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Report of the Working Group on the Biological Effects of Contaminants (WGBEC)

10-15 March 2013

San Pedro del Pinatar, Spain

ICES International Council for the Exploration of the Sea

CIEM Conseil International pour l'Exploration de la Mer

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Executive Summary

In 2013 WGBEC commences its 3-year terms of Reference. The current Chairs Matt Gubbins (UK) and John Thain (UK) had reached the end of their term and two new Chairs were elected, Bjorn Einar Grøsvik (Norway) and Ketil Hylland (Norway) for a period of 3 years.

Respond to requests for advice from the Regional Seas Conventions. Having received no requests for advice from OSPAR, WGBEC reviewed the MIME summary record. OSPAR MIME had identified a need to reduce the number of biological effect techniques in the SGIMC integrated approach and had attempted to select some techniques as 'Common indicators'. WGBEC would like to offer its expert advice in any future decision process.

Consider emerging issues of scientific merit and address knowledge gaps. WGBEC received presentations on Ocean Acidification, Immunotoxicity and Oil Toxicity to Early Life Stages of Fish. The group identified subgroups to work on specific questions relating to these topics over the next three years with the aim of producing published outputs in year three.

Review status of publications and consider requirements for new publications. WGBEC reviewed status with ICES TIMES manuscripts and revised deadlines as appropriate. Several new manuscripts were produced in draft for the meeting to review. One new draft resolution is required in 2013 for the publication of a previously cancelled manuscript.

AQC activities for biological effect methods. An overview of intercalibration activities over the last year was produced and planned events for 2013/14 across Europe advertised to WGBEC members. WGBEC is currently coordinating intercalibration exercises for methods using fish liver and bile.

Respond to requests for advice from the ICES Data Centre. Requests from the data centre were addressed as far as time was available but processes to allow better communication with the data centre were proposed.

Development and harmonization of methodologies for marine monitoring. WGBEC reviewed case studies applying the integrated assessment framework developed by ICES/OSPAR which will be evaluated by OSPAR MIME in 18 months' time. A 'stock take' of completed and ongoing case studies was compiled for future reference. Assessment Criteria for biological effect techniques within this assessment scheme were revised where necessary.

Novel and Emerging compounds in the marine environment. During the meeting three presentations were provided on the issue of emerging compounds in the marine environment. Following discussion a strategy to deliver this ToR over the next three years by a subgroup was agreed.

To evaluate the results of marine litter monitoring and research activities, especially microparticles. The group were presented with a summary of several current research initiatives in this topic area, many of which were in their infancy. A need for coherence and communication between these projects was identified. Members of WGBEC are actively involved in this work area and will contribute to the delivery of this ToR over the next three years.

WGBEC will meet in Copenhagen, Denmark 3-9th March, 2014 together with, WGMS and MCWG to address common ToRs.

1 Opening of the meeting

The ICES WGBEC was hosted this year by Concepción Martínez-Gómez and held at the Instituto Español de Oceanografía (IEO), Centro Oceanográfico de Murcia, Varadero 1, Lo Pagán, 30740 San Pedro del Pinatar, Spain. The meeting opened at 09:30 on Monday 11th March, 2013, with a welcome from Mr Demetrio de Armas, subdirector of research at IEO. The group thanked Concepción Martínez-Gómez for hosting the meeting and for organising the meeting arrangements and hotel accommodation, etc. There followed a 'tour de table' to introduce group members, their affiliations background and science interests. Fifteen participants were present at the meeting, representing eight countries: Belgium, France, Germany, Italy, Netherlands, Norway, Spain, and the UK. The list of attendees is given in Annex 1.

2 Adoption of the agenda

The provisional agenda for the 2013 meeting was approved by the group and issues concerning arrangements for future meetings were discussed. It was noted that there was an outstanding request from MCWG to have a joint meeting together with WGBEC and WGMS during 2014 in Copenhagen. This was discussed in light of the outcome of the 2012 workshop on passive sampling and passive dosing (WKPSPD). It was concluded that there was a clear need to discuss a number of common agenda items with these two other expert groups. It was suggested that a joint meeting in Copenhagen for 2 days would be suitable. WGBEC would require a further 3 days of meeting time to address its own ToRs. WGBEC would like this meeting to address the following common issues:

- Marine litter and microplastics with focus on the role of plastics as a vector for contaminants and their subsequent effects
- Passive sampling and passive dosing including the development of assessment criteria for passive samplers
- Ocean acidification
- Emerging contaminants

Specific ToRs for the joint meeting will need to be agreed with the other groups. WGBEC chairs responded with this information to ICES and the chairs of the relevant groups.

It was noted that the two current co-chairs were coming to the end of their terms in 2013 and that new chair(s) would need to be found. During the week the group elected Bjorn Einar Grøsvik (Norway) as co-chair with support from Ketil Hylland (Norway) for a period of 3 years. The group thanked the outgoing chairs for their efforts.

Recommendation: WGBEC, WGMS and MCWG meet concurrently in 2014 at Copenhagen to address common ToRs identified in section 2.

3 Appointment of rapporteurs and ICES matters

Rapporteurs for the agenda items were selected and a number of emerging ICES issues were discussed by the group. The draft text for the WG webpage was reviewed and amended to better reflect the objectives of the group. Some more appropriate photographs were selected and these will be sent to the secretariat for amendment. Relevant conferences and workshops were brought to the attention of the group. These include the ICES symposium "Pollutant Responses in Marine Organisms" (PRIMO) to be held in Faro in May 2013, and the ICES workshop on linking contaminants to integrated ecosystem assessments (WKLINCON) to be held in Copenhagen at ICES, October 2013. There was some concern expressed about the lack of engagement from the ICES integrated ecosystem assessments community in the proposed WKLINCON. The workshop chairs agreed to discuss with the relevant Steering Group Chair in ICES. The marine litter theme session at ASC 2013 in Reykjavik, Iceland was also advertised and the outcome of the MSFD theme session and discussions concerning integrated ecosystem assessments at ASC 2012 in Bergen, Norway were reviewed.

4 Respond to requests for advice from the Regional Seas Conventions (e.g. OSPAR) and other EGs as required (ToR a)

4.1 OSPAR MIME

WGBEC had received no official requests for advice from OSPAR via the ICES secretariat. However, WGBEC were aware that OSPAR MIME at their 2012 meeting had been discussing the integrated assessment of contaminants with biological effects (SGIMC approach) and the role of biological effects in monitoring programmes. Thierry Burgeot (FR) had attended the MIME meeting on behalf of WGBEC and ICON and presented the integrated assessment of biological effects and contaminants in the North Sea (ICON programme) as a demonstration of the SGIMC integrated approach.

WGBEC reviewed the OSPAR MIME summary report and welcomed the increased consideration of biological effects during the meeting. OSPAR MIME had identified a need to reduce the size of the suite of biological effect techniques in the SGIMC integrated approach and had attempted to select some techniques as 'Common indicators'.

WGBEC is of a strong opinion that reduction of the SGIMC suite of methods will reduce the possibility to detect effects of contaminants in marine ecosystems. WGBEC is also concerned about the process that has resulted in the selection of biological effects methods as 'Common Indicators'. The methods selected are not considered to represent a relevant and robust set of methods to detect effects of contaminants. Any reduction in the number of techniques used for monitoring purposes either within the SGIMC integrated approach or as choice indicator techniques should be evidence-based with clear rationale. In this respect WGBEC would like to offer its expert advice in any decision process for reducing the set of biological effect techniques for monitoring purposes.

In addition, there is an important need for OSPAR to determine a monitoring design strategy i.e the application of the integrated approach, deployment of any techniques, with regard to targeted application, frequency of monitoring, statistical aspects of designing a monitoring programme and techniques for combining assessments across regional scales. Again, WGBEC would like to offer its expect advice in this area should the need arise.

ICES Secretariat should advise OSPAR MIME that should they require further advice on this matter for their 2013 deliberations on integrated assessment, WGBEC would be willing to provide such intersessionally.

ICES WGBEC was also asked to advise on suggested amendment to EAC values for bioassays and Scope for Growth in mussels by Spain. This was addressed by the group and reported here under agenda item 9 below.

4.2 Response to other expert groups

4.2.1 WGEEL

Area of mutual interest: Are contaminants in eels contributing to their decline?

WGBEC and WGEEL in their 2012 reports identified the possibility to collaborate inter sessionally in 2013 and to this end propose to address the following over-reaching questions as a TOR.

a) To describe the spatial and temporal trends in concentrations of "traditional" and/or "emerging" contaminants in eel (but mainly refer to figs available from WGEEL 2008-2012).

b) To describe the potential impacts of contaminants on reproduction in the European eel, based on science of eel and what can be learned from other species models (including endocrine disruption, effect on sex ratio, maternal transfer of bioaccumulated contaminants toward the eggs and effects on the larvae).

c) To describe the potential impacts of contaminants on lipid metabolism and migration in the European eel based on eel science and what can be learned from other species

d) To review the impacts of contaminants on the genetics of the European eel.

e) To explore whether there is experience with assessing/qualifying the bioaccumulation + fitness status in other species, which can be helpful for the eel's quality assessment (Eel Quality Index).

Modus operandi

WGBEC have identified a subgroup who are prepared to contribute to this collaboration:

John Thain(UK), James Readman (UK), Dick Vethaak (NL), Ulrike Kammann (DE), Katja Broeg (DE), and Jakob Strand (DK). WGEEL group members to be identified. Subject to a workplan being agreed with WGEEL, WGBEC will divide up tasks among the subgroup. WGEEL was consulted during the meeting and agreed to provide access to a contaminant database (held by WGEEL) to members of WGBEC to help with this activity. The TOR listed above have been agreed in principle by members of WGEEL but may require amendment. Initially activities will be undertaken by correspondence as WGBEC group members did not have funding for a workshop at this stage, but the possibility of a back to back meeting or workshop will be considered at a later date.

4.2.2 WGMS

In their 2012 report included a recommendation to WGBEC to advise on the suitability of GES targets for contaminants having specific regard to sediment composition e.g. grain size, type of organic matter. The group briefly looked at this issue, but it was not clear what GES targets were being referred to and there was no further explanation provided in the text of the WGMS report that could be identified. WGBEC is content to consider this issue but needs further explanation of the targets involved and factors being referred to. This could be suitable for discussion during the proposed joint meeting in 2014.

4.2.3 WGPDMO

WGBEC asked WGPDMO to make available the tools for conducting the Fish Disease Index assessment at their meeting in 2013. During the meeting WGBEC was made aware that WGPDMO had agreed to rewrite the assessment tool in 'R' and make it available. This was welcomed by the group.

4.2.4 WKPSPD

The chairs had been contacted prior to the meeting by a co-chair of the passive sampling workshop with a request to consider the suitability of toxicity data in the literature for determining suitable assessment criteria for passive samplers. WGBEC agrees that this would be a suitable activity for the group but requires more exposure to the issues (BAC and EAC derivation process for contaminants in water, access to the workshop report and the full list of references identified by the workshop). When these are available WGBEC would like to work on this issue in advance of the proposed joint meeting with MCWG and WGMS in 2014 (Dick Vethaak, NL; Ketil Hylland, NO; Craig Robinson, UK).

Recommendation: **ICES Secretariat should advise OSPAR MIME that should they require further advice on integrated assessment for their 2013 deliberations on integrated assessment, WGBEC would be willing to provide such intersessionally.**

Action: WGBEC ro respond intersessionally with chairs/group members of WGEEL, WGMS, WGPDMO, MCWG and WKPSPD.

5 Consider emerging issues of scientific merit and address knowledge gaps (in relation to the ICES Science Plan) (ToR b).

5.1 Oil toxicity to early life stages of fish

WGBEC had received a request from Tracy Collier (USA) to consider recent studies demonstrating phototoxicity of bunker fuel combined with the fieldwork after the Cosco Busan spill. This may represent the strongest case yet for phototoxicity in a field setting. Note that this appears to be associated with bunker fuel exposures, and not with crude oil.

WGBEC was asked to address the findings that very low ppb levels of tricyclic PAHs, found in weathered oils, are embryotoxic and consider the implications for altering e.g. OSPAR EACs on the information available thus far, and what types of information would be useful to strengthen the case more.

Three papers were provided as background material:

Incardona JP et al. 2012. Unexpectedly high mortality in Pacific herring embryos exposed to the 2007 Cosco Busan oil spill in San Francisco Bay. PNAS 109 (2): E51-E58.

Incardona JP, Collier TK, Scholz NL. 2011. Oil spills and fish health: exposing the heart of the matter. J. Exp. Sci and Env. Epidem. 21(1): 3-4.

Incardona JP, et al. 2012. Potent Phototoxicity of Marine Bunker Oil to Translucent Herring Embryos after Prolonged Weathering. Plos One; 7 (2): e30116.

These publications demonstrate that developing fish embryo and larvae are highly sensitive to different types of PAHs, and that this toxicity is dependant on oil composition, weathering and photo sensitization. Environmental Assessment Criteria for PAHs are at present very scarce (OSPAR Environmental Assessment Criteria, 2012) and a better resolved dataset of EACs on should be elaborated for the oil toxicity to early life stages of fish based on the recent published work. WGBEC appreciate the initiative from Tracy Collier and would be interested in suggestions for EACs of PAHs in water and egg/larvae from Collier and colleagues or other researchers in this field. Such data would be highly valuable for risk assessments of oil exposures to early life stages of fish.

It was brought to the attention of WGBEC that during the 36th Annual Larva Fish Conference held outside Bergen, Norway, 2-6 July 2012, there was a session on effects of oil and natural gas surveys, extraction activity and spills on fish early life stages. Link to conference website: http://www.larvalfishcon.org/conf_home.asp?conferencecode=36th

Considering the information provided above and discussions WGBEC decided to follow the approach below to progress this ToR over the next two years.

1) Review suitability of existing assessment criteria for hydrocarbons in light of new toxicity data to larval fish.

2) Identify uncertainties and knowledge gaps and place these in context of environmental risk assessment framework

3) Account for photooxidation and risk factors relevant to life history and ecology of sensitive species such as exposure to surface micro-layers

4) Produce a review with appropriate recommendations for environmental assessments

This will be worked on by Bjorn Einar Grøsvik (NO), Ketil Hylland (NO), Ulrike Kamman (GE), Sonnich Meier (NO) and North American authors identified above will be invited to contribute to this process.

5.2 Ocean Acidifcation

In contrast to Climate Change, ocean acidification was not addressed in the ICES Science Plan 2009 – 2013 although it is widely considered as a severe emerging problem. Therefore, WGBEC urges ICES to adopt the topic in the new Science Plan. For some years Ocean Acidification and its consequences to ecosystems were recognized as a global problem and have attracted enormous attention. This is reflected by the large number of reports, papers, reviews and integrated science strategies for Ocean Acidification monitoring, research, impact assessments and networking initiatives that emerged in the literature during recent years. In 2010, an ICES document was prepared following a special OSPAR request for advice on monitoring methodologies for ocean acidification (ICES Advice 2010, book 1). In summary, the measurements of two, and preferably three, of the following physical parameters should be monitored: total alkalinity (TA), dissolved inorganic carbon (DIC), partial pressure of CO2 (pCO2) and pH and all waters from estuaries, shelf seas and ocean mode waters and abyssal waters where sensitive ecosystems may be, should be covered. Other programs also recommend additional measurements of temperature, salinity, oxygen and nutrients critical to primary production (NRC, 2010).

Ocean acidification research is in its infancy and most of the knowledge is gathered in recent years but it is clear that ocean acidification may threaten marine ecosystems and the services they provide. Most research on the biological effects of ocean acidification has dealt with acute responses in a few species, and very little is known about the impacts on many ecologically or economically important organisms, their populations, and communities.

WGBEC noted the report from the newly formed Study Group on Ocean Acidification (SGOA) which contained a short section on biological effects of the phenomenon including a table of sources of information and potential effects that might be worth monitoring. It was clear that this area would need further input during the life of the study group. It was noted during discussion that there were several ongoing mesocosm experiments around Europe that might yield new information on effects and suitable endpoints for monitoring (Netherlands, Italy, Norway, UK). WGBEC members were aware of several significant reviews of this issue. The group developed the following strategy for the remainder of its 3 year ToR:

1) To review the existing literature for recommendations on suitable species / endpoints for monitoring

2) To focus efforts on those parameters relating to the expertise of WGBEC (endpoint measurements in individuals / populations rather than e.g. biogeographic trends etc)

3) To account for in-combination effects with other climate change variables (e.g. carbonate chemistry changes and temperature)

4) To produce a written review for publication including monitoring recommendations. This would be started in 2013 led by a small group of Kris

Cooreman (Belgium), Steve Brooks (Norway), Klaas Kaag (Netherlands), Aldo Viarengo (Italy), Matthew Sanders (UK).Documents for review and activity are to be recorded in the ocean acidification folder on the 2013 SharePoint site.

Recommendation: That SCICOM should consider including OA specifically in the revised ICES science plan

Recommendation: that the WGBEC subgroup identified to work on effects of ocean acidification attend future meetings of the SGOA to get better communication and foster joint working.

5.3 Immunotoxicity

Ketil Hylland (NO) gave an overview of current understanding of immunotoxicology in fish, with particular focus on Atlantic cod. Immunotoxicology is a challenging research area even for mammalian systems and even more so for fish as any response to toxic substances will be affected by age, sex, diurnal and seasonal cycles, nutritional state and health state of the individual. In addition there are obvious species differences, so any determination of immuntoxicological impact will have to be tailored for the species used. Most of the studies available on fish immune systems have, for obvious reasons, focused on general characterization.

Until the present, most studies on immune modulation in fish by toxicants have quantified functions of macrophages (respiratory burst, phagocytic activity) or innate components of the immune system. More recently, studies have also addressed changes in the expression of relevant genes and cell-dependent immunity.

Environmental immunotoxicology was discussed by WGBEC in 2011 and 2012, based on reviews by Tom Hutchinson (UK) and Andrea Johnson (US), respectively.

The aim of the group over the 3-year period is to develop or identify methods by which to assess environmental immunotoxicity in marine ecosystems. Following on from the internal reviews presented the past couple of years, WGBEC decided a strategy for the 3-year period (Table 5.3).

Table 5.3. Tasks and deadlines for WGBEC immunotoxicology strategy.

Task/deliverable	Type product	Deadline	Lead
review of issues and status	scientific paper	end 2013	Ketil Hylland
review and selection of methods/endpoints	presentation, discussion	WGBEC 2014	to be decided
review methods/endpoints	scientific paper	end 2014	to be decided
protocol for immunotoxicology "biomarkers"	presentation, discussion	WGBEC 2015	to be decided
case studies using protocol	scientific papers	Subsequent 3 year reporting cycle	members of team

The 2013 WGBEC meeting identified Johan Aerts, Dick Vethaak and Ketil Hylland as members to be involved in the continuing work on immunotoxicology, in addition to members who have previously shown interest (Tom Hutchinson, Andrea Johnson).

6 Review status of publications and consider requirements for new publications (ToR c)

6.1 ICES TIMES

WGBEC reviewed status with ICES TIMES manuscripts and revised deadlines as appropriate. Several new manuscripts were produced in draft for the meeting to review. Status of the manuscripts was deemed satisfactory. One new draft resolution may be required in 2013 for the publication of previously cancelled manuscript MHC02 blue mussel histopathology by Bignell et al., (awaiting confirmation from co-author).

The current status of WGBEC TIMES manuscripts is given in table 6.1 below.

Table 6.1 Current status of ICES TIMES publications

Resolution Ref	Deadline	Description	Comment on status
2012/1/SSGHIE08	30/04/13	The report on the COMET assay for fish and mussels Author/Editor: Tim Bean (UK) and Farida Akcha (France).	Draft manuscript produced and presented for review at WGBEC 2013. May need additional methods section adding no change to deadline.
2012/1/SSGHIE09	30/04/13	The report on the Condition Index for fish and mussels. Author/Editor: John Thain (UK), Matthew Gubbins (UK), Concepcion Martinez Gomez (ES), and Lennart Balk (SE).	This is referred to also as 'supporting parameters'. Document very close to completion still expected by end of April.
2012/1/SSGHIE10	30/04/13	The report on the Stress On Stress assay for mussels. Author/editor: John Thain (UK) and Concepcion Martinez Gomez (Spain).	First draft completed and preliminary review conducted at WGBEC. No change expected to delivery deadline.
2012/1/SSGHIE11	31/07/13	The report on the Lysosomal Membrane Stability in the Blue Mussel Author/editor: Concepcion Martinez Gomez (Spain), John Bignell (UK) and David Lowe (UK).	Amended document completed as first draft and preliminary review conducted at WGBEC. No change to delivery date expected.
2009/1/SCICOM08	30/11/12	The method for determining 'Reproductive Success in Eelpout' Author/Editor: Jakob Strand (Denmark) Reviewer: WGBEC/SSGHIE	Has been 'close to completion' for > 1 year. No response from author prior to WGBEC. Need to revise delivery date.
2006/1/MHC06	08/10/12	The Protocol for Extraction Methods for Bioassays Author/Editor: Hans Klamer (NL), Steve Brooks (NO) and John Thain (UK) Reviewer: Chair of SSGHIE	Manuscript sent to ICES and confirmed as received by Paul Keizer July 2013.

Resolution Ref	Deadline	Description	Comment on status
2006/1/MHC07	08/10/12	The protocol for conducting EROD determinations in flatfish Author/Editor: Compiled by M. Gubbins, WGBEC members Reviewer: Chair of SSGHIE	This manuscript has been reviewed by WGBEC and accepted edits will be sent to ICES by 30/04/13. For publication as a minor revision to TIMES 23.
2008/1/MHC13		Protocol for measuring dioxin-like activity in environmental samples using LUC assays. Author/Editor: Cor Schipper, Dick Vethaak et al (Netherlands)	TIMES 54 Awaiting publication
2002/1E03		Biological Effects of Contaminants: Oyster (Crassostrea gigas) Embryo Bioassay Author/Editor: John Thain (UK)	TIMES 55 Awaiting publication
2007/1/MHC02		Blue Mussel Histopathology Author/Editor: John Bignell, Steve Feist, Dave Lowe and MirenCajaraville	Removed 2012. Draft manuscript still in progress. Draft resolution required later.
2008/1/MHC14		The protocol for measuring micronucleus formation in cells as an indicator of toxicant induced genetic damage Author/Editor: Brett Lyons (UK)	Removed 2012. Existing Nature protocol identified as suitable and could be used as a standard method reference. Bolognesi, C. And Fenech, M.. 2012. Mussel Micronucleus Cytome Assay. NATURE PROTOCOLS, 2012, Vol7, No 6, p.1125-1137. Published online 17 May 2012; doi:10.1038/nprot.2012.043
2008/1/MHC15		Protocol for measuring estrogen/androgen activity in environmental samples using the YES/YAS yeast screen assays Author/Editor: John Thain (UK) and Kevin Thomas (Norway)	Removed. Author unable to work on this until late 2013.
2008/1/MHC12		The protocol for gonadal histology in flounder Author/Editor: Steve Feist and co-authors	Removed. Document not being progressed.

Resolution Ref	Deadline	Description	Comment on status
2006/1/MHC09		The protocol for measuring multi-drug / multi-xenobiotic resistance (MDR/MXR) in blue mussels by calcein and efflux Author/Editor: A. Kolhler (Germany)	Permanently removed.

Requirements for new TIMES manuscripts were discussed. The possibility of a method manuscript for litter monitoring was raised. This will be revisited after EU protocols have been defined.

6.2 Other publications

The publication by ICES of the collaborative research report on integrated monitoring and assessment (ICES CRR 315) was noted by WGBEC. Dick Vethaak (Netherlands) outlined a publication plan for putting the key aspects of this information in the peer review journal 'Chemosphere' together with a demonstration case study. Ketil Hylland (Norway) presented the 'ICON' project publication plan as a series of peer review papers in a special edition of 'Marine Pollution Bulletin' (MPB). Authors have been contacted to confirm authorship, deadlines and length of publications. This information will be forwarded to the MPB editor.

It is expected that further publications will arise from the review activity being conducted by WGBEC under agenda items 5, 10, 11.

Action: Chair(s) and TIMES editor to monitor progress of manuscripts to comply with deadlines.

7 Report progress on AQC activities for biological effect methods including harmonization activities initiated from WGBEC and within OSPAR, HELCOM and MEDPOL maritime areas; (ToR d)

Any biological effect method to be used for national or international monitoring programmes should be subject to appropriate internal and external AQC, particularly as this is a requirement for submitting data to the ICES database. It is likely that the role of AQC will take on an even greater importance with the use of biological effect methods for monitoring GES (Descriptor 8) in the EU MSFD.

At its meeting in 2012 WGBEC discussed AQC activities for biological effect methods and agreed to initiate a low cost programme for EROD and PAH bile metabolites. It was reported (JT) that Cefas UK, had collected samples of fish liver and bile from wild-caught fish and distributed these to interested laboratories, 11 in total from Norway, Denmark, France, Germany, Spain, The Netherlands and the UK. Data from this exercise would be processed and reported in full at the WGBEC 2014 meeting.

It was noted at the 2012 meeting that QUASIMEME had been unable to run an imposex AQC round due to a lack of participants. Several members of WGBEC indicated their interest in another intercalibration exercise and as a result Klass Kaag contacted QUASIMEME in this respect. In June-August ten participants took part in the exercise with between 70-80% of the laboratories provided satisfactory results (see QUASIMEME report BE-1 imposex and intersex in marine snails: issue 1:19th Dec 2012).

WGBEC are not aware of any AQC activities underway in the HELCOM maritime area.

Prof, Aldo Viarengo reported that MEDPOL were anticipating receiving funding in the near future for intercalibration exercises with LMS neutral red, micronuclei and lipofucsin. He agreed to inform the group when this activity is underway.

Ketil Hylland informed the group of an intercalibration exercise on LMS (neutral red) in mussels taking place in 2013 involving Norway, Sweden and Denmark. This is being led by Sweden and it is unclear if this could be expanded to include additional participants outside the Nordic region.

Action: intersessional work (Thomas Maes on behalf of Cefas (UK)) on processing EROD and PAH bile metabolite sample exchange exercise

8 Response to requests for advice from the ICES Data Centre (ToR e)

WGBEC received requests for clarification on data submission issues from OSPAR MIME (Rob Fryer, UK) and responded to specific queries regarding imposex, EROD, ALA-D, PAH bile metabolites and AChE parameters. These queries were answered and sent to ICES data centre and Rob Fryer. The details of the response are also recorded on the WGBEC 2013 sharepoint site. Some residual issues remain to be addressed between the Data Centre and the Chair of WGBEC during April.

Guidance was also provided to the Data Centre on requirements for reporting formats for marine litter and there was an interest expressed by some members to participate in a likely forthcoming workshop on developing the report formats to accept such data types.

It was noted during the meeting that there is a lack of understanding of reporting format issues within WGBEC. This is caused by an absence of data submitters from the group and difficulties in comprehending the nature of the requests coming from ICES. WGBEC felt that while it was best placed to advise on issues of data quality, suitability, supporting data requirements etc, greater communication with those familiar with the reporting formats and database structure is required in order to be able to respond adequately to requests from the Data Centre. It was suggested that a list of contacts be generated to create a distribution list for communications regarding biological effects reporting formats by data type / parameter. WGBEC can identify the 'experts' for advice by parameter, but would need assistance from the ICES Data Centre to identify the data submitters with the experience of the reporting formats / database. These contacts could then be used to respond to future requests for advice, coordinated by WGBEC as appropriate.

Recommendation: That the Data Centre should provide to WGBEC a list of contacts submitting biological effects data.

Recommendation: Future requests for advice on data Centre issues are requested at least 3 months before the meeting to allow time to find relevant experts to advise.

9 Development and harmonization of methodologies for marine monitoring (ToR f)

9.1 Integrated assessment

WGBEC received presentations from Ketil Hylland (NO) on the ICON integrated assessment demonstration programme and Aldo Viarengo (IT) on an integrated approach being used in Italy. Details of these are available on the WGBEC 2013 sharepoint. It was identified that a number of continuing uncertainties with application of the SGIMC assessment framework persist and that a 'procedure document' detailing these should be produced to encourage consistency of application as well as develop a confidence or robustness indicator.

Action: ICON steering group – produce a procedure manuscript and robustness indicator for integrated monitoring datasets to aid the development of case studies.

With the interim adoption of the SGIMC approach by OSPAR on a 3-year trial basis there is a request to Contracting Parties to provide evidence of application and assessment of the value of the new approach (cf OSPAR MIME 2012). WGBEC therefore collated examples of national and international case studies either completed, planned or in progress across the ICES/OSPAR regions to keep track of progress with case studies:

ICON integrated assessment demonstration programme (Integrated assessment of contaminant impacts on the North Sea (ICON). Interim final assessment for consideration by MIME 2012: doc OPSAR MIME 12/3/5-E (L).)

Integrated assessment of the Firth of Forth area of Scotland using the SGIMC framework (Robinson, C.D., Gubbins, M.J., Lyons, B.P., Bignell, J., Bean, T., MacNeish, K., Dymond, P., Dobson, J., and Thain, J.E. Assessing Good Environmental Status for Descriptor 8 – an integrated assessment of contaminants and their biological effects across multiple matrices in the Firth of Forth, Scotland ICES CM2012:G).

Integrated assessment of the Humber estuary, UK http://berlin.setac.eu/embed/Berlin/ET_extended_abstracts_Part2.pdf

Integrated assessment of the Thames estuary, UK (documentation pending?)

In the Dutch national JAMP, fish-disease monitoring with dab and flounder has been integrated with residue-contaminant measurements (including exposure biomarkers such as biliary PAH metabolites) and contaminants in sediment, and supporting biological and hydrographical data. The integrated approach allowed evaluation of one facet of coastal and estuarine ecosystem health, but at the same time demonstrates that migration patterns play a critical role in explaining the distribution of chronic diseases such as liver neoplasms in flatfish.

Vethaak, A.D., Pieters, J., Jol, J.G. (2009). Long-term trends in the prevalence of cancer and major diseases among flatfish in the S.E. North Sea as indicators of changing ecosystem health. Env. Sci. Techn. 43: 2151–2158.

Integrated assessment and demonstration with Seine estuary (France) ICON data. Reported by Thierry Burgeot in WGBEC 2012 report section 5.3.2.

Spanish case studies:

MAGRAMA. 2012. Estrategias Marinas- Evaluación inicial, buen estado ambiental y objetivos ambientales. DEMARCACIÓN MARINA NORATLANTICA. DESCRIPTORES DEL

BUEN ESTADO AMBIENTAL 8. CONTAMINANTES Y SUS EFECTOS BIOLOGICOS. Autores (IEO): Lucía Viñas, Juan Bellas, Mª Victoria Besada, Mª Ángeles Franco, José Fumega, Amelia González-Quijano.Unidad solicitante: Dirección General de Sostenibilidad de la Costa y del Mar. Ministerio de Agricultura, Alimentación y Medio Ambiente. http://www.magrama.gob.es/es/costas/temas/estrategias-marinas/IV_D8_Noratlantica_tcm7-207277.pdf

MAGRAMA. 2012. Estrategias Marinas- Evaluación inicial, buen estado ambiental y objetivos ambientales. DEMARCACIÓN MARINA DEL ESTRECHO Y ALBORÁN. DESCRIPTORES DEL BUEN ESTADO AMBIENTAL 8. CONTAMINANTES Y SUS EFECTOS BIOLOGICOS. Autores (IEO): José Benedicto, Juan Antonio Campillo, Beatriz Fernández, Concepción Martínez-Gómez, Víctor M. León. Unidad solicitante: Dirección General de Sostenibilidad de la Costa y del Mar. Ministerio de Agricultura, Alimentación y Medio Ambiente. http://www.magrama.gob.es/es/costas/temas/estrategias-marinas/IV_D8_Estrecho_y_Alboran_tcm7-207246.pdf

MAGRAMA. 2012. Estrategias Marinas- Evaluación inicial, buen estado ambiental y objetivos ambientales. DEMARCACIÓN MARINA LEVANTINO-BALEAR. DESCRIPTORES DEL BUEN ESTADO AMBIENTAL 8. CONTAMINANTES Y SUS EFECTOS BIOLÓGICOS. Autores (IEO): José Benedicto, Juan Antonio Campillo, Beatriz Fernández, Concepción Martínez-Gómez, Víctor M. León. Unidad solicitante: Dirección General de Sostenibilidad de la Costa y del Mar. Ministerio de Agricultura, Alimentación y Medio Ambiente. http://www.magrama.gob.es/es/costas/temas/estrategias-marinas/IV_D8_Levantino-Balear_tcm7-207261.pdf

Norway will also perform a biomonitoring programme around two offshore oil and gas platforms in the North Sea in 2013. A suite of biological effects markers and chemical analyses will be used to assess the potential impact of drilling discharges from these two offshore platforms. Data collected will include chemical concentrations (PAH, NPD, metals) and biomarker responses (PAH metabolites, DNA adducts, COMET, EROD, LMS, AChE, histology) in up to three fish species. Invertebrates will also be collected for additional chemical and biomarker measurements. It is proposed that the chemical and biomarker data from this programme will be assessed following the integrated assessment framework for contaminants and biological effects for application to determine Good Environmental Status (GES) for descriptor 8 of Marine Strategy Framework Directive (MSFD) (SGIMC, 2011).

9.2 Review and develop assessment criteria for biological effects methods

WGBEC maintains an active list of up to date assessment criteria to account for changes in available data concerning background values at reference sites for BACs and new toxicity data for EACs. New data types and monitoring species may also be added to the compiled list of criteria subject to the approval of the group. During 2013 representations were received from Germany to revise the BAC for HPLC-F analysis of 1-OH pyrene and 1-OH phenanthrene in (Baltic) herring; from Spain to revise the BAC values of EROD, micronucleus and AChE in red mullet and the BAC and EAC values of SFG in mussels. These were accepted and are shown as amendments to the original values in the assessment criteria log at Annex 2 below.

Recommendation: That the ICES secretariat inform OSPAR that WGBEC in accordance with a 2011 request, has continued to revise the biological effect assessment criteria developed in 2011 by the ICES/OSPAR SGIMC process, and to forward to OSPAR MIME the current revised list of assessment criteria as in Annex 2.

9.3 Report on national monitoring programmes

National reports on recent monitoring and research activity were received in the form of reports and text contributions by correspondence from Spain (including Basque country), Germany and France. Details on these reports are curated on the 2013 SharePoint and it is intended to continue to build an accurate reflection of the sum of national biological effects monitoring over the next two meetings and compile this information in the form of a manuscript for the final 2015 report.

10 Novel and emerging compounds (e.g.) pharmaceuticals, recreational drugs and biocides in the marine environment (ToR g).

During the meeting three presentations were provided on the issue of emerging compounds in the marine environment. The first presentation by Steven Brooks (NO) showed the detection of illicit drugs in urban water ways and the pattern of drug use within 30 major European cities. The effects of recreational drugs in the marine environment were presented as negligible with low concentrations measured in the environment due to the adequate wastewater treatment.

The two presentations on biocides in the marine environment included the occurrence of zineb and ethylenethiourea (ETU) presented by Steven Brooks and the toxicity of booster biocides and their mixtures to larvae of selected marine organisms presented by Juan Bellas. The zineb transformation product ETU was detected within the particulate fraction at low μg/L concentrations that could show environmental risk to marine organisms. High toxicity of alternative antifouling compounds was observed. More studies on their degradation and the toxicity of their degradation products are needed. The inclusion of the combined effects of antifoulants in water quality regulations is advocated to develop appropriate regulatory strategies.

It was agreed following discussions that further information be acquired on the quantities used and the overall input of booster biocides to the marine environment, with the aim to provide more information on the overall risk of these biocides to marine organisms within marina and harbours.

Other groups of emerging contaminants not presented, such as pharmaceuticals, will be considered to determine whether they pose a risk to the marine environment.

Following discussion it was decided to follow the subsequent strategy for delivery of this ToR

1) Continue to receive updates on inputs, concentrations and effects of emerging contaminants including: biocides, pharmaceuticals, nanoparticles and recreational drugs and in-combination effects

2) Consider the above in the context of environmental risk assessment

3) Produce a review document for each of these issues by 2015 highlighting advances made, continued knowledge gaps and recommendations for environmental monitoring.

A subgroup was identified to progress this issue. Steve Brooks (NO), Kevin Thomas (NO), Juan Bellas (SP).

11 To evaluate the results of marine litter monitoring and research activities, especially microparticles (plastic/non plastic) and associated chemicals (ToR g)

WGBEC received presentations from Thomas Maes (UK) concerning European project MICRO and the UK national monitoring for Descriptor 10. Dick Vethaak presented the national Dutch litter monitoring and research projects and the EU FP7 project CLEANSEA. Bjorn Einar Grøsvik presented the EU project BIOCLEAN and Steve Brooks (NO) presented the MIME project. It was apparent that all of these projects are ongoing at present and there is a need for coordination to share protocols and knowledge and avoid duplication of effort across Europe.

11.1 Status on monitoring protocols for marine litter in biota

Further developments taking place in TSG10, who is aiming to produce a final report by June 2013. Method uptake, testing, QA development and harmonization by national monitoring of member states and within EU funded projects such as CleanSea/MICRO/...

- EU MSFD Technical Group Descriptor 10 http://www.ices.dk/projects/MSFD/TG10final.pdf
- Marine Litter : Technical Recommendations for the Implementation of MSFD Requirements http://publications.jrc.ec.europa.eu
- MICRO www.ilvo.vlaanderen.be/micro
- CleanSea www.cleansea-project.eu

11.2 Marine litter research outcomes and results of impact assessments on key marine organisms. Evidence of bioaccumulation, toxicity and adverse physical, biological and chemical effects of microplastics and associated contaminants on a range of marine organisms, populations and communities.

WGBEC discussed several examples from peer reviewed literature.

E.g.: Occurrence of plastic particles in fish from English channel (Lusher, 2012), ingested fishing line by nephrops in Clyde sea (Murray, 2011), uptake of microplastics by mussels from Belgian breakwaters as shown by fieldwork (Claessens, 2011), ingestion of microplastics by Arenicola leading to behavioural changes (Besseling et al., 2013), accumulation of plastic-derived chemicals in tissues of seabirds ingesting marine plastics (Tanaka, 2013), marine litter ingestion by stranded Sperm Whale in Spain (De Stephanis, 2013), plastic ingestion by harbour seals (Rebolledo, 2013)

11.3 Evidence of transfer of microplastics and associated contaminants through marine food chains.

A first study has been published, showing the 'natural' trophic transfer of microplastic, from mussels and its translocation to haemolymph and tissues of a crab (Farrell, 2013).

Recommendation: that the EU Commission set up instruments to ensure communication and collaboration between these 4 large EU projects.

References

Besseling et al., Effects of Microplastic on Fitness and PCB Bioaccumulation by the Lugworm Arenicola marina (L.), Environ. Sci. Technol. 2013, 47, 593−600

Claessens et al., Occurrence and distribution of microplastics in marine sediments along the Belgian coast, Marine Pollution Bulletin 62, 2011, Pages 2199–2204.

de Stephanis, R., et al. As main meal for sperm whales: Plastics debris. Mar. Pollut. Bull. (2013)

Elisa L. Bravo Rebolledo, Jan A. Van Franeker, Okka E. Jansen, Sophie M.J.M. Brasseur, Plastic ingestion by harbour seals (Phoca vitulina) in The Netherlands, Marine Pollution Bulletin, Volume 67, Issues 1–2, 15 February 2013, Pages 200-202.

Kosuke Tanaka, Hideshige Takada, Rei Yamashita, Kaoruko Mizukawa, Masa-aki Fukuwaka, Yutaka Watanuki, Accumulation of plastic-derived chemicals in tissues of seabirds ingesting marine plastics, Marine Pollution Bulletin, Available online 5 January 2013.

Lusher, A.L., et al. Occurrence of microplastics in the gastrointestinal tract of pelagic and demersal fish from the English Channel. Mar. Pollut. Bull. (2012).

Murray, F., Cowie, P.R. Plastic contamination in the decapod crustacean Nephrops norvegicus (Linnaeus, 1758). Mar. Pollut.Bull. (2011).

Paul Farrell, Kathryn Nelson, Trophic level transfer of microplastic: Mytilus edulis (L.) to Carcinus maenas (L.), Environmental Pollution, Volume 177, June 2013.

12 Any other business

WGBEC had received a request from ex-member Lennart Balk (Sweden) to consider the emerging issue of thiamine deficiency in marine wildlife which has been linked to population-level effects in seabirds and marine fish. The issue may be linked to contaminant effects and would be of considerable interest to the group. Accordingly WGBEC would like to invite Lennart Balk to introduce the issue to the group at its meeting in 2014.

Action: Chairs to invite Lennart Balk for a specific time slot during the 2014 meeting. The ToR for 2014 are amended accordingly below at Annex 3.

13 Recommendations List

Agenda item	Recommendation
Agenda item 2:	WGBEC, WGMS and MCWG meet concurrently in 2014 at ICES HQ Copenhagen to address common ToRs identified in section 2.
Agenda item 4:	ICES Secretariat should advise OSPAR MIME that should they require further advice on integrated monitoring for their 2013 meeting, WGBEC would be willing to provide such advice intersessionally.
Agenda item 5:	That SCICOM should consider including OA specifically in the revised ICES science plan
Agenda item 5:	That the WGBEC subgroup identified to work on ocean acidification attend future meetings of ICES SGOA to get better communication and foster joint working.
Agenda item 8:	That the Data Centre should provide to WGBEC a list of contacts submitting biological effects data.
Agenda item 8:	That future requests for advice on data Centre issues are requested at least 3 months before the meeting to allow time to find relevant experts to advise.
Agenda item 9:	That the ICES secretariat inform OSPAR that WGBEC in accordance with a 2011 request, has continued to revise the biological effect assessment criteria developed in 2011 by the ICES/OSPAR SGIMC process, and to forward to OSPAR MIME the current revised list of assessment criteria as in Annex 2.
Agenda item 11:	That the EU Commission and/or ICES set up instruments to ensure communication and collaboration between 4 large EU projects on marine litter and microplastics (this may be a suitable role for a future EG on marine litter).

14 Action List

Agenda item	Action
Agenda item 4:	WGBEC ro respond intersessionally with chairs/group members of WGEEL, WGMS, WGPDMO, WGMC and WKPSPD.
Agenda item 6:	Chair(s) and TIMES editor to monitor progress of manuscripts to comply with deadlines.
Agenda item 7:	Intersessional work (Thomas Maes on behalf of Cefas (UK)) on processing EROD and PAH bile metabolite sample exchange exercise
Agenda item 9:	The ICON steering group – produce a procedure manuscript and robustness indicator for integrated monitoring datasets to aid the development of case studies.
Agenda item 12:	The Chairs of WGBEC to invite Lennart Balk for a specific time slot during the 2014 meeting. The ToR for 2014 are amended accordingly below at Annex 3.

Annex 1: List of participants

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Annex 2: Update assessment criteria in light of new data during WGBEC 2013: from agenda item 9.2

In light of the requirement for national and international assessments of monitoring data against agreed assessment criteria. WGBEC considered that it would be best practise to maintain an up-to-date record of the current recommended AC values (BAC and EAC) arising from the SGIMC process and updated as new data arise. Changes are foreseen in the calculation of BAC values based on new monitoring data from reference sites for example. Data from new sentinel monitoring species may also arise, new toxicity data may allow the calculation of new EAC values or new techniques may be added.

The current list of AC for biological effects methods is therefore replicated here (Table 9.2) and details of changes to values proposed added beneath. Where an AC value has been updated or newly included it is given in bold in the table. A new column has been added to the table to describe the summary statistic that should be used for assessment against the AC value. This will be populated at further meetings, informed by demonstration assessments such as ICON (agenda 5c).

Table 9.2. CURRENT Assessment criteria for biological effects measurements. Values are given for both background assessment levels (BAC) and environmental assessment criteria (EAC), as available. Values in bold have been updated by WGBEC in 2012 or 2013, changes made in 2013 are described below the table.

Biological Effect	Applicable to:	BAC	EAC
VTG in plasma; µg/ml	Cod	0.23	
	Flounder	0.13	
Reproductive success in fish	Eelpout, Zoarces viviparus		
Mean prevalence (%) of:	Malformed fry	1	2
	Late dead fry	2	4
	Early dead fry	2.5	5
	Total abnormal fry	5	10
EROD; pmol/mg protein pmol/min/ mg protein S9 * pmol/min/ mg microsomal protein	Dab (F)	178	
	Dab (M)	147	
	Dab (M/F)	680*	
	Flounder (M)	24	
	Plaice (M)	9.5	
	Cod (M/F)	145*	
	Plaice (M/F)	255*	
	Four spotted megrim (M/F)	13*	
	Dragonet (M/F)	202*	
	Red mullet (M)- April	208	
	Red mullet (M/F)- October 12-18 cm; GSI<1 Bottom temperature 16-20ºC	115*	
	Eelpout (F)	10	

Biological Effect	Applicable to:	BAC	EAC
PAHs Bile metabolites; (1) ng/ml; HPLC-F (2) pyrene-type µg/ml; synchronous scan fluorescence 341/383 nm (3) ng/g GC/MS * 1-OH pyrene ** 1-OH phenanthrene	Dab	16 (1) * 3.7 (1) ** 0.15 (2)	 22(2)
	Cod	21 (1) * 2.7 (1) ** 1.1 (2)	483 (3) * 528 (3) ** 35 (2)
	Flounder	16 (1) * 3.7 (1) ** 1.3 (2)	 29(2)
	Haddock	13 (1) * 0.8 (1) ** 1.9 (2)	 35(2)
	Eelpout	92 (1) * 7.9 (1) **	
	Herring	143(1) * 2.6(1) **	
DR-Luc; ng TEQ/kg dry wt, silica clean up	Sediment (extracts)	10	40
DNA adducts; nm adducts mol DNA	Dab	1	4,0
	Flounder	1	4,0
	Long Rough Dab		4,0
	Halibut		5,8
	Herring and sprat		0,39
	Cod	1.6	6,7
	Haddock	3.0	6,7
Bioassays; % mortality	Sediment, Corophium	20	60
	Sediment, Arenicola	10	50
	Water, copepod	10	50
Bioassays; % abnormality	Water, oyster embryo	20	50
	Water, mussel embryo	30	50
	Water, sea urchin embryo	10	50
Bioassay; % growth	Water, sea urchin embryo	30	50
Lysosomal stability; minutes	Cytochemical; liver all species	20	10
	Neutral Red Retention: all species	120	50
Micronuclei; 0/00 (frequency of micronucleated cells) 1 Gill cells 2 Haemocytes 3 Erythrocytes	Mytilus edulis	2.5 1 2.5 2	
	Mytilus galloprovincialis	3.9 2	
	Mytilus trossulus	4.5 2	
	Flounder	0.3 3	
	Dab	0.5 3	
	Eelpout	0.4 3	

Biological Effect	Applicable to:	BAC	EAC
	Cod	0.4 3	
	Red mullet (M/F) 12-18 cm; GSI<1 Bottom temperature 16-20ºC Autumn (October)	0.4 3	
Comet Assay; % DNA Tail	Mytilus edulis	10	
	Dab	5	
	Cod	5	
Stress on Stress; days	Mytilus sp.	10	5
AChE activity; nmol.min-1 mg prot-1 1 gills 2 muscle tissue 3 brain tissue * French Atlantic waters ** Portuguese Atlantic waters + French Mediterranean Waters ++ Spanish Mediterranean Waters +++ Baltic sea	Mytilus edulis	30 1*	21 1*
		26 1**	19 1**
	Mytilus galloprovincialis	291+	201+
		15 1++	10 1++
	Flounder	235 2*	165 2*
	Dab	150 2*	105 2*
	Red mullet	155 2+	109 2+
	Red mullet (M/F) 12-18 cm; GSI<1 Bottom temperature 15-16ºC Autumn (October)	1183++	833++
	Eelpout	124 2+++	87 2+++
Externally visible diseases*** Ep,Ly,Ul Ep,Ly,Ul Ac,Ep,Fi,Hp,Le,Ly,St,Ul,Xc Ac,Ep,Fi,Hp,Le,Ly,St,Ul,Xc Ac,Ep,Hp,Le,Ly,St,Ul,Xc Ac,Ep,Hp,Le,Ly,St,Ul,Xc Italics: ungraded, bold: graded NA: Not applied	Dab	Fish Disease Index (FDI): F: 1.32, 0.216 M: 0.96, 0.232 F: 1.03, 0.349 M: 1.17, 0.342 F: 1.09, 0.414 M: 1.18, 0.398 M: males F: females	Fish Disease Index (FDI): F: NA, 54.0 M: NA, 47.7 F: 50.6, 19.2 M: 38.8, 16.1 F: 48.3, 21.9 M: 35.2, 16.5

Biological Effect	Applicable to:	BAC	EAC
Liver histopathology-non specific	Dab	NA	Statistically significant increase in mean FDI level in the assessment period compared to a prior observation period or Statistically significant upward trend in mean FDI level in the assessment period
Liver histopathology-contaminant-specific	Dab	Mean FDI <2	Mean FDI ≥ 2 A value of FDI = 2 is, e. g., reached if the prevalence of liver tumours is 2 % (e. g., one specimen out of a sample of 50 specimens is affected by a liver tumour). Levels of FDI ≥ 2 can be reached if more fish are affected or if combinations of other toxicopathic lesions occur.
Macroscopic liver neoplasms	Dab	Mean FDI <2	Mean FDI ≥ 2 A value of FDI = 2 is reached if the prevalence of liver tumours (benign or malignant) is 2 % (e. g., one specimen out of a sample of 50 specimens is affected by a liver tumour). If more fish are affected, the value is FDI > 2.

Biological Effect	Applicable to:	BAC	EAC
Intersex in fish; % prevalence	Dab Flounder Cod Red mullet Eelpout	5	
Scope for growth Joules/hr/g dry wt.	Mussel (Mytilus sp.) (provisional, further validation required)	25	15
Hepatic metallothionein ìg/g (w.w.) 1 Whole animal 2Digestive gland 3Gills * Differential pulse polarography	Mussel edulis	0.6 1* 2.0 2* 0.6 3*	
	Mytilus galloprovincialis	2.0 1* 3.92* 0.6 3*	
Histopathology in mussels	VVbas: Cell type composition of digestive gland epithelium; µm3/µm3 (quantitative)	0.12	0.18
	MLR/MET: Digestive tubule epithelial atrophy and thinning; µm/µm (quantitative)	0.7	1.6
	VVLYS and Lysosomal enlargement; µm3/µm3 (quantitative)	VvLYS 0.0002	V>0.0004
	S/VLYS: µm2/µm3	4	
	Digestive tubule epithelial atrophy and thinning (semi-quantitative)	STAGE ≤1	STAGE 4
	Inflammation (semi-quantitative)	STAGE ≤1	STAGE 3
Imposex/intersex in snails VDSI	Nucella lapillus	<0.3	<2

*****: Assessment criteria for the assessment of the Fish Disease Index (FDI) for externally visible diseases in common dab (*Limanda limanda*). Abbreviations used: Ac, *Acanthochondria cornuta;* Ep, Epidermal hyperplasia/papilloma; Fi, Acute/healing fin rot/erosion; Hp, Hyperpigmentation; Le, *Lepeophtheirus sp.;* Ly, Lymphocystis; St, *Stephanostomum baccatum*; Ul, Acute/healing skin ulcerations; Xc, X-cell gill disease.**

Full details of how the original assessment criteria and how they were derived can be found in the SGIMC 2010 and SGIMC 2011 and WKIMON 2009 reports on the ICES website and in the OSPAR Background Documents for individual biological effects methods. In addition, amendments and the justification for same can be found in the ICES WGBEC report 2012.

9.2.1. Additional information for red mullet

The Spanish Oceanographic Institute (*Instituto Español de Oceanografía*, IEO) use the benthic fish red mullet as target species within the framework of the national biomonitoring pollution programme along the Spanish Mediterranean waters. Assessment criteria of hepatic EROD activity, AChE activity in brain and frequency of

micronuclei in erythrocytes of red mullet have been revised during WGBEC 2013 and updated with data available from reference sites obtained during the annual surveys of 2008 and 2010. The surveys were conducted in October (period of sexual rest or postspawing). Data from three reference sites have been used: Almería (2008), Santa Pola (2010) and Palos Cape (2010). ACs are referred to specimens within the size range [12-18] cm and with a GSI <1.

EROD *activity in red mullet*:
Data from three reference sites have been used to calculate EROD assessment criteria: Almería (2008), Santa Pola (2010) and Palos Cape (2010). Sex differences in the biomarker responses were checked for EROD activity (p-value >0.05). BAC was established as the 90th percentile of values (both genders N= 65) from the reference sites. Bottom water temperature and salinity in the reference sites ranged between 16.7-20.1 ºC and 37.3-37.5, respectively. Units of EROD activity BAC value referred male red mullet sampled in April has been corrected.

AChE activity *in red mullet*:
Data from one reference site have been used to calculate AChE assessment criteria: Palos Cape (2010). Sex differences in the biomarker responses were checked (p-value = 0.374). BAC was established as the 10th percentile of values (both genders) from the reference site(both gendersN= 17). EAC was calculated by sustracting 30% from the BAC value. Bottom water temperature and salinity in the reference sites was 15.2 ºC and 37.8, respectively.

Micronuclei frequency *in red mullet*:
Data from three reference sites have been used to calculate MN frequency assessment criteria: Almería (2008), Santa Pola (2010) and Palos Cape (2010). Sex differences were not checked due to a smaller number of specimens of each sex (<6) from some reference site. BAC was established as the 90th percentile of values (both gendersN= 37) from the reference site. Bottom water temperature and salinity in the reference sites ranged between 16.7-20.1 ºC and 37.3-37.5, respectively.

9.2.2. PAH bile metabolites in herring

During WGBEC 2013 meeting Germany made available results of measurement of PAH metabolites by means of HPLC-F in herring bile. For the herring BAC from 2012 was based on measurement of few (n=21) pooled samples it has been indicated before that an update of herring BAC for bile metabolites was desirable. The former values151 ng/ml for 1-hydroxypyrene and 4.5 ng/ml 1-hydroxyphenanthrene were substituted by 143 ng/ml for 1-hydroxypyrene and 2.6 ng/ml for 1-hydroxyphenenthrene. These new BAC are based on a dataset concerning of 149 pooled samples from the Baltic Sea and were calculated by using the lower 10th percentile of all data. However, most of the samples represent fish caught in coastal areas and even offshore regions of the Baltic Sea cannot be regarded as a reference-site like regions. So, the BAC should be updated when data from other and/or lower contaminated regions are available.

9.2.3. SFG EAC and BAC revision

The background document for SFG (in the ICES CRR 315 report) states that health-status thresholds have yet to be defined for SFG, but from the extensive datasets that exist, the following values can be estimated, based on Widdows *et al*. (1995a,b, 2002) and from other WGBEC practitioners:

- Animals may be considered to have low stress if the SFG is above +15 (J h–1 g–1).
- Animals may be considered as moderately stressed if the SFG is between +5 to +15 (J h–1 g–1).
- Animals may be considered to be highly stressed if the SFG is below +5 (J h–1 g–1).

From these observations a provisional EAC and BAC was suggested at:

- background assessment criterion (BAC) at +15 (J h–1 g–1).
- environmental assessment criterion (EAC) +5 (J h–1 g–1).

In the light of discussion at WGBEC 2012 and 2013 and in particular recent datasets and assessment by Juan Bellas Bereijo IEO Vigo, Spain, other IEO colleagues and other WGBEC members these values were re-evaluated. Using the definition that a BAC is defined as the normal range value for a healthy population and the EAC is the value below which acute and chronic effects would be expected to be observed then the SFG EAC and BAC values are defined as:

BAC > 25 (J h–1 g–1).

EAC < 15 (J h–1 g–1).

The dataset from the IEO monitoring program is obtained from 40 sampling points located along >1000 km coastline in the N-NW Spain, during 2007-2012. The methodology used for SFG assessment follows ICES TIMES#40, with a slight modification for the estimation of the absorption efficiency, which consists in using a diet of microalgae and marine silt, in order to increase the proportion of the inorganic matter in food to correctly apply the Conover method. The results obtained are similar to those reported by Widdows *et al*. (1995a,b, 2002) and, in agreement with those studies, maximum SFG values of 25 J h^{-1} g^{-1} are obtained when recommended diet conditions of 0.43 mg POM l^{-1} are used.

Annex 3: WGBEC Terms of reference 2014-2015

The **Working Group on Biological Effect of Contaminants** (WGBEC), chaired by Bjorn-Einar Grøsvik, (NO), and Ketil Hylland, (NO), will meet in Copenhagen, Denmark, 3-7 March 2014, to work on ToRs and generate deliverables as listed in the Table below.

WGBEC will report on the activities of 2014 (the second year) by 30 April 2014 to SSGHIE.

ToR	Description	Background	Science Plan topics addressed	Duration	Expected Deliverables
a	Respond to requests for advice from Regional Seas Conventions (e.g. OSPAR, EU) as required.	*Advisory requirement*. WGBEC has a history in its ToR of responding to requests from OSPAR and these have always been considered as a priority and importance by the EG. In addition, there is a wide breadth of knowledge and expertise which allows the EG to respond in an informed manner to these requests.	Advice to ICES	Annual 2012-2015	Each year advice is reported to ICES secreatariat for onward transmission e.g. to OSPAR
b	Consider emerging issues of scientific merit and address knowledge gaps (in relation to the ICES science plan). -Oil toxicity to early life stages of fish -Ocean Acidification -Immunotoxicity - Novel monitoring techniques (e.g. 'omics technology) - Thiamine defficiency in marine wildlife (2014 only)	*Science and advisory requirement* In reviews over the past three years WGBEC has considered emerging special scientific issues in relation to biological effects and contaminants and also in relation to the ICES Science Plan These topics have been selected as of current concern.	112, 172, 241, 242	2012-2015	Review paper published in the peer review literature (2015)
c	Review status of publications and consider requirements for new publications - ICES TIMES - Other ICES publica-	*Science and advisory requirement.* It is important for WGBEC to keep track of publication progress with biological effects methods it has	Advice to ICES	Annual 2012-2015	Publication of ICES TIMES methods for marine monitoring purposes

	tions - peer review publications	considered useful for monitoring. Protocols are needed for national and international programmes as well as monitoring to met OSPAR and EU MSFD obligations.			
d	Conduct assessment of data as required -Quality assurance data from method intercomparison trials - Integrated assessment of monitoring data (and advise on procedures to other groups as appropriate)	*Science and advisory requirement* AQC is vital to support, report and assess data, particularly for cross maritime areas and developments and harmonization in this area need to be taken forward in a coordinated manner.	123, 241, 242, 244	2012-2015	Report each year via ICES secretariat to OSPAR on progress with AQC initaitives / schemes for biological effect methods. Report to ICES data centre on current AQC programmes.
e	Respond to requests for advice from the Data Centre	*Advisory requirement* Biological effect data are increasingly being submitted to the ICES database and technical queries arise. WGBEC can assist with answering queries from the ICES Data Centre.	Advice to ICES	Annual 2012-2015	Provide support and information to ICES data centre that can be used to facilitate submission of biological effects data to the ICES database
f	Development and harmonization of methodologies for marine monitoring and surveillance including: - Integrated assessments -Environmental risk assessment -Review and develop assessment criteria for biological effects methods - Report on national monitoring programmes for biological effects	*Science and advisory requirement* WGBEC has found it of value to discuss, feedback and support national monitoring programmes across the maritime areas and this is a valuable opportunity to improve and harmonize programme designs and assessment of data (e.g. OSPAR / MEDPOL / WFD / HELCOM/ EU MSFD)	241	Annual 2012-2015	Report via ICES secretariat to OSPAR on annual review of assessment criteria for JAMP biological effects and progress with the application of the OSPAR SGIMC integrated approach. Report to ICES data centre on current AQC programmes. Link up with MCWG and WGMS on integrated approach and

					assessment of data.
g	Address issues in relation to novel and emerging contaminants (e.g. pharmaceuticals, nanoparticles, toxicity of mixtures etc) -Pharmaceuticals and recreational drugs in the marine environment. -Biocides in the marine environment.	*Science requirement* These are two issues identified by WGBEC that are of value and special scientific interest to understanding the effects of contaminants in the marine environment. Information on environmental impacts is currently lacking.	123, 172, 242, 241	2012-2015	Provide report to ICES on these special scientific issues and publish in the peer reviewed literature (year 3)..
h	To evaluate the results of marine litter monitoring and research activities, especially microparticles (plastic/non plastic) and associated chemicals: -Status on monitoring protocols for marine litter in biota -Marine litter research outcomes and results of impact assessments on key marine organisms. Evidence of bioaccumulation, toxicity and adverse physical, biological and chemical effects of microplastics and associated contaminants on a range of marine organisms, populations and communities. -Evidence of transfer of microplastics and associated contaminants through marine food chains.	*Science and advisory requirement* There has been considerable interest over the past two years on the biological effects of plastic particles, particularly in relation to contaminants associated with plastic particles. It is important that this work area is reviewed and any reports and feedback from other Expert Groups considered by WGBEC.	241, 243, 344	2012-2015	Review and report to ICES on how this work area is developing and identify how this may be progressed and applied to marine monitoring programmes. Link up with other EGs with intetrest in this topic i.e. MCWG and WGMS (planned for 2014) Publish outputs in peer review literature (Year 3).

Summary of the Work Plan

Year 2	Requests for advice from ICES, OSPAR and requests for support from data centre will be addressed each year as appropriate. Time allocation is variable depending on the task and preparation required pre the meeting and reporting post meeting.

Year 3	Requests for advice from ICES, OSPAR and requests for support from data centre will be addressed each year as appropriate. Time allocation is variable depending on the task and preparation required pre the meeting and reporting post meeting. Complete and sign off 3 yr report and report on publication outputs.

Supporting information

Priority	The activities of this group will allow ICES to advise on issues relating to the design, implementation and execution of regional research and monitoring programmes pertaining to hazardous substances in the marine environment. To develop procedure for quality assurance of biological effects data and to improve assessments of data relating to the biological effects of contaminants in the marine environment. The highest priority relates to providing sound scientific advice in response to requests from international programmes e.g. OSPAR JAMP.
Resource requirements	The main input to this group is from National experts. Each attendee is self-funded from their own / organization / institute resources.
Participants	The group is normally attended by 15 - 30 members.
Secretariat facilities	None.
Financial	No financial implications.
Linkages to ACOM an groups under ACOM	ACOM and SSGHIE
Linkages to othe committees or groups	There are linkages to MCWG, WGMS, WGPDMO and more recently WGEEL
Linkages to othe organizations	None directly althought the WG has had input and links at its meetings with MEDPOL scientists