information

List of information sour...

Annex 3: Lists of substances NOT considered to be of emerging concern, and list of substances already identified as being of potential concern

List of lists.xls

Annex 6: OSPAR Special Request to WGMS and MCWG: Final Report, October 2017

Report to ICES from WGMS and MCWG on the 2017 Special Request from OSPAR on the selection and de-selection of hazardous substances of concern to coastal and marine waters in the OSPAR maritime area

Introduction

The ICES Working Group on Marine Sediments in relation to pollution (WGMS) and Marine Chemistry Work Group (MCWG) were tasked ahead of their March 2017 meetings to jointly respond to ACOM regarding a Special request from OSPAR on the selection and de-selection of hazardous substances of concern to coastal and marine waters. A preliminary report was submitted in March 2017 that highlighted a number of groups of contaminants of emerging concern to the marine environment. Following feedback from OSPAR Hazardous Substances Committee on their requirements, this report collates information on the physico-chemical properties, production, usage, toxicity and environmental occurrence of many of these substances. The report has been drafted jointly by experts from the two ICES Working Groups working intersessionally.

Methods

The interim report in March 2017 listed eight substance groups as being contaminants of emerging concern to the marine environment. These were: alternative brominated flame retardants (aBFRs), corrosion protection agents, Dechlorane Plus, phosphorous flame retardants (OPFRs), per- and poly-fluoroalkyl substances (PFASs) other than PFOS and PFOA, benzotriazoles, siloxanes and new antifoulants. A template document was designed in order to capture the required information in a systematic manner. Volunteer experts from the two Working Groups have obtained, collated and summarised literature-sourced information on the physico-chemical properties, production, usage, toxicity and environmental occurrence of five of the identified substance groups; there were no volunteers available to produce documents on siloxanes, benzotriazoles, or new antifoulants.

Results

A template file was completed for each of five substance groups, with information generally being provided for more than 15 substances in each group. In a number of cases the data are not complete due to knowledge gaps and research needs, such as on toxicity or environmental concentrations / behaviour. The key findings are summarised in Table 1, whilst the template files are attached as Annexes.

Table 1: Summary of the template files for each substance group.

Substance group	Author(s)	Comment
Alternative brominated flame retardants (aBFRs)	Sara Losada Rivas sara.losadarivas@cefas.co.uk Jon Barber jon.barber@cefas.co.uk Catherine Munschy Catherine.Munschy@ifremer.fr Katrin Vorkamp kvo@envs.au.dk	Template document contains information on the physico-chemical properties, usage, toxicity and environmental concentrations of 16 different substances, which include brominated aromatic compounds, brominated phthalates, brominated alkanes and brominated ethers. aBFRs are a diverse group of compounds, with variable physico-chemical characteristics and toxicity; they tend to be lipophilic and not readily degradable. Some of them are genotoxic, teratogenic, or potentially endocrine disrupting.
Corrosion protection agents	Torben Kirchgeorg Torben.Kirchgeorg@bsh.de	Two templates were received – one for organic substances and one for galvanic anodes. Both are partially completed, noting that much research is needed on the release of corrosion inhibitors from resins and on the concentrations of Potentially Toxic Elements in the marine environment close to marine renewable energy parks.
Dechlorane Plus	Roxana Sühring (Cefas) Roxana.suhring@cefas.co.uk	Document received detailing properties, usage, and environmental (especially biota) concentrations of 3 dechloranes, including Dechlorane Plus. Dechloranes are lipophilic and hence bioaccumulative, but there is a shortage of data on their toxicity and persistence; modelling suggests that they are likely to be persistent and they have structural similarities to toxic organochlorine pesticides.
Organophosphorous flame retardants (OPFRs)	Ian Allan Ian.Allan@niva.no Katrin Vorkamp kvo@envs.au.dk Karina Peterson Karina.Petersen@niva.no Philippe Bersuder philippe.bersuder@cefas.co.uk	The template document outlines the physico-chemical properties, usage, toxicity and environmental concentrations of ca. 25 substances. As hydrophobicity and other physico-chemical properties are very wide ranging, depending upon the molecular structure (length and branching) and functional group, it is not possible to readily summarise the environmental behaviour or risk of OPFRs; many are not thought to be bioaccumulative, although some are neurotoxic, reprotoxic or suspect carcinogenic.
Per- and polyfluoroalkyl	Lutz Ahrens lutz.ahrens@slu.se	The template document details the physico-chemical properties of 25 perfluoroalkyl

substances (PFASs) other than PFOS or PFOA	Katrin Vorkamp kvo@envs.au.dk Philippe Bersuder philippe.bersuder@cefas.co.uk	substances (PFASs) (including PFOS and PFOA) and summarises reported environmental concentrations and toxicity of PFASs (not clear if the summed concentrations included PFOS/PFOA). PFASs are considered to be persistent, bioaccumulative and toxic, although the degree to which this applies for the individual compounds varies depending upon the length of the fluorinated hydrophobic carbon chain and the type of hydrophilic functional group (sulfonate or carboxylate).
New antifoulants	No template completed	
Benzotriazoles	No template completed	
Siloxanes	No template completed	

Discussion

The documents indicate the vast number of contaminants of emerging concern, and their wide ranging environmental concentrations and behaviours, even within these five substance groups. The documents provide information (where it is available) that will allow OSPAR to assess whether these substances are of sufficient concern to require monitoring through the JAMP/CEMP, or to highlight to Contracting Parties where there are significant knowledge gaps. The work of Tornero and Hanke (2016) is highlighted as being of importance in this field. They established a list of 276 substances that might be released from sea-based sources, including 22 antifouling biocides. They also provided an overview of those substances which have already been considered in European regulations.

Reference

Tornero, V. and Hanke, G. 2016. Chemical contaminants entering the marine environment from sea-based sources: A review with a focus on European seas. *Marine Pollution Bulletin*, **112,** 17-38. http://dx.doi.org/10.1016/j.marpolbul.2016.06.091

01. aBFRs template.docx

02. Corrosion protection template.dc

03. Dechloranes template.docx

04. OPFR template.docx

05. PFASs template.docx

06. request text.docx

Annex 7: Technical Minutes from the Review Group RGHAZ

Review of ICES Marine Chemistry Working Group (MCWG) and Working Group on Marine Sediments in Relation to Pollution (WGMS) report on the 2017 Special Request from OSPAR on the selection and de-selection of hazardous substances of concern to coastal and marine waters in the OSPAR maritime area.

Special requests from OSPAR

ICES WGMS and MCWG are requested to report on the selection and de-selection of hazardous substances of concern to coastal and marine waters in the OSPAR maritime area.

a) identify and collate information on projects, activities and sources of information for new and emerging hazardous substances of concern to coastal and marine waters.

b) review the information to identify new and emerging substances, identify information gaps and recommend what further work is needed

Reviewer: Emma Undeman, Sweden (chair)

With additional comments provided by Victoria Torneo and Georg Hanke, JRC

Chair WGMS: Celine Tixier, France, and Craig Robinson, UK

Chair MCWG: Koen Parmentier, Belgium

Secretariat: Sebastian Valanko

Written for ADGHAZ

General comments:

- The report builds on a preliminary interim report that addresses the issues of task a) (see above), i.e. describes the information used to pre-select the 8 substance groups. This brief report describes that members of the two contributing WGs listed various projects or screening efforts they were aware of in a spreadsheet during meetings in 2017, however no systematic literature review or other search for relevant information in scientific databases appears to be conducted. It is commented that this list must be further processed and analyzed, but it not clear how (if) this list of projects and scrutinized compounds was actually used, in particular as the substance groups considered to be of emerging concern appears to have been specified by MCWG already in 2016. Despite the interim report, it is hence unclear how the pre-selection of substance groups was made. A clarification of this circumstance should be given.
- Since no documentation is available to the RG describing the information used and analysis made to decide on substance groups to review more thoroughly in the second part of the request (b above), this makes it difficult to judge if the request from OSPAR is fully addressed by ICES.

- It would indeed be valuable if the information on the approach that was used for scrutinizing substances and selecting specifically these compound groups was available, and to what extent the selection was based on information specifically related to the OSPAR area. It can be noted that JRC is currently reviewing the procedures for identification of emerging contaminants across EU, taking different information sources and responsibilities into account. The OSPAR/ICES experience from this work can be valuable for the JRC review (comment by Georg Hanke).
- Eight substance groups were identified by ICES as of emerging concern, but no volunteers were available to do the data compilation for three of the groups. The request by OSPAR is hence not fully addressed.
- On the other hand, is it not necessarily relevant to present groups or classes of chemicals as being of emerging concern, as inherent properties and associated hazards can be diverse within a group. It appears as if a thorough analysis of the relevance to OSPAR areas of the identified substances in various screening projects and other information sources would have served as a good first selection for both individual substances or substance groups of emerging concern. An information source that can be added to the list of projects, and possibly used as a candidate selection instrument, is the SIN list by ChemSec (www.sinlist.org) listing chemicals fulfilling REACH criteria for PBT or vPvB substances.
- The intended use of the requested output stated by OSPAR ("Request from OSPAR to support the work on the selection and de-selection of hazardous substances for HASEC") is rather un-specific and leaves a lot of room for ICES to do their own interpretation and decisions about level of ambition in the report. This is reflected in the templates for information delivery to OSPAR made by ICES, which aim at collecting some basic data for each compounds class. However, it is not specified in detail which data should be included and to what extent the availability or quality of data should be discussed. It is not specified if environmental concentrations should be compiled for e.g. OSPAR region marine or aquatic environments, or any environment. The extent of data compilation and depth of analysis made is therefore variable for the five compound classes.
- The templates designed by ICES requests substance specific information typically used in a risk assessment of a chemical compound. Hence the given information is useful since it provides data that can potentially be used as a basis for selecting chemicals to prioritize in screening/monitoring activities. The information is given either in running text or tables, although the type of information given is often suitable for tables (see e.g. OPFRs).
- It is recommended to consider the WFD prioritizing process as guidance for the templates, and also to consider the work of NORMAN network. For EU members in particular, it is beneficial if ICES/OSPAR work supports fulfilling the commitments under the MSFD (comment by Georg Hanke).
- It can be noted that "de-selection" of compounds would require data compilation not only for emerging contaminants, but also for well-known classical

contaminants that may have ceased to be relevant parameters to monitor due to banned use and low environmental levels.

- The discussion section of the report states that: "The documents provide information (where it is available) that will allow OSPAR to assess whether these substances are of sufficient concern to require monitoring through the JAMP/CEMP, or to highlight to Contracting Parties where there are significant knowledge gaps", which is the case, although in most cases the provided information is that there seems to be a lack of knowledge. The selection of information to provide (physical-chemical properties, environmental degradation rates and bioaccumulation potential, production/use data, toxicity and observed concentrations in environmental matrices) depends on the risk/hazard criteria or prioritization scheme to be used. OSPAR relies (according to their website) on REACH criteria to identify substances of possible concern, and it is supposedly these criteria that have been considered by ICES when designing the templates. This should be clarified in the report. It can be noted that in the aBFR data sheet, also Stockholm Convention and OSPAR specific criteria are mentioned.
- It is noted in the request details that "HASEC is aware that a similar exercise is already established under the WFD through the Watch List process and therefore the work for the marine environment would need to build on and be coordinated with this process", a brief discussion about how ICES/OSPAR prioritization activities aligns with the WFD prioritization and Watch List process would be informative. In previous WFD prioritization processes, lists such as the OSPAR priority list has been included in the "list of lists" proposing the initial candidates for further ranking.
- The report is indeed rather brief, and a more detailed description of the method, the design of the templates, the anticipated use of the information by OSPAR and the recommended further work needed would be helpful to any external reader.
- Substance evaluation according to REACH criteria for Substances of Very High Concern (PBT, vPvB) requires the following information:
    - P, vP: Degradation half-life in marine, fresh/estuarine water, sediment or soil. Indication from ready biodegradation tests or other screening tests or QSAR model
    - B, vB: bioconcentration factor in aquatic species. Indication from experimentally determined or QSAR log KOW. Studies of bioaccumulation in terrestrial species, humans, vulnerable/endangered species, chronic toxicity studies, studies on toxicokinetics, studies on biomagnification or measured trophic magnification factors. Molecular size.
    - T: NOEC or EC10 for marine or freshwater organism, or tests to determine if a substance is carcinogenic, mutagenic, toxic for reproduction, have specific target organ toxicity after repeated dose, or evidence of chronic toxicity (e.g. long term toxicity testing in invertebrates or fish), or growth inhibition studies on aquatic plants, long-term or reproductive toxicity testing with birds.

In addition to standardized tests, REACH also allows "other information provided that its suitability or reliability can be reasonably demonstrated" to identify PBT or vPvB substances. As standardized tests are often not performed in scientific studies, much data falls within the "other information" category and requires, if REACH methodology is strictly followed, some judgement of its reliability and relevance is needed.

- On this note, what is generally lacking is an analysis of the collected data. Either in terms of comments on the quality, variability, representativeness, coverage of the literature survey, or the completeness of the data for the purpose of doing some kind of risk assessment or prioritization exercise. The responsible scientists' judgement about the urgency to include the selected substances on the OSPAR priority list would be valuable.
- The part b) of the request is hence not completed as an analysis of the data to allow identifying substances of emerging concern relevant for the OSPAR area is lacking, and it should in the report be differentiated between general research needs and the needs to clarify the relevance of particular contaminants in the OSPAR area (comment by Victoria Torneo).
- Despite the use of templates, there are inconsistencies between physical chemical properties given for the different compound groups. This should be commented on and justified. E.g. for PFAS no vapor pressure or Henry's Law constant is given, which is reasonable as these molecules are (judging from the pKa values reported) practically always dissociated at environmentally relevant pH. However, the selection of physical-chemical properties to present (either due to relevance or data availability) should be explained and motivated. The availability of data differs much for the five substance groups, and reasons for this could be highlighted.
- The discussion section of the report states that: "The documents provide information (where it is available) that will allow OSPAR to assess whether these substances are of sufficient concern to require monitoring through the JAMP/CEMP, or to highlight to Contracting Parties where there are significant knowledge gaps". In many cases, "further research needed" is indeed the recommendation to fill knowledge gaps regarding inherent physical-chemical properties, toxicity or environmental concentrations. It is however not useful to state that more research is needed in a too general manner. To fill all data gaps identified in this report is a formidable task. OSPAR Contracting Parties would therefore be better served if it could be specified *which* data gaps that are most urgent to fill, i.e. recommendations about prioritization.
- The report refers to the review of sea-based sources of chemical substances by Tornero and Hanke. This review article provides a comprehensive list of possible candidates based on use (qualitative), but no other data (quantitative) to base risk assessment on. Hence, for the substances listed in the review, data need to be compiled or produced to allow for a risk assessment or some kind of prioritization. It can also be noted that it is indeed difficult to determine the relative importance of sea-based sources and land based sources for chemicals with diverse applications. Sea based emissions can in many cases be much lower than land based emissions, but on the other hand these emissions occur

directly to the sea, whereas land based emissions are always partly reduced by retention in the terrestrial system.

- It is stressed that the article by Torneo and Hanke is prepared specifically to complement the WFD processes for collecting information on potentially occurring substances in marine waters, but does not provide a complete prioritization of substances (comment by Georg Hanke).
- A final general remark is that an overview of the outcome of the data compilation effort should be given. For example, it would be valuable to indicate for which chemicals there is enough data to do e.g. a PBT/vPvB-assessment and for these indicate the result. When possible, data on the environmental concentrations should be compared to the reported toxicological thresholds. Although the data is scattered and many knowledge gaps need to be filled, this report could state more clearly for which of these compounds there is enough data to do an environmental risk assessment.
- It is acknowledged that this work is done on a voluntary basis with limited resources.

Specific comments in addition to the general comments

Alternative brominated flame retardants

- The data compilation is comprehensive and summarizes many information sources. The data can be used to do e.g. a PBT/vPvB assessment for many of the listed compounds.
- Log KAW values are sometimes very high, it appears as if minus sign is sometimes missing. This should be checked. The for log BCF = m log KOW+b, which values for m and b where used, was this correlation derived for a specific compound class or a broader group of compounds?
- An important comment in this data sheet is that the selected aBFRs are those most commonly analyzed and this also impacts which are found in the environment. It is not clear if there are aBFRs that are extensively used but not analyzed (e.g. due to analytical challenges).
- It is informative that environmental concentrations and range is given, it would have been good to include also some information about geographical location.
- BB-153: measured concentrations is only given for biota, but not water, air, sediment or sludge. As this compound is banned and regulated, one would expect more monitoring data to be available.
- For example, the draft risk profile for hexabromobiphenyl presented at the Persistent Organic Pollutants Review Committee second meeting in 2006 (document UNEP/POPS/POPRC.2/9) includes relevant information (comment by Victoria Torneo).
- There are registration dossiers at ECHA for some aBFRs (e.g. BEH-TEBP, TBBPA-DBPE, TBP) whose information should be considered. For example, according to ECHA, DBHCTD is suspected to be bioaccumulative while TBBPA-DBPE does not bioaccumulate. This info is missing in the template (Comment by Victoria Torneo).

- There are no comments on data or knowledge gaps, or recommendations on future work needed.

Corrosion protection

- The purpose of this table seems to be mainly to draw attention to a previously overlooked source of sea-based emissions of chemicals namely leaking from epoxy resins (bisphenols) and polyurethane coatings of submerged constructions such as wind farms. No data to perform risk assessment are provided.
- Very little information is given. No physical chemical properties are listed, although this data is available at least for some compounds. This should be motivated. Some compounds are as pointed out already listed, e.g. bisphenol A (OSPAR) and alkylphenols (OSPAR/WFD prio list).
- There is information that could have been included. For example, there is an ECHA registration dossier for BADGE and 4,4′-methylenediphenyl diisocyanate is in the REACH restriction list (comment by Victoria Torneo).

Dechlorane

- The data compilation is comprehensive and summarizes many information sources.

Organophosphorous flame retardants

- The data compilation is comprehensive and summarizes many information sources.
- OPFRs are a group of compounds exhibiting diverse physical-chemical properties, environmental behavior and are used in many different applications. A discussion of the risks associated with these compounds as a group is therefore difficult. An important point made is that these compounds are used as replacement for some banned brominated flame retardants and are used in large volumes.
- Physical-chemical properties are not reported, instead references to extensive reviews are made. It is not clear if basic data required for e.g. PBT/vPvB analysis is available.
- It can be noted that there are PBT assessments available at ECHA for some of these substances (e.g. EHDPP, IPP, TBEP/TBOEP, TBP/TiBP); (comment by Victoria Torneo).
- Oftentimes unclear which reference is the source of information.

PFAS

- There are hundreds or thousands of compounds that can be classified as "PFAS". The data sheet describes this large compound class and reports data for selected PFASs which have been analyzed or described in the scientific literature.
- Typical use of PFASs is not described.
- Extensive list of physical-chemical properties of a large number of PFAS provided, but information on bioaccumulation potential is not given all though it is stated that "PFASs have high bioaccumulation potential". Bioaccumulation

of PFASs has been an important issue, e.g. difference in bioaccumulation potential for short chained and long-chained PFAS, and the differences in uptake mechanisms (i.e. binding to proteins rather than lipids) compared to classical POPs.

Further research needed is not indicated.