Hazardous Substances Series

OSPAR/ICES Workshop on the evaluation and update of background reference concentrations (B/RCs) and ecotoxicological assessment criteria (EACs) and how these assessment tools should be used in assessing contaminants in water, sediment and biota

9 – 13 February 2004

The Hague

FINAL REPORT

Anders Bignert , Daniel Cossa, Richard Emmerson, Rob Fryer, Christine Füll, Jose Fumega, Remi Laane, Hector Martinez Calls, Brendan McHugh, Brian Miller, Geoff Millward, Colin Moffat (editor), Janny Pijnenburg (editor), Patrick Roose, Anders Ruus, Stefan Schmolke, Foppe Smedes, Jakob Strand, Joost Stronkhorst, John Thain, Chrystèle Tissier, Theo Traas (editor) and Jacek Tronczynski.

OSPAR Commission
for the Protection of the Marine Environment of the North-East Atlantic

ICESCIEM
International Council for the Exploration of the Sea
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The Convention for the Protection of the Marine Environment of the North-East Atlantic (the "OSPAR Convention") was opened for signature at the Ministerial Meeting of the former Oslo and Paris Commissions in Paris on 22 September 1992. The Convention entered into force on 25 March 1998. It has been ratified by Belgium, Denmark, Finland, France, Germany, Iceland, Ireland, Luxembourg, Netherlands, Norway, Portugal, Sweden, Switzerland and the United Kingdom and approved by the European Community and Spain.

La Convention pour la protection du milieu marin de l'Atlantique du Nord-Est, dite Convention OSPAR, a été ouverte à la signature à la réunion ministérielle des anciennes Commissions d'Oslo et de Paris, à Paris le 22 septembre 1992. La Convention est entrée en vigueur le 25 mars 1998. La Convention a été ratifiée par l'Allemagne, la Belgique, le Danemark, la Finlande, la France, l'Irlande, l'Islande, le Luxembourg, la Norvège, les Pays-Bas, le Portugal, le Royaume-Uni de Grande Bretagne et d'Irlande du Nord, la Suède et la Suisse et approuvée par la Communauté européenne et l'Espagne.

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Workshop on BRC-EAC 9-13/02/2004
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OSPAR CONVENTION FOR THE PROTECTION OF THE MARINE ENVIRONMENT OF THE NORTH EAST ATLANTIC

OSPAR/ICES WORKSHOP ON THE EVALUATION AND UPDATE OF BACKGROUND REFERENCE CONCENTRATIONS (BRCS) AND ECOTOXICOLOGICAL ASSESSMENT CRITERIA (EACS) AND HOW THESE ASSESSMENT TOOLS SHOULD BE USED IN ASSESSING CONTAMINANTS IN WATER, SEDIMENT, AND BIOTA

THE HAGUE (NETHERLANDS): 9-13 FEBRUARY 2004

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Outputs and Recommendations

Main Outputs

1. The main outputs from the workshop are:

   a. recommendations for:

      i. a revised nomenclature for Background Reference Concentrations employing the terms Background Concentration (BC) and, for assessment purposes, Background Assessment Concentrations (BACs);

      ii. a revision of the nomenclature for EACs from Ecotoxicological Assessment Criteria to Environmental Assessment Criteria;

      iii. the adoption of a background concentration of zero for xenobiotics;

      iv. a revised methodology for the derivation of EACs which will bring them more into line with the approach taken for the derivation of Quality Standards (QS) for the Water Framework Directive;

      v. the further elaboration and testing of a statistical method for testing whether monitored concentrations are near background (based upon the method approved by MON 2003 (MON 2003 Summary Record, Annex 8)) during the current evaluation and update of BCs and EACs;

      vi. further work required to complete the current update of BCs and EACs, focusing particularly on the finalisation of those BCs and EACs required in the forthcoming assessment of CEMP data, and;

   b. a considerably expanded and updated dataset on concentrations of naturally occurring substances in pristine areas in the OSPAR maritime area for use in the derivation of background concentrations;

   c. the recommendation that the update of BCs and EACs should be included as a more regular element of the ASMO work programme.

Provisional conclusions and recommendations from the evaluation and update of Background/Reference Concentrations

2. The subgroup on the evaluation and update of Background Reference Concentrations was chaired by Professor Geoff Millward (United Kingdom).

Conclusions

3. The provisional conclusions for the update of Background Reference Concentrations are that:

   a. following review and evaluation of the existing BRCs for the North-East Atlantic the terminology should be revised;

   b. the terminology should be re-confirmed as Background Concentrations (BCs) for metals and PAHs;

   c. the relevance of existing BRCs for xenobiotics has been assessed;

   d. the background concentration for xenobiotics should be zero;

   e. a considerably extended and updated dataset for the derivation of background concentrations has been compiled;

   f. the relevance and integrity of the dataset requires peer review;

g. a possible statistical approach for testing whether monitored concentrations are near background or close to zero has been assessed. To support the use of the statistical method Background Assessment Concentrations would be developed for assessment purposes based, in part, on the precision of the CEMP data;

h. there is merit in using the updated BCs as part of the CEMP assessment; the arrangements at §3 should be adopted to finalise the update.

Recommendations

4. The provisional recommendations for the update of Background/Reference Concentrations are that:

a. the term BRC (or B/RC) should no longer be used. The term "Background Concentrations" should be applied to naturally occurring and xenobiotic substances;

b. the assembled dataset for establishing background concentrations needs to be assessed by ICES expert working groups to allow the use of revised BCs in the CEMP assessment (see §3 below);

c. the proposed statistical method for testing when monitored concentrations are near background should be tested as part of an on-going process as the rationalisation of the BC dataset proceeds;

d. the compatibility between the BCs and the EACs needs to be explored following scrutiny of the updated datasets;

e. a more regular evaluation and update of Background Concentrations, the underlying dataset and the methodology for their application should be included in the ASMO work programme;

f. OSPAR confirm the adoption of background concentration for xenobiotics as zero.

Provisional conclusions and recommendations for the evaluation and update of Ecotoxicological Assessment Criteria

5. The subgroup for the evaluation and update of Ecotoxicological Assessment Criteria was chaired by Mr Theo Traas (the Netherlands).

Conclusions and Recommendations

6. In view of criticism of the current EACs and the difficulties in their practical application, several fundamental changes in EACs are proposed:

a. that the definition of EACs is changed from Ecotoxicological Assessment Criteria to Environmental Assessment Criteria. This change reflects the primary role of EACs as tools for the assessment of environmental data, for example OSPAR JAMP and CEMP data, and the need for integrated assessment of chemical and biological effects data;

b. the methodology for derivation of EACs has also been thoroughly reviewed and brought more into line with the approach taken for the derivation of Quality Standards (QS) for the Water Framework Directive. Although EACs are not equal to QS in the water framework, EACs have been redefined to relate to them. The adoption of EU methods (either from the EU water framework directive or the EU new and existing substances directives) is recommended, allowing easy adoption of EU assessments for OSPAR purposes. EU methods for secondary poisoning can be used to improve the meaning of biota monitoring, with regard to toxicity for top predators;

c. the old range of EACs is no longer endorsed, but replaced by Lower-EAC and Upper-EAC values that have defined ecotoxicological meaning. A criticism of the previous EACs was that the ranges of values were difficult to use and interpret. Although two new EAC values are proposed at a lower and an upper level, it is important to recognise that these are in most cases independently derived and more robust than the previous values. The values are derived as follows:

i. the lower EAC value is a concentration derived for protection of all marine species from chronic effects, including the most sensitive species;

ii. the upper EAC is defined as the highest (transient) concentration that is expected not to cause acute toxic effects;

d. interpretation of environmental assessment data is made easier using the new values, through the derivation of a "traffic light" system to allow contaminant concentrations to be used to assess the state of the environment and prompt appropriate environmental management options:

i. below the lower-EAC value, measured contaminant concentration should not give rise to any biological effects. No immediate management action would be required, the monitoring frequency could be reduced or monitoring ceased;

ii. between the lower and the upper EAC value, biological effects are possible (e.g. biomarker response, impaired growth, reproduction). Management actions could be to identify the reasons for elevated level(s), the use of expert judgement to assess significance, check trends and variability or the introduction of additional monitoring;

iii. above the upper-EAC, long-term biological effects are likely (e.g. impaired growth, reproduction and survival), and acute biological effects (survival) are possible. Appropriate management actions could involve additional analysis to verify findings, identification of the reason(s) for elevated level(s), re-design of monitoring strategies for specific elevated contaminants and consider resource or emission management issues;

e. most sediment EACs have been based on equilibrium partitioning due to a paucity of ecotoxicological data. This lack of data has not been remedied. Such EACs should continue to be regarded as provisional and need validation with additional sediment toxicity tests and/ or co-occurrence data, especially for metals;

f. for biota, two different types of EACs can be derived. The first type is based on the derived EACs for water or sediment, and transferred to biota using appropriate BCF. The second type takes into account that fish or mussels are food for predators. Levels in mussel or fish can be derived that protect against this so-called secondary poisoning. It is recommended to calculate both types of biota EACs for comparison;

g. where insufficient ecotoxicological data exists for marine species then freshwater data could be used but the EAC data should be regarded as provisional as in previous derivations;

h. for substances with a natural background, the added risk approach as used in the WFD could be adopted to avoid the problems of separating background values from lower EAC values. Further consultation is needed to decide on this issue;

i. an expanded set of EACs for additional substances on the OSPAR priority substances list could be developed using the methodology proposed and taking account of existing EU assessments under the Existing Substances Regulation and the Water Framework Directive. New substances of interest to OSPAR have been identified where sufficient ecotoxicological data exists to allow EACs to be derived;

j. finalising the update of EACs will require further work, which should take into account existing EU assessments. Possible arrangements for the completion of this work are detailed at § 3 below.

Proposals for Further Work

Initial arrangements for further work to finalise the update of Background Concentrations

1. Finalising the update of Background Concentrations in time for their use in the assessment of CEMP data will require completing the dataset, screening the integrity of the dataset and deriving BCs from the dataset. To achieve this, the following arrangements are proposed:

a. that Contracting Parties will have until the meeting of the SIME working group (24-26 February 2004) to provide further data suitable for the derivation of Background Concentrations. The Chairman of SIME should alert SIME delegations that any further data should be submitted either before or at SIME;

b. that SIME should be invited to make arrangements for an expert sub-group to work during the course of the meeting to incorporate any further data in the dataset and carry out a preliminary scrutiny of the relevance and integrity of the dataset;

c. that in order to further screen the relevance and integrity of the dataset and to work up examples of the derivation of BCs and Background Assessment Concentrations (BACs) from the dataset for selected substances (e.g. Cd, Hg, Pb and selected PAHs in sediments and biota):

   i. the ICES Working Groups on Marine Sediments in relation to Pollution (WGMS) and Working Group on Statistical Aspects of Environmental Monitoring (WGSAEM) (1-5 March 2004) should be invited to work in collaboration, to carry out a further scrutiny of the BC dataset and to construct draft background concentrations and background assessment concentrations for metals and PAHs in sediments, and;

   ii. the ICES Marine Chemistry Working Group (MCWG) (15-19 March 2004) should be invited to carry out a further scrutiny of the BC dataset and to construct draft background concentrations and background assessment concentrations for metals and PAHs in biota;

d. subject to the progress made under § 3a-§ 3c above, ASMO should be invited to examine a screened and peer reviewed dataset for the derivation of background concentrations and worked through examples of the derivation of draft BCs and BACs for metals and PAHs. If appropriate, ASMO should be invited to make arrangements for any further work required to finalise the update of background concentrations and background assessment concentrations, if practically possible, in time for their adoption by OSPAR 2004, in order to allow their use in the forthcoming assessment of CEMP data.

Proposed further work for finalisation of EAC

2. In order to finalise this update of EACs, SIME and ASMO should be invited to consider what arrangements should be made for further work:

a. to facilitate the finalisation of the update of CEMP-relevant EACs in time for their use in the forthcoming assessment of CEMP data. Draft updated EACs could be developed for CEMP substances only using the updated methodology based upon;

   i. the data used by the 1996 EAC workshop;

   ii. available data from ESR RAR reports, and;

   iii. fact sheets for Water Framework Directive priority substances, where available.

   This would need 4-5 people familiar with the updated method to carry out preparatory work of 2 days each and to attend a 3 day meeting to finalise the update.

b. to develop draft updated EACs using the updated methodology for an expanded group of substances on the OSPAR List of Chemicals for Priority Action (possibly those for which monitoring in the marine environment is required following the development of monitoring strategies) subject to the availability of data in EU Existing Substance Regulation RARs or Water Framework Directive fact sheets;

c. to peer review the updated EACs e.g. by an appropriate ICES working group such as the Working Group on the Biological Effects of Contaminants (WGBEC).

3. Contracting Parties should be invited to consider whether they are able to provide resources either to lead or to contribute to this work.

Background

1. The Joint Assessment and Monitoring Programme (JAMP) requires the development of assessment tools for pursuing the monitoring strategies for substances (or groups of substances) on the OSPAR List of Chemicals for Priority (JAMP Tool HT-3). Background/Reference Concentrations (BRCs) are needed to assess the anthropogenic contribution of contaminants in the environment. Ecotoxicological Assessment Criteria (EACs) link chemical monitoring data and /or joint chemical/biological effects monitoring data and are based on toxicity tests for individual substances.

2. OSPAR 1997 adopted Background/Reference Concentrations (BRCs) for contaminants in sea water, biota and sediment and Ecotoxicological Assessment Criteria (EACs) for trace metals, PCBs, PAHs, TBT and some organochlorine pesticides as assessment tools for use in preparing the QSR 2000. Following MON 2002 the Netherlands developed a proposal for an OSPAR workshop to evaluate existing BRCs and EACs, to narrow their range if possible, and if necessary update and expand them to cover more substances before ASMO 2004. Terms of Reference for the Workshop were agreed by ASMO 2003 (Annex 1) and ICES agreed to co-sponsor the Workshop at the 2003 meeting of the Advisory Committee on the Marine Environment.

3. The workshop was hosted by the Netherlands at the premises of The National Institute on Coastal and Marine Management, The Hague, between 9 and 13 February 2004 organised by Janny Pijnenburg (task manager) and Remi Laane with the assistance of France (Michel Marchand and Chrystèle Tissier), The Netherlands (Foppe Smedes) and the UK (Colin Moffat). The workshop was chaired by Dr Remi Laane and attended by representatives of Belgium, Denmark, France, Germany, The Netherlands, Norway, Spain and United Kingdom (Annex 2). The ICES Marine Chemistry Working Group was represented by Colin Moffat.

Summary Record

Agenda Item 1 – Opening of the Meeting

1.0 On behalf of The National Institute on Coastal and Marine Management (RIKZ), Mrs. Drs I van der Hee MBA (Director) welcomed delegates to The Hague.

1.1. Ben van de Wetering of the European Commission gave a lecture on the development of the European Marine Strategy. The slides are presented at Appendix 8.1.

Representation at the Meeting

1.2. The workshop was chaired by Dr Remi Laane (The Netherlands) and attended by representatives of Belgium, Denmark, France, Germany, The Netherlands, Norway, Spain and United Kingdom. The ICES Advisory Committee on the Marine Environment was represented by Dr Colin Moffat.

Agenda Item 2 – Adoption of the Agenda

2.1 The agenda was adopted as at Annex 3.

Agenda Item 3 – Review of BRC and EAC development

3.1 *Joost Stronkhorst (Netherlands)* reviewed work on Ecotoxicological Assessment Criteria since the first workshop on EACs, which led to the adoption of the values at Annex 4. The principle question is: What concentrations are critical in the environment?

3.1.1 The initial Workshop was based on three stages:

- Step 1 – Evaluation of national guideline values for the marine environment
- Step 2 – Evaluation of available toxicity data
- Step 3 – Setting the ecotoxicological criteria – set a RANGE

3.1.2 The end product was a table (see Annex 4) in which the EACs were either firm (f) or provisional (p) and were defined for metals, organochlorine compounds, PAHs and TBT in water, sediment fish and mussel. The criteria were meant to aid in interpret monitoring data.

3.1.3 The AECs that have been derived during the previous three workshop have the intent to classify monitoring results in terms of need for further investigations. Concentrations above the upper end of the range indicate areas where additional assessments are required, while areas with concentrations below the lower end of the range might be excluded from monitoring. Over the last few year several new developments are occurred in the field of setting environmental quality guidelines. A state-of-the art overview on the derivation and application of Sediment Quality Guidelines will be published by SETAC in due coarse ("Use of Sediment Quality Guidelines (SQGs) and Related Tools for the Assessment of Contaminated Sediments"). With regard to water quality standards in is expected that the European Commission will propose standards for priority substances for inland and marine waters in 2004/5 within the Water Framework Directive.

3.2 *Remi Laane (Netherlands)* presented a history of the development of Background Reference Concentrations (BRCs). The associated presentation is at Appendix 8.2.

3.2.1 The process began in 1992 with a workshop on the concentration of natural compounds and was followed, in 1996, by an OSPAR/ICES workshop on background/reference concentrations for nutrients, and for contaminants in seawater, biota and sediments. The product was BRCs for a number of contaminants in a variety of compartments as detailed in Annex 5.

3.2.2 Since 1996 a considerable body of literature has developed, additional results have been presented, new ideas considered together with new models and methodologies. Thus it was considered appropriate to review BRCs in 2004.

3.2.3 In 1992 background (fresh and marine) was taken as referring to:

- no human impact (metals, radionuclides, nutrients, PAHs, dioxins);
- historical trends (cores and 'old' data); and
- samples from pristine areas.

In addition, use was made of:

- equilibrium and steady state models; and
- extrapolation and statistical models.

They covered broad, generic ranges with nearly no geographical differentiation.

3.2.4 Quality Values were developed and included:

- Sediment Quality Values (SQVs) for freshwaters and saltwaters; and
- Sediment Background Values (SBVs) for freshwater and saltwater.

They gave a large range and needed a log scale to get the data on one graph.

3.2.5 In 1996 background concentrations were reviewed (all compounds) considering both geological and historical times**.**

3.2.6 In 2004 there are 150,000 compounds, lists of priority substances, but still debates on what constitute pristine areas.

Agenda Item 4 - Discussions on methods for the derivation of BRCs

4.1 *Geoff Millward (UK)* gave a presentation entitled 'Background Reference Concentrations for Trace Metals: Problems and Perspectives'. The slides are presented at Appendix 8.3.

4.1.1 Several points were emphasised including:

- The need to get the terminology correct
- The acceptance criteria – are assessments done on a general scheme of acceptance criteria?
- The shelf life of data

4.1.2 The examples of metals in sediments, seawater and organisms were used to emphasise specific points such as

- The question of normalisation
- The question of standardisation (e.g. the size of animal)
- The specific components analysed (e.g. which metals or which CB congeners)
- The units used when reporting data and the basis of the units (e.g. wet weight, dry weight, lipid weight).

4.2 *Foppe Smedes (Netherlands)* gave a paper entitled 'Grain size and Contaminants in Sediment' The relevant presentation is at Appendix 8.4.

4.2.1 The initial emphasis of this talk was on working with a homogeneous medium. Which ever compartment is being studied (water, sediment or biota) there are issues with respect to homogeneity (water - suspended matter/dissolved matter; biota – lipid content; sediment – grain size).

4.2.2 Models for considering pollution levels in aqueous systems and sediments were presented.

4.2.3 Normalisation, which corrects contaminant contents for differences in samples composition in order to allow the results to be compared, was considered in relation to Background Concentrations (BCs), Reference Concentrations (RCs) and EACs.

4.2.4 Particle size distribution in replicate samples was compared in relation to sieving and it was shown that sieving does produce a more homogeneous matrix. There was a progressive improvement from the original sample after sieving to give a < 63 micron and then a < 20 micron fraction.

4.2.5 Issues relating to normalisation were discussed as was the derivation/use of PIVOT values.

Agenda Item 5 - Overview methods for EAC and QS (EU/Water Framework Directive) and PNEC (Technical Guidance Document [TGD])

5.1 *Chrystèle Tissier (France)* gave a paper entitled 'Determination of EAC for the water compartment. OSPAR methodology, WFD and TGD methodology'. The slides are presented at Appendix 8.5.

5.1.1 The decisions following the 1996 Workshop were presented. They included the fact that the derivation of EACs is only possible if toxicity data are available for at least three species, either marine or freshwater.

5.1.2 The OSPAR methodology was outlined and the results of the 1996 Workshop presented. These included for:

- PAHs – general procedure was used
- Pesticides and PCBs – EACs were only derived for lindane and TBT
- Metals – the general procedure was used except for As and Cr where marine chronic data were not available.

5.1.3 Chemical risk assessment was considered in the context of both the Water Framework Directive and the Technical Guidance Document (TGD) on risk assessment.

5.1.4 With respect to the TGD, the estimation of a predicted no effect concentration (PNEC) for an environmental ecosystem was reviewed on the basis of both assessment factors and statistical extrapolation.

5.1.5 The added risk approach was detailed for naturally occurring substances such as metals.

5.1.6 Details were provided on the WFD Environmental Quality Standards (EQS).

5.2 *Chrystèle Tissier (France)* gave a paper entitled 'Derivation of ecotoxicological assessment criteria for sediment: a review'. The slides are presented at Appendix 8.6.

5.2.1 Sediment quality has traditionally been assessed on the basis of the bulk chemical concentration of individual compounds and comparison with background or reference values. This does not, however, provide sufficient information on the occurrence of potential biological effects.

5.2.2 Definitions of the following were presented:

- *Guideline*: indicative value which includes a certain amount of uncertainties represented by false negatives and false positives
- *Criterion*: indicative value below which there should not be any toxic effect on organisms. A criterion should be more accurate than a guideline
- *Standards*: regulatory values as opposed to guidelines and criteria.

5.2.3 The results of the 1996 Workshop were summarised for PAHs, Pesticides and PCBs and Metals (see slide 5 Appendix 8.7).

5.2.4 Developments with respect to chemical risk assessment within the context of the WFD were presented.

5.2.5 The advantages and disadvantages of using the Apparent Effect Threshold (AET) and the Screening Level Concentration (SLC) were discussed priori to considering the Effect Range Low(ERL)/Effect Range Medium (ERM) and Threshold Effect Level (TEL)/Probable Effect Level(PEL) approaches.

5.2.6 Logistic regression models were then considered.

5.2.7 The conclusions from this talk are presented in slides 17 and 18 of Appendix 8.7.

5.3 *Theo Traas (The Netherlands)* presented a paper 'Approaches for deriving EACs for biota'. The associated PowerPoint Presentation is at Appendix 8.7.

5.3.1 Three approaches were outlined:

- Critical Body Residues – this method was not progressed due to a lack of data
- Direct effects
- Secondary Poisoning

5.3.2 Secondary poisoning was discussed in relation to various international frameworks including:

- the Technical Guidance Document (TGD) on Risk Assessment (which is in support of various Commission Directives and a Regulation)
- The Water Framework Directive
- OSPAR

The conclusion was that the TGD describes secondary poisoning in most detail.

5.3.3 Consideration was given to the relevance of top predators and to both freshwater and marine food chains with respect to the derivation of $PEC_{oral\ toppredator}$.

5.3.4 An example, using dieldrin, was presented.

Agenda Item 6 - Discussion on use of BRCs and EACs

6.1 *Rob Fryer (UK)* presented his paper on effective environmental standards during which he outlined the concept of a modified green (precautionary test). The slides are at Appendix 8.8. This concept was discussed in detail throughout the Workshop, specifically in the Parallel Session covering BRCs. A working document was prepared to aid the discussion (Annex 6.1).

6.2 During the meeting the concept outlined in the Working Document was discussed, honed and a revised paper produced by Rob Fryer (Annex 6.2).

Agenda Items 7 to 12

7.1 Following the initially Plenary sessions, the remainder of the Workshop was conducted predominantly in two parallel sessions:

7.2 Paralle1 Session 1 - This dealt with the Workshop Terms of Reference covering BRCs and incorporated Agenda Items 7 and 11.

7.3 Parallel Session 2 – This dealt with the Workshop Terms of Reference covering EACs and incorporated Agenda Items 8 and 12.

7.4 At the start of each day the Workshop met in Plenary so as to update all participants on progress in the two sub-groups (Agenda Items 9 and 10). The Chairs of the two sub-groups gave presentations on progress. This provided an opportunity for a broader discussion on the ideas and concepts being developed in the separate groups. In addition, it provided a forum for considerations on the compatibility of the developing EACs and BCs.

Agenda Item 13 – Reporting Results

8.1 Each sub-group produced a detailed report covering the discussions and output. These are presented at:

- BRC Sub-Group: Annex 6
- EAC Sub-Group: Annex 7

Agenda Item 14 – Overall Discussion

9.1 At the final Plenary session, the Chairs of the two Sub-Groups presented their closing summaries. This included the outputs and recommendations as presented in the relevant sections of this report. In addition, proposals for further work and the need for a review of the dataset gathered at the Workshop by

expert ICES Working Groups was highlighted. Again, this information is summarised in a separate section of the report.

9.2 The Chair of the Plenary sessions (Remi Laane) thanked the Sub-Group Chairs (Theo Traas and Geoff Millward) for their guidance of the two groups. In addition, he thanks all participants of the Workshop for their input.

9.3 Colin Moffat, on behalf of the participants, thanked Remi Laane for Chairing the Plenary Sessions and specifically for hosting an excellent Japanese meal.

Annex 1: Terms of reference for an OSPAR/[ICES][1] workshop on the evaluation and update of Background Reference Concentrations (BRCs) and Ecotoxicological Assessment Criteria (EACs) and how these assessment tools should be used in assessing contaminants in water, sediment, and biota

(Source ASMO 2003 Summary Record Annex 8)

1. Introduction

1. Assessment tools of relevance for the Joint Assessment and Monitoring Programme (JAMP) are Background Reference Concentrations and Ecotoxicological Assessment Criteria for trace metals and organic contaminants. Background Reference Concentrations (BRCs) are needed to assess the anthropogenic contribution of contaminants in the environment. Ecotoxicological Assessment Criteria (EACs) link chemical monitoring data and /or joint chemical/biological effects monitoring data and are based on toxicity tests for individual substances. There is a need to evaluate existing BRCs and EACs to narrow their range if possible and update /expand them if necessary. This will take place in an OSPAR/[ICES][1] workshop to be held in the Netherlands in February 2004.

2. The terms of reference for the workshop are as follows:

2. With regard to BRCs the workshop will develop proposals to:

   a. review and update where appropriate, the existing BRCs for the North-East Atlantic and/or assess the relevance of existing BRCs for xenobiotics;

   b. expand the BRCs where appropriate to cover more substances;

   c. discuss the need of BRCs for xenobiotics in terms of limits of detectability.

3. With regard to EACs the workshop will develop proposals to:

   a. review existing EACs and consider whether further work is needed to expand the list for those substances and matrices (water, sediment, and/or biota) for which the former three workshops have not yet provided data;

   b. upgrade, where appropriate, the "provisional" and revise if necessary the "firm" EACs.

4. With regard to the use of BRCs and EACs the workshop will develop proposals on:

   a. how BRCs and EACs should be used when assessing CEMP data;

   b. draft guidance on the use and interpretation of BRCs and EACs.

3. Arrangements and background information to be considered

5. The workshop will take as its basis the BRCs and EACs agreed by OSPAR in 1997. It will consider any new information, provided by Contracting Parties in response to a questionnaire, regarding possible changes or additions to existing BRCs or EACs and information on national marine assessment criteria in use. The workshop will take into account the developments in the EC draft Technical Guidance Documents (Marine chapter) and the EC process of setting water quality objectives.

6. The workshop will consist of three parts.

[1] To be confirmed in June 2003.

1. Background Reference Concentrations

Assessment of the relevance of existing BRCs; update and expand, if useful, existing BRCs.

The BRCs were elaborated during an OSPAR/ICES workshop in Hamburg on 22-25 October 1996 (OSPAR Agreement 1997-14).

2. Ecotoxicological Assessment Criteria

Assessment of the relevance of existing EACs; update and expand, if useful, existing EACs.

For the assessment of JAMP chemical monitoring data a set of EACs for selected trace metals and organic micro contaminants were developed at three workshops (the first in Scheveningen (The Netherlands), November 1993, the second in Berlin (Germany), November 1995, and the third in The Hague (Netherlands), November 1996). The outcome of the three workshops resulted in the EACs agreed by OSPAR in 1997 (OSPAR agreement 1997-15). The outcome of the third workshop was entitled: "Report on the Third OSPAR workshop on ecotoxicological assessment criteria. The Hague 25-29 November 1996".

For some (relevant) substances and matrices no EACs have yet been derived.

A number of the EACs derived to date are regarded as provisional due to the limited quantity of toxicological data of marine species available or accessible at the workshops.

The workshop will, where appropriate, update the provisional EACs.

Firm EACs for substances that are also WFD substances will, if relevant, be updated utilising the work done by the expert working group on environmental quality standards.

Furthermore the workshop will expand, if useful, existing EACs with substances from the WFD list that are relevant for the marine environment.

Special attention will be paid to the EACs for biota that preferably will be derived using the methodology for secondary poisoning (as described in the EC draft Technical Guidance Document chapter 2 "Environmental risk assessment- Marine").

3. The application of EACs and BRCs

Preparation of guidance on the use of BRCs and EACs for the assessment of JAMP data in 2004.
During the MON meeting in The Hague in November 2002, a presentation was given by the UK (MON 02/4/2-E, Appendix 3): Testing for compliance with EACs and BRCs. Experts will need to discuss and agree on the use and interpretation of BRCs and EACs.

4. Schedule of preparatory work

May/June 2003:	The organising countries (Netherlands, France, United Kingdom) with the assistance of the OSPAR Secretariat to draft a work plan for the workshop. The Netherlands to draft a questionnaire requesting proposals for possible changes or additions to existing EACs/BRCs and supporting data/information.
June 2003:	Questionnaire to be circulated to Contracting Parties requesting response by December 2003.
June/August 2003:	Invite EC to join the organising committee.
August-December 2003:	Preparatory work for the workshops: • Circulate invitation to Contracting Parties to attend the workshop • Invite chairpersons for each part of the workshop • Arrange preparatory work to be undertaken • Meeting of the organising committee, if necessary.

December 2003:	Contracting Parties to return their responses to the questionnaire circulated by the Netherlands in June 2003.
	Prepare background information for the workshop.
February 2004:	Workshop to take place in the Hague (Netherlands).
February/March 2004:	Outcome of workshop to be submitted to MON, SIME, as timetable allows.
April 2004:	Outcome of workshop and any recommendation from MON or SIME to be submitted to ASMO.

5. Reporting

7. The report of the workshop, including proposals for amending or adding to existing BRCs or EACs, and guidelines on the application of BRCs and EACs, will be submitted to ASMO 2004 for endorsement. Amendments or additions to the BRCs or EACs agreed by ASMO 2004, and agreed guidelines on applying BRCs and EACs, will be taken into account by MON in preparing an assessment in 2005 of temporal trends and levels of contaminants in sediment and biota.

6. Participants and lead person

8. The lead person for the workshop is:

Janny Pijnenburg
Ministry of Transport, Public Works and Water Management
National Institute for Coastal and Marine Management / RIKZ
PO box 20907
NL-2500 EX The Hague
Telephone: 00 31 70 311 4301 e-mail A.M.C.M.Pijnenburg@rikz.rws.minvenw.nl

The workshop is open to participants nominated by OSPAR Contracting Parties and Observer Organisations, and to members of relevant ICES Working Groups and Committees.

Annex 2: Workshop Participants

Patrick ROOSE Management Unit of the North Sea Mathematical Models-Royal Belgian Institute for National Science 3e en 23 Linieregimentsplein B-8400, Oostende Belgium **E-mail:** p.roose@mumm.ac.be	**Jakob STRAND** National Environmental Research Institute Dept of Marine Ecology Frederiksborgvej 399 4000 Roskilde Denmark **E-mail:** jak@dmu.dk
Chrystèle TISSIER Cellule ARC Ifremer/Ineris Centre Ifremer de Nantes BP 21105 44311 Nantes Cedex 3 France **E-mail:** Chrystele.tissier@ifremer.fr	**Daniel COSSA** Ifremer Centre de Nantes BP21105 443311 Nantes cedex 3 France **E-mail:** dcossa@ifremer.fr
Jacek TRONCZYNSKI Ifremer Centre de Nantes BP21105 443311 Nantes cedex 3 France **E-mail:** jtronczy@ifremer.fr	**Stefan SCHMOLKE** Federal Maritime and Hydrographic Agency (BSH) Germany **E-mail:** stefan.schmolke@bsh.de
Christine FÜLL Umweltbundesamt Fachgebiet II 3.2 Bismarckplatz 1 14193 Berlin Germany **E-mail:** christine.fuell@uba.de	**Brendan McHUGH** Marine Institute Snugboro Road Castleknock, Dublin 15 Ireland **E-mail:** Brendan.mchugh@marine.ie
Foppe SMEDES National Institute for Coastal and Marine Management/RIKZ PB Box 207 9750 AE Haren The Netherlands **E-mail:** F.Smedes@rikz.rws.minvenw.nl	**Theo P. TRAAS** National Institute for Public Health and the Environment Postbus 1 3720 BA Bilthoven The Netherlands **E-mail:** TP.Traas@rivm.nl

Joost STRONKHORST National Institute for Coastal and Marine Management/ RIKZ PO Box 20907 2500 EX The Hague The Netherlands **E-mail:** j.stronkhorst@rikz.rws.minvenw.nl	**Remi LAANE** National Institute for Coastal and Marine Management/RIKZ PO Box 20907 2500 EX The Hague The Netherlands **E-mail:** R.W.P.M.Laane@rikz.rws.minvenw.nl
Janny PIJNENBURG National Institute for Coastal and Marine Management/ RIKZ PO Box 20907 2500 EX The Hague The Netherlands **E-mail:** a.m.c.m.pijnenburg@rikz.rws.minvenw.nl	**Anders RUUS** Norwegian Institute for Water Research (NIVA) Brekkeveien 19 PB 173 Kjelsas N-0411 Oslo Norway **E-mail:** anders.ruus@niva.no
Hector MARTINEZ CALLS Centro De Estudios De Puertos y Costas-Cedex Spain **E-mail:** hector.martinez@cedex.es	**Jose FUMEGA** Ministerio de Ciencia y technologica Instituto Espanol de Oceanografia Centro Oceanografico de Vigo Canido-Cabo Estay Vigo Spain **E-mail:** jose.fumega@vi.ieo.es
Anders BIGNERT Contaminant Research Group Swedish Museum of Natural History P.O. Box 50 007 S-104 05 Stockholm Sweden **E-mail:** anders.bignert@nrm.se	**Rob FRYER** Fisheries Research Services Marine Laboratory PO Box 101 375 Victoria Rd Aberdeen AB11 9DB United Kingdom **E-mail:** R.Fryer@marlab.ac.uk
Richard EMMERSON OSPAR Secretariat New Court 48 Carey Street London WC2A 2JQ United Kingdom **E-mail:** richard@ospar.org	**Geoff MILLWARD** School of Earth, Ocean and Environmental Sciences University of Plymouth Plymouth, Devon PL4 8AA United Kingdom **E-mail:** g.millward@plymouth.ac.uk

Brian MILLER Scottish Environment Protection Agency 5 Redwood Crescent Peel Park East Kilbride Glasgow G74 5PP United Kingdom **E-mail:** brian.miller@sepa.org.uk	**Colin MOFFAT** Fisheries Research Services Marine Laboratory PO Box 101 375 Victoria Road Aberdeen AB11 9DB United Kingdom **E-mail:** c.moffat@marlab.ac.uk
John THAIN Centre Environment Fisheries and Aquaculture Science Burnham Laboratory Remembrance Avenue Burnham-on-Crouch Essex CM0 7AH United Kingdom **E-mail:** j.e.thain@cefas.co.uk	**Wim Hegeman** Water Research Foundation Johan Wagenaarlaan 4 2132 KE Hoofddorp The Netherlands **E-mail**: waterResearch@waterresearch.nl

Annex 3: Workshop Agenda

Plenary session (Chair: R.Laane)

1. Opening of the workshop
    - Official opening by Mrs. Drs I van der Hee MBA, director of RIKZ
    - Lecture by Ben van de Wetering (European Commission) - European Marine Strategy, A European Approach to Marine Protection
2. Adoption of agenda
3. Review of BRC and EAC development
    - BRC developments by Remi Laane
    - EAC developments by Joost Stronkhorst
4. Discussion on methods for the derivation of BRCs
    - Developments in methodology by Geoff Millward (UK)
    - Sediment grain-size and contaminants by Foppe Smedes (NL)
    - Identification of subjects for later discussion
5. Overview methods for EAC and QS (EU/Water Framework Directive) and PNEC (Technical guidance document)
    - Overview of methods for water by Chrystèle Tissier (France)
    - Methods for the derivation of sediment quality criteria by Chrystèle Tissier (France)
    - Overview of methods used for biota, taking secondary poisoning into account by Janny Pijnenburg (talk given by T Traas)
    - Identification of subjects for later discussion
6. Discussion on use of BRCs and EACs
    - Statistical issues in the construction and use of B/RCs and EACs by Rob Fryer (UK)
    - Identification of subjects for later discussion

Parallel sessions (G. Millward and T. Traas)

7. Methodological aspects on BRC derivation and use
8. Methodological aspects on EAC derivation and use

Plenary session (R. Laane)

9. Agreement on methods used by the workshop for development of EACs and BRCs and the use of them
10. Discussion on substances that need (update of) EAC and BRC by priority

Parallel sessions (G. Millward and T. Traas)

11. Development of BRC and EAC
12. Agreement on BRC and EAC

Plenary session (R. Laane)

13. Reporting results
14. Overall discussion

Annex 4: Ecotoxicological assessment criteria (EAC) as determined at the Workshop on Ecotoxicological Assessment Criteria for biota (November 1995, Berlin, Germany) and reported to the OSPAR Environmental and Assessment and Monitoring Committee (ASMO) (Ref: ASMO 96/9/11-E(L))

Cautionary note: These assessment criteria have no legal significance and should only be used for the preliminary assessment of the JMP/JAMP chemical monitoring data with the aim of identifying potential areas of concern. When applied, an indication should be given as to whether the EAC was firm or provisional

Substance	Water (µg/l)	Sediment (mg/kg dw)	Fish (mg/kg fw)	Mussel (mg/kg dw)
TRACE METALS				
As	1-10 (f)	1-10 (p)	n.r.	n.r.
Cd	0,01-0,1 (f)	0,1-1 (p)	f.c.	f.c.
Cr	1-10 (f)	10-100 (p)	n.r.	n.r.
Cu	0,005-0,05 (f)[1]	5-50 (p)	f.c.	f.c.
Hg	0,005-0,05 (f)	0,05-0,5 (p)	f.c.	f.c.
Ni	0,1-1 (p)	5-50 (p)	n.r.	n.r.
Pb	0,5-5 (f)	5-50 (p)	f.c.	f.c.
Zn	0,5-5 (f)	50-500 (p)	n.r.	n.r.
ORGANOCHLORINE PESTICIDES				
DDE	n.r.	0,0005-0,005 (p)	0,005-0,05 (f)	0,005-0,05 (f)
Dieldrin	n.r.	0,0005-0,005 (p)	0,005-0,05 (f)	0,005-0,05 (f)
Lindane	0,0005-0,005 (f)	n.r.	0,0005-0,005 (f)	n.r.
PAHs				
Naphthalene	5-50 (f)	0,05-0,5 (f)	n.r.	0,5-5 (p)
Phenanthrene	0,5-5 (p)	0,1-1 (f)	n.r.	5-50 (p)
Anthracene	0,001-0,01 (p)	0,05-0,5 (f)	n.r.	0,005-0,05 (p)
Fluoranthene	0,01-0,1 (p)	0,5-5 (p)	n.r.	1-10 (p)
Pyrene	0,05-0,5 (p)	0,05-0,5 (p)	n.r.	1-10 (p)
Benz[*a*]anthracene	n.d.	0,1-1 (p)	n.r.	n.d.
Chrysene	n.d.	0,1-1 (p)	n.r.	n.d.
Benzo[*k*]fluoranthene	n.d.	n.d.	n.r.	n.d.
Benzo[*a*]pyrene	0,01-0,1 (p)	0,1-1 (p)	n.r.	5-50 (p)
Benzo[*ghi*]perylene	n.d.	n.d.	n.r.	n.d.
Indeno[123-*cd*]pyrene	n.d.	n.d.	n.r.	n.d.
ΣPCB_7	n.r.	0,001-0,01 (p)	0,001 – 0,01 (f)	0,005-0,05 (f)
TBT	0,00001-0,0001 (f)	0,000005-0,00005 (p)	n.r.	0,001-0,01 (f)

f = firm p = provisional f.c. = for future consideration dw = dry weight fw = fresh weight
n.r. = not relevant in relation to the current monitoring programme n.d. = no data available or insufficient data available
[1]this range is within the background range for natural water. This value should be compared to the bioavailable fraction of Cu in seawater

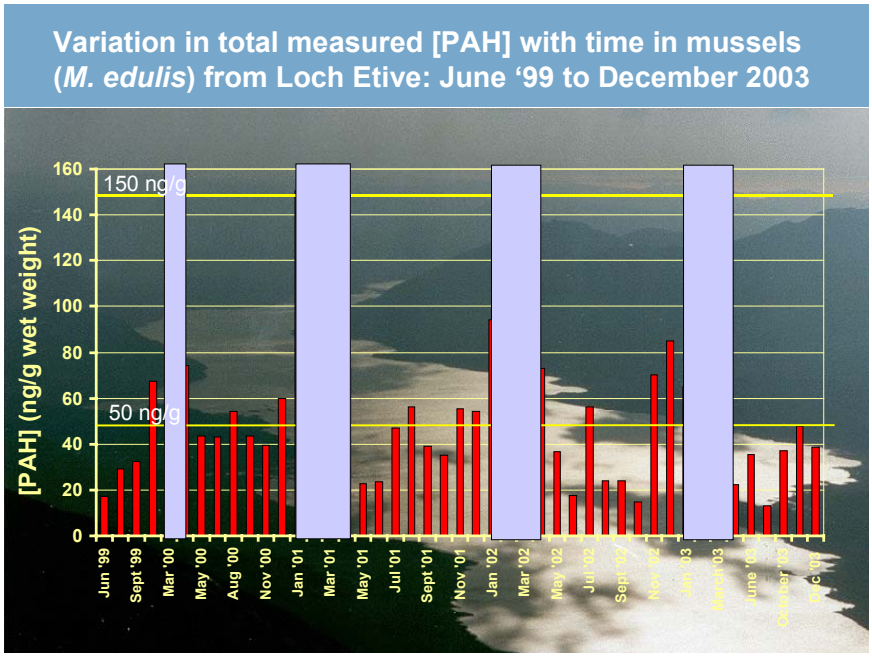
Annex 5: Determinands and compartments (biota, sediment, seawater) for which B/RCs were defined for the OSPAR Convention Area or a specific region at the 1996 Hamburg Workshop (Ref document)

Determinand	Units[a]	Compartment	Area
Cd, Hg, Pb, Cu, Zn	mg/kg ww	Biota – blue mussel	Convention wide
Hg	mg/kg ww	Biota – round and flat fish	Convention wide
Metal[b]/Al	Not applicable	Fine sediments	Convention wide
Cd, Cu, Co, Cr(VI), Fe, Pb, Mn, Hg, Ni, Se(IV), V, U, Zn	ng/kg	Dissolved	Atlantic Ocean
			Northern North Sea
			English Channel Southern North Sea
			Celtic Sea
CB 153	µg/kg ww	Biota – blue mussel	Convention wide
Sum 7 CBs	µg/kg ww	Biota – blue mussel	Convention wide
PAH[c] (Nap, C1 – C3 Nap, Acy, Ace, Fl, Phen, C1 – C2 Phen, An, Flu, Py, B[*a*]A, Chr, B[*b+k*]Flu, B[*a*]Py, DB[*a,h*]An, Per, I[1,2,3-*cd*]Py, B[*ghi*]Pe)	ng/g dw	Surface sediments	Barents Sea
			Arctic Ocean to Iceland Sea
			Northern North Sea/ Skagerrak
			Southern North Sea
	ng/l	Surface water[d] (not C3 Nap, C2 Phen; includes DBT, C1 DBT, B[*e*]Py, Cor)	North-east Atlantic
			Northern North Sea
			Central North Sea Southern North Sea
HCB, pp-DDE, CB 28, 52, 101, 153, 138, 180	pg/g dw	Surface Sediments	Norwegian Sea
			Iceland Sea/ Norwegian Sea
			South Norway/ Skagerrak

[a]ww, wet weight; dw, dry weight
[b]Fe, Li, Hg, Cd, Pd, Zn, As, Cr, Ni, Cu, Co, Ti, V
[c]Nap, naphthalene; C1 – C3 Nap, alkylated naphthalene, Acy, acenaphthylene; Ace, acenaphthene, Fl, fluorene; Phen, phenanthrene; C1 – C2 Phen, alkylated naphthalene; An, anthracene; Flu, fluoranthene; Py, pyrene; B[*a*]A, benz[*a*]anthracene; Chr, Chrysene; B[*b+k*]Fl, benzo[*b+k*]fluoranthene; B[*a*]Py, Benzo[*a*]Pyrene; DB[*a,h*]An, Dibenz[*a,h*]Anthracene; Per, perylene; I[1,2,3-*cd*]Py, Indeno[1,2,3-*cd*]Pyrene; B[*ghi*]Pe, Benzo[*ghi*]Perylene.
[d]DBT, dibenzothiophene; C1 DBT, methylated DBT, B[*e*]Py, benzo[*e*]pyrene; Cor, coronene.

Annex 6: Summary of B/RC Sub-Group

Daniel Cossa
Richard Emmerson
Rob Fryer
Jose Fumega
Hector Martinez Calls
Brendan McHugh
Geoff Millward (Chairman)
Colin Moffat
Patrick Roose
Stefan Schmolke
Foppe Smedes
Jakob Strand
Jacek Tronczynski



(Data from FRS Marine Laboratory, Scotland, UK)

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1. Background

1. The B/RC Group comprised of members from Belgium, France, Germany, Ireland, the Netherlands, Spain and the UK. Relevant literature was made available prior to the meeting, including reports of previous workshops on the assessment of background concentrations (Laane, 1992; OSPAR/ICES Workshop, 1996). New data for inclusion in the discussion was also available on the web site before the meeting and some participants had scanned the ICES database and their national databases. Some participants brought up to date scientific literature to the meeting and W. Hegeman (The Netherlands) provided comprehensive logistical support in acquiring background papers as required during the meeting. A paper on the development of a statistical approach to assessment, entitled "Effective Environmental Standards" (see Appendix 6.1), was presented prior to the meeting by Rob Fryer (Fisheries Research Services, United Kingdom). During the Workshop, a second paper, entitled "The use of Background Concentrations in the assessment of CEMP data" (see Appendix 6.2), was developed by Dr Fryer. The new statistical approach was extensively discussed by the Group and it was refined as the week progressed so that participants had a clearer understanding of its application.

2. Approach to Review and Updating by the B/RC Group

2. Following the main plenary session, the B/RC Group met to set an agenda for its activities. This included:

- Terminology
- Compartments
- Criteria of Selection (of data)
- Units
- Ranges
- Shelf life
- Update of 1996 document
- Convergence between OSPAR and the EU Water Framework Directive

3. For the data review two study groups were formed, one reviewing and updating the information on metals in all three compartments [sediments; water; biota] and the other, organic compounds. The whole group met each day for a brief plenary, after which work on the major tasks began. The daily timetable involved compilation of the data punctuated by plenaries to discuss key issues and to assess progress, as required.

4. Several plenary sessions of the B/RC Group focused on the terminology in current use and the way in which the B/RCs might be used by OSPAR during the JAMP assessments, specifically with regard to hazardous substances. Consideration was made as to the use of the term "Background/Reference Concentrations" (B/RCs) as opposed to Background Concentrations, particularly if the Background Concentration for man-made compounds was set at zero. After some debate on this matter it was concluded that man-made substances should have a concentration of zero and that the term "Background Concentrations" was the most appropriate.

5. The B/RC Group devoted a significant amount of time to debating the matter of how the B/RCs, or any alternatives proposed by the B/RC Group, might be used by the OSPAR community. At the heart of the discussion was a proposal to adopt an advanced statistical method, developed by UK scientists from FRS and the Centre for Environment, Fisheries and Aquaculture Science (CEFAS). This method had previously been discussed at both the ICES Working Group on the Statistical Aspects of Environmental Monitoring and the OSPAR Working Group on Monitoring. Since members of the Group were not experts in the field of statistics, R Fryer gave two presentations to impart the details of the method to the non-specialists. These were complimented by an explanatory text ("The Use of Background Concentrations in the Assessment of CEMP Data") written during the course of the Workshop and presented at Appendix 6.2.

6. The Group spent most time assembling current data from national monitoring programmes and from literature sources. Additionally, data was supplied electronically from national sources during the updating process. The revised datasets, together with relevant literature citations, were assembled in a systematic and coherent spreadsheet format developed by P. Roose (Belgium). The basis of the dataset is presented in Appendix 6.3.

3. Definitions for Background Concentrations (BCs) and Background Assessment Concentrations (BACs)

7. There was a need to consider definitions for Background Concentrations (BCs) and Background Assessment Concentrations (BACs). Prior to this, the Group agreed that contaminants should be divided into two sets:

- Natural occurring elements (e.g. metals) and compounds (e.g. PAHs)
- Man-made compounds, also called xenobiotics, including PCBs, pesticides, flame retardants, tributyl and triphenyl tin.

3.1 Background Concentration (BC)

8. Following significant discussion a definition of Background Concentrations was adopted that was similar to that established at the 1996 meeting of the Working Group. A simplified version of the original definition was adopted.

Background Concentration

The Background Concentration is the concentration of a contaminant at a "pristine" or "remote" site based on contemporary or historical data.

9. The issue of deciding a Background Concentration for man-made compounds was discussed at length, including the difficulty of establishing a BC for compounds that are entirely man-made and should not be present in the environment. There was unanimous agreement that:

The Background Concentration of a man-made compound is taken as zero.

3.2 Background Assessment Concentrations (BAC)

10. The term Background Assessment Concentration arose from discussion and from the application of the statistical method. The proposed definition for BACs is:

The Background Assessment Concentration is a value for testing whether the concentrations [sediments; water; biota] at a site are at or close to background.

4. Review, Updating and Expansion of Data

11. The approaches adopted in the 1996 Document to review and updating were explored in detail. There was general consensus on the previous approach to data compilation, particularly with respect to identifying "pristine" or "remote" areas. The Group discussed and agreed that a set of Acceptance Criteria should be adopted for reporting the concentrations of the various contaminants during this review process. The following criteria were identified:

- the data should be from a site in the OSPAR area that qualifies as "pristine" or "remote" under the terms previously described in OSPAR/ICES (1996);
- the data should be derived from samples collected and manipulated in a way that minimised contamination and were analysed to the highest standards;

- the database should consist of determinations of total concentrations of particulate and dissolved species;
- the data should be verified using certified reference materials and/or inter-laboratory calibration;
- the data should, where possible, be part of repeated measurements at a fixed site to eliminate natural variability in the definition of a sample population.

12. Following a review, it was concluded that data was available as summarised in Table 6.1.

13. In order to overcome the inhomogeneity and natural variability in environmental samples the Group agreed that, where data exits, a series of appropriate co-factors should accompany the concentration data for each contaminant in the three compartments. The co-factors were defined as follows:

Sediment

14. % grain size; concentrations of aluminium, lithium and particulate organic carbon; water content.

Water

15. Temperature; salinity; dissolved organic carbon; concentration of total organic carbon; concentration of suspended particulate matter (SPM), particulate organic carbon.

Biota

16. Length; lipid concentration; condition index; ash weight; dry weight.

Table 6.1. Available Data sets for construction of Background Concentrations (BCs)

Contaminant[1]	OSPAR Region				
	I	II	III	IV	V
Metals – sediment	√	√	√	√	
Metals – water		√	√	√	√
Metals – biota	√	√	√	√	
PAH – sediment		√	√	√	
PAH – water	√			√	
PAH – biota		√	√	√	
PCB – sediment		√	√	√	
PCB – water					
PCB – biota		√	√	√	
OCPs – sediment			√		
OCPs – water				√	
OCPs – biota		√	√	√	

[1]PAH – polycyclic aromatic hydrocarbon; OCPs – organochlorine pesticides

5. Issues Arising from the Data Compilation

5.1 Assessment of the New Dataset

17. Following the review and updating process it was established that there were more than 2000 records in the compiled dataset, a considerable increase over the datasets reported in 1992 and 1996. In order to provide a preliminary assessment of the relevance and integrity of the new data, representative components of the dataset were summarised in graphical form. The preliminary assessment showed that there could be elements of the dataset, particularly some extreme concentrations (both high and low) for some contaminants, that required further consideration. It was agreed that scrutiny of the dataset would be conducted in the weeks immediately following this meeting. This would be undertaken by Patrick Roose and attendees at the OSPAR Working

Group on Concentrations, Trends and Effects of Substances in the Marine Environment. (SIME) to be held in London from 24 to 26 February 2004.[2]

5.2 Sample Location

18. The assessment of the new dataset drew attention to the requirement of careful selection of sites which might be assumed to be "pristine" and/or "remote". For example, it was shown that in Region I the concentrations of metals in *surface* sediments were generally uniform and independent of location within the region. On the other hand, metals in *surface* sediments, and some shallow cores, from Region IV (mainly nearshore Bay of Biscay) showed elevated concentrations that were significantly above those for Region I.

19. The conclusion of this comparison was that surface sediments would give reliable BCs for the contaminants in the mainly "pristine" Region I while only contaminant concentrations from deep cores would give reliable BCs in nearshore anthropogenically-impacted areas, such as those in Region IV. While identification of sites that are likely to be "pristine" and/or "remote" will remain largely subjective, care should be taken when compiling data from sites, however "remote", which are adjacent to major centres of population or else may have been influenced by atmospheric transport and subsequent deposition.

5.3 Setting Background Concentrations for General Use

20. The Group considered whether it was reasonable to set BCs, covering metals and PAHs, for general use prior to the scrutiny of the dataset. It was decided that it was inappropriate to set such BCs until the outcome of the data scrutiny was known.[3] In time, further consideration would be given as to whether the BCs should cover the whole Convention Area or whether they should be specific to each of the regions. The issue of setting BCs with the newly compiled dataset was unresolved as far as PAHs and metals were concerned, and therefore the 1996 BCs remain extant. The Group recommended that the BC for xenobiotics should be zero.

5.4 Lifetime of the Dataset

21. The Group also considered the matter of the lifetime of the data, since the review and updating process normally occurs infrequently. For example, the 1992 document was updated in 1996 and the 1996 document was not updated until 2004. Furthermore, the rate of production of new data appeared to have accelerated over the past few years. Thus, it was felt by members that a more regular revision of the database was called for and that annual assessments of the Background Concentrations should be considered by the OSPAR Environmental and Assessment and Monitoring Committee (ASMO).

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2 At SIME 04 extensive discussion took place with respect to the outcome of the Workshop, including the review of the dataset. A summary of these discussions will be available as part of the Summary Record of the meeting. The Proposals for Further Work, as detailed in the relevant section of this report were basically endorsed by SIME. In addition, the UK provided additional data for the dataset.

3 It should be noted that the proposals for further work include a specific request to the ICES Working Groups on Marine Sediments in relation to Pollution (WGMS) and Working Group on Statistical Aspects of Environmental Monitoring (WGSAEM) (1-5 March 2004) to carry out a further scrutiny of the BC dataset and to construct draft background concentrations and background assessment concentrations for metals and PAHs in sediments, and that the ICES Marine Chemistry Working Group (MCWG) (15-19 March 2004) carries out a further scrutiny of the BC dataset and constructs draft background concentrations and background assessment concentrations for metals and PAHs in biota.

6. Application of Background Concentrations

22. The Group considered, at length, the papers by R. Fryer (FRS) concerning the development of a statistical test to determine whether the concentrations of a contaminant, derived from monitoring data, comply with background concentrations. This procedure had been presented to, and adopted by, the OSPAR Working Group on Monitoring (MON 02/4/2). The intention of this method development is to design a technique which will help assess the OSPAR policy objective for hazardous substances namely:

achieving concentrations in the environment near background values for naturally occurring substances and close to zero for man-made synthetic substances.

23. The method involves the use of the Background Concentrations and it adopts a precautionary approach. The method could have the potential as a sound statistical method to carry out reliable assessments, which cover natural and man-made contaminants, in sediment water and biota in any region of the Convention area, provided reliable BCs exist. The drawback to the method is that it requires the establishment of a secondary concentration level, which could be called the Background Assessment Concentration (BAC). The BAC is a concentration near to the background and its value for a particular contaminant will depend, for PAHs and metals, on the BC and the precision of the programme (possibly defined as in Appendix 6.2). If a value of zero is accepted for xenobiotics then the derivation of a factor based on the BC and the precision of the programme is not appropriate and an alternative process will need to be developed.

24. The Group discussed the merits of the proposed statistical methodology and some members felt that the method was too sophisticated and a simpler approach (e.g. t-tests) might be more appropriate. Others were concerned about a method that required the Background Concentration to be raised by some factor, decided by the method, rather than experts in the field. Some felt that current international water quality objectives require adherence to fixed concentrations (BCs) and any suggestion that these limits would need to be modified was thought to be inappropriate.

25. It was pointed out that the function of the method was not to raise background concentrations arbitrarily but to decide, statistically, whether or not the mean concentration of a contaminant was below the BAC. Thus, the proposed statistical method involves an assessment of whether the monitored data has achieved the BAC before the BC. The significance of this approach is that it represents a trade-off between accepting a tolerable level of contamination and the benefit of having a precautionary test. The advantages of the statistical approach were summarised as:

- being statistically sound and based on a precautionary approach;
- having a potential for wide applicability covering all contaminants in all regions of the Convention Area (providing BCs are available);
- having application as a strategic management tool by countries wishing to assess the status of their marine environments;
- allowing OSPAR to test its policy objectives.

26. During the Workshop R. Fryer calculated some examples of output from the statistical method using UK CEMP monitoring data. The results from this dataset (Appendix 6.2) showed that there were some differences between the BACs that would need to be set for metals, CBs and PAHs. On the basis of one dataset it was concluded that it may not be possible to define a set of generic conditions governing the setting of a BAC. The Group felt that more experiments were needed with data abstracted from a wider range of data, covering several OSPAR countries, in order to establish the general applicability of the method. However, the outcome of the discussion was that members had a greater appreciation of the method and there was a general consensus that, with further development and refinement, it had potential application in the assessment of the monitored data.

7. Further Considerations on the dataset – Origins of the Data

27. At an early stage in the proceedings it was agreed that a data set should be compiled containing information on concentrations of metals, PAHs and organohalogen compounds in seawater, sediments and biota by OSPAR region. This data was collated from information provided by participants in the Workshop and from the literature, some of which was obtained directly during the Workshop (see Appendix 6.3).

7.1 Metals in Seawater

1. Construction of the Dataset

28. The data compiled for constructing the data base consists of trace and ultra-trace concentration levels (between pico and nanograms per litre ranges). They have been selected on the basis of the best quality assurance (QA) criteria for this type of data, namely peer review. Thus, data gathered here are from the open literature, mainly scientific journals such as Marine Chemistry, Deep Sea Research, Marine Pollution Bulletin, etc. Most of the data used in the previous OSPAR assessment appears valid and these were incorporated with new results available.

29. Despite the process which has resulted in the assemblage of new, validated data, and thus the availability of more numerous data than for the previous OSPAR assessment, there is still a scarcity. In most of cases, the data only allow assessment of ranges of concentrations and statistically qualified assessments are the exception. This group of experts stresses the necessity for the acquisition, as soon as possible, of more data on the concentration of chemical contaminants in sea waters.

30. Most of data apply to filtered samples and as such can be qualified as the dissolved fraction. However, in offshore zones most of concentrations refer to unfiltered samples. With the exception of Pb and perhaps Hg, the unfiltered sample consists mainly of dissolved species.

31. The data have been classified on the basis of their location (region) in the OSPAR Convention Area, and the depth where the samples have been collected. This information has been included in the framework of the OSPAR data base. Four (4) depth ranges have been considered:

- Surface (SURFACE) (< 200 m);
- North East Atlantic Central Waters (NEACW) (200 – 500 m);
- North East Atlantic Deep Waters (NEADW) (1250 – 3000 m); and
- Lower Deep Waters (LDW) (3000 – 4500 m).

32. These water-masses are identified by their characteristic temperatures and salinities, since their position and circulation in the world oceans are well documented. For surface waters, the data cover zones II to V for dissolved cadmium, copper, nickel, lead, and mercury. Data for dissolved zinc, iron and silver are also available for a more limited zone. For deep waters the values only refer to the open ocean of the North East Atlantic.

2. General comment on distribution variability

33. As expected, the biologically driven metals (Cd, Cu, Ni) follow nutrient like distributions with higher concentration in deep water than in surface.

34. Most of the metals show a high variability in the surface waters.

35. Certain metals, including Cd and Cu, exhibit higher concentrations near and on the shelf than in the open ocean areas. In addition, particular attention has been paid on shelf slope zone (e.g., OMEX EU Project) which are the boundaries between OSPAR regions. The results have shown that they are sites of large metal variability.

36. Physical and biological processes, which govern metal behaviour in the Ocean, are seasonally variable.

3. Precautionary approach for using these ambient levels for assessing marine contamination.

37. The data presented consist of ambient concentrations, which can be used for assessing the "Background concentrations" of each OSPAR region.

38. It has to be born in mind that, even for a specific region and a specific metal, a unique Background Concentration is unrealistic. In addition, the time response to added metal contaminants is regionally and elementary specific. These facts have to be taken into account in the assessment techniques.

Table 7.1. Summary statistics available for trace metals in the surface waters of the OSPAR Regions

Metal (ng/l)		**OSPAR Region**			
		II	III	IV	V
Cd	Range	6-34	6 – 28	4 – 12	-
	Mean ± s.d.	-	-	-	6,5 ± 5,6
Cu	Range	140 – 360	63 – 378	-	-
	Mean ± s.d.	-	-	-	98 ± 20
Pb	Range	20 – 30	10 – 90	-	6 – 11
	Mean ± s.d.	-	-	-	-
Hg	Range	0,05 – 1,30	0,06 – 1,90	0,10 – 2,00	0,06 – 0,087
	Mean ± s.d.	-	-	-	-
Ni	Range	100 – 400	116 – 464	-	-
	Mean ± s.d.	-	-	-	129 ± 12

s.d. – standard deviation

4. References

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7.2 Metals in biota

1. Construction of the Dataset

39. Data on the concentrations of individual metals in biota from a number of OSPAR regions were compiled from various sources. These included OSPAR CEMP data collected by contracted parties in addition to available literature data. Contaminant data from a number of OSPAR regions were available for inclusion in the database.

40. Data from diverse regions, including Barents Sea, Norwegian coast, Eastern Scheldt, west coast of Scotland and South West Ireland in addition to other available OSPAR CEMP data were included. Data from peer reviewed literature were added to the available monitoring scheme data but were screened to ensure that sufficient QA and co-factor information were available.

41. A number of information requirements were necessary to allow inclusion into the biota compartment database. These included parameter details, source, type, location, OSPAR region, unit of measurement, basis (dry/wet weight), qualifier flag (if applicable) and concentration information (see Appendix 6.3). Documented and acceptable QA information was also required in order for a dataset to be included in the database.

42. For each distinct data-set a number of summary statistics, including the maximum, minimum, mean, median and standard deviations were generated for each individual metal parameter. Similar statistics were calculated for appropriate co-factors including mussel or fish lengths and wet and dry weight information.

2. Metal concentrations in mussels

43. Data were initially screened to eliminate those from sites likely to be close to potential sources of contamination, such as might be found in major estuaries. Data were generally generated in accordance with National and European food safety and environmental monitoring requirements for each of the OSPAR contracted parties. Additional information from available literature was also included where the above selection criteria were met.

44. Data were generally presented on a wet weight basis. Where original data were generated on a dry weight basis appropriate correction factors were used to carry out appropriate conversions.

45. Individual sample datasets were pooled where locations were considered to be of similar geographical area. Summary statistics were then generated for these data which was then included as a single entry to the database.

3. Concentrations in fish tissues

46. Data were initially sorted to eliminate those likely to originate close to potential sources of contamination. These data were generally generated in accordance with individual countries food safety national and/or environmental monitoring programme requirements.

47. Concentration data collected from landings of fish at major fishing ports were used for entry to the database. Edible muscle and/or liver tissue information for each species were included. Data were expressed on a wet weight basis for available parameters.

7.3 Metals in Sediment

1. Construction of the Dataset

48. Before the workshop participants were requested to bring with them all available data that could help to evaluate present Background Concentrations or contribute to the update of the values. The data that were the basis for the BC values in 1996 were geographically wide spread. Some data were not felt appropriate for the OSPAR convention area. It was decided that the group would try to collect as much data as possible in the convention area and including the region relevant data already collected by the 1996 workshop data. From the collected data BC values could be deduced for comparison with the present BC values and lower EAC values.

49. All data collected, and those selected from the 1996 report, were normalised either through the ratio method or applying the OSPAR guidelines as discussed below. From all collected datasets a short data sheet was prepared that summarises all the information and approach used for normalisation and lists the values with the statistics when available. The data were collected in a dataset that was set-up during the workshop.

2. Normalisation

50. The views developed at the workshop on BC values in Hamburg that it was only possible to set background values for fine grained sediment samples is supported by the present group. It did not seem feasible to set BC values for sandy or rocky material. The group however felt it was appropriate to define fine grained sediment more precisely. For normalisation using the simple ratio method with Al or Li it was suggested to take into account only samples with more than 40 mg /kg of Li. It was decide not to use Al for this criterion as in glacial areas the Al content in the rock material is often very high without the presence of the fine material it is supposed to represent. At the level of 40 mg/kg Li the samples contain sufficient amount of fine material that the contents in the sand fraction of both Al and Li, and the target elements are not seriously influencing the metal/Al or metal/Li ratio. In addition, at this level the type of digestion used is not as critical as for samples where the sand fraction dominates. Because of the relatively high Al concentration in sandy samples from glacial origin the Al/Li ratio appeared to be a good identifier for deviating sediment matrices.

51. Following the view of the OSPAR Working Group on Monitoring not to work with ratios but national concentrations in the normal measuring range of fine grained samples it was decided to multiply metal/Al ratios with respectively 50 000 mg/kg and metal/Li with 50 mg/kg. The result is a normal concentration of each element in mg/kg as would be present in a sample containing either 50 g/kg Al or 50 mg/kg Li. It should be noted that samples being compared to the resulting BC values will also need to be normalised to the same composition.

52. This 50 g/kg for Al, 50 mg/kg for Li, to be used for metals (and 2,5 % organic carbon for organic compounds) reflects the European wide average composition of fractions <20 µm and <63 µm. So to a certain extent the results of measurements in these fractions can be compared with BCs requiring minimal normalisation.

53. However, while collecting the data the 40 mg/kg Li criterion led to the discarding of data that were particularly interesting for improving the coverage of the convention area. Therefore, it was decided to apply the OSPAR normalisation guidelines to such samples. For this approach pivot values for Al, Li and other metals needed to be available. Therefore, this was only possible in cases where a grain size analysis had been performed. By plotting the grain size fraction against the Al and Li content it was possible to determine the pivot values for these elements from the intercept values. For the other elements the pivot values as suggested in the 2002 ICES WGMS report (Annex 9) were used to apply the OSPAR normalisation. Because the normalisation of coarser samples is always an extrapolation, an error propagation is prescribed by the guidelines. Unfortunately, this was not possible, as the variability of most of the input parameters is not known.

Therefore the result of a normalisation that required an extrapolation of more than a factor 3 was discarded. In case of the normal analytical error of about 10% the final error would be 30%. In cases where the Al and Li relationship with the grain size showed more variation than expected from the regular analytical variation, the maximum allowed extrapolation factor was reduced. The extent to which this was reduced was decided by the subgroup performing the normalisation.

3. Dated Cores

54. Daniel Cossa (France) provided data on the metal concentrations found in a dated cores sampled in the south part of the Bay of Biscay (Lat: 43°39'N; Long: 01°51' W). Data on Al, Cu, Cd, Pb, Zn and Hg were provided for 0 – 1, 1 – 2, 2 – 3, 3 – 4, 4 – 5, 5 – 7, 7 – 9, 9 – 11, 11 – 13, 13 – 15, 15 – 17, 17 – 19, 19 – 21, 21 - 23, 23 – 25, 25 – 27, 27 - 29 and 29 – 31 cm. In this area, the sedimentation rate is 0,24 cm a^{-1}. On this basis sections were dated from 1987 to 1864. It was proposed that the data from the deeper part, i.e. > 24 cm (earlier than 1900) were used as the BC for sediment for OSPAR Region IV.

7.4 Organic Compounds in Water

55. Data covering polycyclic aromatic hydrocarbons (PAHs) and chlorinated biphenyls (CBs or PCBs) were gathered from the ICES database, the literature, papers submitted to the Workshop and from Workshop participants (for a full list see Appendix 6.3).

1. Chlorinated Biphenyls

56. A limited amount of the CB data was Convention wide. However, the bulk of the CB data was restricted to Regions I and II with depth specific data for the Norwegian Sea, the Greenland Sea and the Faroe Bank Channel. Data was also supplied for the English Channel. Concentrations were generally reported as fg/l.

57. Although data was often reported as individual congeners, some was supplied from the ICES database as the sum of the ICES 7 CBs (CB 28, 52, 101, 118, 138, 153 and 180).

58. As part of the review process, a paper summarising data on selected organic contaminants in OSPAR Regions II and IV was submitted to the Group by Jacek Tronczynski (France). This included data for dissolved chlorinated biphenyls (CB 31, 28, 52, 101, 110/77, 118, 153, 138, 187, 174, 180 and 194) in sea water. The seawater samples were taken in the water column at different depths: surface, intermediate (20 – 60 m) and bottom, slightly below 100 meters. The samples were collected by pumping seawater through all PTFE tubing and pumps into stainless steel or glass 20-L containers. The off-shore and coastal samples were filtered and extracted onboard in the vessel's clean laboratory. The water samples were filtered through GF/F fibre-glass filters (0,7 µm nominal porosity), pre-baked at 450°C. The filtered seawater was extracted by solid phase extraction on XAD-2 (polystyrene divenly benzene) resins (370 mm x 19 mm columns) with peristaltic suction pumps. The seawater and SPM samples were in contact with only Teflon, stainless steel or glass during collection and further treatment and were not exposed to hydrocarbon vapours. The amounts of water filtered for SPM was between 100 to 450 L and the corresponding volumes of water extracted for dissolved hydrocarbon analysis were between 90 to 180 L (Fernandes et al. 1997, Tronczynski et al. 1998 and 2004; see Appendix 6.4).

2. PAHs

59. Data for individual compounds was limited to often less than 10 entries and came mainly from either the ICES database or else were from samples collected from Biscay Bay. Regions I, II and IV were included.

7.5 Organic Compounds in Biota

1. Data selection and assessment

60. Data covering polycyclic aromatic hydrocarbons (PAHs), chlorinated biphenyls (CBs or PCBs) and selected pesticides were gathered from the ICES database, the literature, papers submitted to the Workshop and from Workshop participants (for a full list see Appendix 6.3).

61. When preparing the initial information, participants had given some consideration to identifying samples that could be regarded as from 'pristine' sites while others had reported data as part of a wider 5 stage classification scheme. In the latter case, 'pristine' or Class 1 was considered as the 'current reference concentration' or 'background reference concentration' and was calculated by dividing by a factor of 2 the minimal concentration of the data set (see Tables 2 – 9, Appendix 6.4).

62. The current OSPAR B/RC values were mainly developed at the Workshop held in Hamburg in 1996. The Workshop discussed at some length both the nomenclature and the possible approaches to the derivation of Background Concentrations. The main difficulties are that most environmental materials available for analysis today, such as water, fish or shellfish, in most parts of the OSPAR area will reflect current environmental conditions, together with the current levels of environmental contamination. The presence of persistent organic contaminants in remote (e.g. Arctic) areas is clear evidence of long-range transport of these substances away from areas where they are manufactured and used, and it is known that other substances, such as lead and cadmium, can exhibit significant atmospheric transport. The 1996 Workshop concluded that there were three main approaches that could be adopted to determine Background Concentrations:

a) Background concentrations could be derived from data from geological times, i.e. pre-industrial times. Clearly, there is no opportunity to collect material today from most environmental matrices that would reflect pre-industrial conditions. The one possible opportunity are sub-surface sediments preserved in areas where sediment accumulation is occurring. This approach has been demonstrated to be effective in specialised areas such as Norwegian fjords, but there are rather few areas in the likes of UK marine waters where continuous accumulation of sediment has occurred over the necessary time scale. Thus for OSPAR Region III and the west side of Region II there are only limited areas where this approach may be applicable. Areas which could probably be used in this way are some Scottish sea lochs, and a few off-shore accumulating areas, such as basins on the west coat of Scotland and mud banks in the Irish Sea. There are few, if any, such locations off the east coast of Great Britain.

b) Background concentrations could be derived from published historical data, i.e. historical measurements. The main problems with this approach are the unavailability of any data for many of the OSPAR priority substances (such as metals and persistent organic contaminants) more than a few decades old, and concerns over the quality of the data that may be available. The only substances for which useful and reliable data may be available are nutrients in sea water, but these will not extend back beyond the early 20th century.

c) Background concentrations could be derived from recent data from pristine areas, i.e. areas that do not experience significant anthropogenic contamination. As noted above, the long-range atmospheric transport of contaminants is well recognised, and results in the presence of contaminants in areas very distant from sources. Some environmental processes can lead to the concentration of volatile organic contaminants in polar areas, areas that might intuitively be considered relatively unlikely to experience anthropogenic contamination. The widespread distribution of contaminants leads to the concept of there being a background degree of general environmental contamination. The level is increased in areas that receive more direct inputs of contaminants.

63. The procedures that was adopted by the UK, and detailed in a paper submitted to the Workshop by Ian Davies (FRS Marine Laboratory, UK) mainly relied on approach c) above, i.e. the identification of ranges of concentrations to reflect the ranges found in relatively uncontaminated parts of the UK. The UK is fortunate in this respect, in that it includes considerable areas of sea that do not receive significant direct or riverine discharges of OSPAR priority contaminants. For example, there are large areas in the north and far west of the UK where industrial activity and population numbers are low. These areas, and others, provide opportunities to observe concentrations of contaminants that can be considered as background values. The data submitted by the UK came from laboratories in Scotland, England and Northern Ireland. All these laboratories contributed to the

UK National Marine Monitoring Programme, and all participated in the QUASIMEME Laboratory Performance Study scheme. For contaminants in shellfish, UK data had been gathered to cover the requirements of the EU Shellfish Hygiene Directive with data being reported on a wet weight basis. The individual datasets were of different sizes and so were treated separately during the data analysis. Where possible, the data were initially sorted to eliminate data from sites likely to be close to potential sources of contamination, such as might be found in major estuaries. However, some of the datasets covered a range of environmental settings, including potential reference conditions and areas where some degree of contamination was likely. These data were not sorted, but an expression of the lower range of values was obtained by computing the minimum and 30-percentile values for each determinand.

64. As an example, the summarised data for the OSPAR priority PAH compounds in mussels are listed in Table 7.2. In general, there is quite good agreement between the two sets of data, bearing in mind the wide ranges of concentrations of PAH compounds that can be found in mussels. For some compounds, the upper bound for the 'remote site' data exceeds that for the data based on the minimum and 30-percentile values, and for other compounds the reverse occurs.

65. Table 7.2 also includes proposed BC[4] values for PAHs in mussel tissue, derived from the summarised data sets. In cases where two sets of data are available, the upper bound to the proposed range is the higher upper bound of the two individual ranges.

66. There are no current OSPAR B/RCs for PAH in mussels.

Table 7.2. Polycyclic aromatic hydrocarbons in mussel tissue – Ranges of background concentrations, derived from FRS and CEFAS data, and proposed UK background concentrations (see Footnote regarding terminology). There are no current OSPAR BCs for PAH in mussels.

Determinand	Scottish 'remote sites' ng g^{-1} wet weight	Lower range values[a] ng g^{-1} wet weight	Proposed UK BC values ng g^{-1} wet weight	Current OSPAR BC ng g^{-1} wet weight
Naphthalene	0,2 – 1,6	0,2 – 1,6	0,2 – 1,6	Not defined
Phenanthrene	0,5 – 2,5	0,6 – 3,5	0,5 – 3,5	Not defined
Anthracene	0,2 – 0,8	0,1 – 0,5	0,2 – 0,8	Not defined
Fluoranthene	0,6 – 5,6	2,0 – 14	0,6 - 14	Not defined
Pyrene	0,7 – 5,1	1,4 – 11	0,7 - 11	Not defined
Benzo[*a*]anthracene	0,2 – 4,0	0,5 – 2,0	0,2 – 4,0	Not defined
Chrysene	0,4 – 7,3	1,5 – 4,0	0,4 – 7,3	Not defined
Benzo[*a*]pyrene	0,2 – 2,3	0,2 – 0,9	0,2 – 2,3	Not defined
Benzo[*ghi*]perylene	0,2 – 5,0	0,1 – 1,3	0,1 – 5,0	Not defined
Indeno[123-*cd*]pyrene	0,2 – 1,6	0,1 – 0,6	0,1 – 1,6	Not defined

[a]obtained by computing the minimum and 30-percentile values for each determinand.

67. The upper limits of the concentrations presented in Table 7.2 for PAH in mussels correspond to the 'high' or Class 4 contamination level as defined, for OSPAR Regions II and IV, in Appendix 6.4 and reproduced in Tables 7.3 and 7.4 below. Thus, further discussion is required together with input form ICES Working groups.

[4] It should be noted that the abbreviation used in the paper prepared by Ian Davies was BRC. This has been changed in the Workshop report to BC.

Table 7.3. (also presented as Table 2 in Appendix 6.4)
OSPAR Region II (La Manche English Channel French Coast from 51°00.20 N; 2°00.00 E to 48°16.90 N; 4°15.50 W)

STATISTICAL CLASSIFICATION OF CURRENT CONDITIONS for selected unsubstituted polycyclic aromatic hydrocarbons (PAHs) in marine molluscs tissue (mussel *Mytilus edulis* and oyster *Crassostera gigas*)

CONCENTRATIONS in μg kg^{-1} wet weight tissue; Ranges for RNO – Réseau National d'Observation 2001 – Reference Concentration proposed by France

Determinand		**Class 1**	**Class 2**	**Class 3**	**Class 4**	**Class 5**
Contamination level		**CRC**				
			Low	**Moderate**	**High**	**Very High**
Naphthalene*	Naphthalene	< 0,1	0,1 - 0,2	0,2 - 0,5	0,5 - 1,1	> 1,1
Fluorene*	Fluorene	< 0,1	0,1 - 0,2	0,2 - 0,5	0,5 - 1,4	> 1,4
Phenanthrene	Phenanthrene	< 0,6	0,6 - 1,2	1,2 - 3,2	3,2 - 8,8	> 8,8
Anthracene	Anthracene	< 0,1	0,1 - 0,2	0,2 - 0,6	0,6 - 2,3	> 2,3
Fluoranthene	Fluoranthene	< 0,5	0,5 - 1,4	1,4 - 6,4	6,4 - 29,2	> 29,2
Pyrene	Pyrene	< 0,4	0,4 - 0,9	0,9 - 5,4	5,4 - 32,7	> 32,7
Benz[a]anthracene	B[a]anthr	< 0,1	0,1 - 0,2	0,2 - 1,7	1,7 - 13,3	> 13,3
Chrysene/Tri	Chrysene/Tri	< 0,5	0,5 - 1,0	1,0 - 5,6	5,6 - 29,6	> 29,6
Benzo[b]fluoranthene	B[b +j]Fl	< 0,6	0,6 - 1,5	1,5 - 7,9	7,9 - 41,0	> 41,0
Benzo[k]fluoranthene	B[k]Fl	< 0,2	0,2 - 0,4	0,4 - 1,7	1,7 - 7,3	> 7,3
Benzo[e]pyrene	B[e]py	< 0,6	0,6 - 1,3	1,3 – 7,0	7,0 - 36,2	> 36,2
Benzo[a]pyrene	B[a]py	< 0,1	0,1 - 0,2	0,2 - 1,3	1,3 - 7,1	> 7,1
Perylene	Perylene	< 0,1	0,1 - 0,2	0,2 - 0,7	0,7 - 2,9	> 2,9
Indeno[1,2,3-cd]pyrene	Indeno[cd123]P	< 0,2	0,2 - 0,5	0,5 - 1,5	1,5 - 4,6	> 4,6
Dibenz[a,h]anthracene	DBA	< 0,1	0,1 - 0,2	0,2 - 0,7	0,7 – 2,0	> 2,0
Benzo[g,h,i]perylene	B(ghi)perylene	< 0,3	0,3 - 0,7	0,7 - 2,4	2,4 – 8,0	> 8,0

*compounds prone to evaporative losses during sample work-up

2. The impact of seasonality

68. Seasonality has an impact on organic contaminant loading in e.g. shellfish. Concentrations tend to increase over the winter period as the shellfish mature and then decrease following spawning. Thus, when assessing contaminant loading against reference values, the time of year must be noted and reference samples and test samples should have been collected at the same time of year. The variation over time was illustrated using a dataset for PAH in mussels. Forty four (44) samples of farmed mussels were collected approximately monthly from Loch Etive, Scotland (see Figure at start of Appendix 6). Loch Etive is distant from any industrial or urban inputs of PAH, and experiences only minor boat traffic. The data are therefore expected to represent background concentrations, with the only likely sources of hydrocarbon contamination being fuel used on the small boat servicing the shellfish farm.

Table 7.4. (also presented as Table 5 in Appendix 6.4)
OSPAR Region IV: Golfe de Gascogne Biscay Bay French Coast from 48°07.03 N; 4°17.00 W to 43°21.60 N; 1°46.60 W

STATISTICAL CLASSIFICATION OF CURRENT CONDITIONS for selected unsubstituted polycyclic aromatic hydrocarbons (PAHs) in marine molluscs tissue (mussel *Mytilus edulis* and oyster *Crassostera gigas*)

CONCENTRATIONS in µg kg^{-1} wet weight tissue; Ranges for RNO – Réseau National d'Observation 2001 – Reference Concentration proposed by France

Determinand		**Class 1**	**Class 2**	**Class 3**	**Class 4**	**Class 5**
Contamination level		**CRC**	**Low**	**Moderate**	**High**	**Very High**
Naphthalene*	Naphthalene	< 0,05	0,05 - 0,1	0.1 - 0,3	0,3 - 0,6	> 0,6
Fluorene*	Fluorene	< 0,1	0,1 - 0,2	0,2 - 0,4	0,4 - 1,2	> 1,2
Phenanthrene	Phenanthrene	< 0,5	0,5 - 1,0	1,0 - 2,6	2,6 - 7,2	> 7,2
Anthracene	Anthracene	< 0,1	0,1 - 0,2	0,2 - 0,8	0,8 - 3,5	> 3,5
Fluoranthene	Fluoranthene	< 0,7	0,7 - 2,0	2,0 - 5,1	5,1 - 12,5	> 12,5
Pyrene	Pyrene	< 0,6	0,6 - 1,6	1,6 - 4,3	4,3 - 11,1	> 11,1
Benz[a]anthracene	B[a]anthr	< 0,1	0,1 - 0,4	0,4 - 0,9	0,9 - 2,2	> 2,2
Chrysene/Tri	Chrysene/Tri	< 0,7	0,7 - 1,9	1,9 - 4,0	4,0 - 8,6	> 8,6
Benzo[b]fluoranthene	B[b +j]Fl	< 0,4	0,4 - 0,9	0,9 - 2,7	2,7 - 7,5	> 7,5
Benzo[k]fluoranthene	B[k]Fl	< 0,1	0,1 - 0,3	0,3 - 0,9	0,9 - 2,8	> 2,8
Benzo[e]pyrene	B[e]py	< 0,4	0,4 - 0,9	0,9 - 2,3	2,3 - 5,7	> 5,7
Benzo[a]pyrene	B[a]py	< 0,05	0,05 - 0,1	0,1 - 0,2	0,2 - 0,3	> 0,3
Perylene	Perylene	< 0,1	0,1 - 0,3	0,3 - 0,8	0,8 - 2,4	> 2,4
Indeno[1,2,3-cd]pyrene	Indeno[cd123]P	< 0,1	0,1 - 0,3	0,3 - 0,5	0,5 - 0,9	> 0,9
Dibenz[a,h]anthracene	DBA	< 0,1	0,1 - 0,2	0,2 - 0,3	0,3 - 0,4	> 0,4
Benzo[g,h,i]perylene	B(ghi)perylene	< 0,2	0,2- 0,4	0,4 - 0,7	0,7 - 1,3	> 1,3

*compounds prone to evaporative losses during sample work-out

Table 7.5. Application of proposed BC values to data on PAHs in mussel tissue from Loch Etive, Scotland

PAH	Number of data points	Percentage of data points below BC range	Percentage of data points within BC range	Percentage of data points above BC range
Naphthalene	44	0	73	27
Phenanthrene	44	2	98	0
Anthracene	44	66	32	2
Fluoranthene	44	2	98	0
Pyrene	44	9	91	0
Benz[*a*]anthracene	44	18	80	2
Chrysene	44	11	87	2
Benzo[*a*]pyrene	44	27	71	2
Benzo[*ghi*]perylene	44	2	96	2
Indenopyrene	44	11	82	7

69. This dataset was also used to explore the possible implications of the suggested BC values for contaminants in mussel tissue (Table 7.5). For almost all compounds, the large majority of the data points fall within the BC ranges derived in the UK paper. The points falling below the range were normally samples for which the concentration was below the limit of quantification of the analytical method. The occurrence of a

moderate proportion of concentrations above the proposed BC range for naphthalene would be consistent with occasional low levels of contamination of boat engine fuel.

70. Proposed BC values were also presented by the UK for CBs (CB 28, 52, 101, 118, 153, 138, 180 and Sum ICES 7) in mussel, selected pesticides (alpha-, beta-, gamma-, delta-HCH, op-DDT, pp-DDT, PP-TDE, pp-DDE) in mussel tissue and CBs in fish liver.

3. Other sources of data

71. a. *Republic of Ireland:*

Chlorinated hydrocarbon concentrations in shellfish from Irish waters and various fish species landed at selected Irish Ports was made available to the workshop. The data for both the shellfish and fish covered the period 1997 – 2001. The determination of chlorinated hydrocarbon concentrations in shellfish from Irish waters was carried out by the Marine Institute to fulfil the monitoring requirements of legislation including:

- EU Council Directive 79/923/EEC on the quality required of shellfish growing waters
- EU Directive 91/492/EEC laying down the health conditions for the production and placing on the market of live bivalve molluscs
- Statutory Instrument (SI) No. 200 of 1994.

72. To ensure sufficiently high quality data was produced, quality control samples, including reference materials, were analysed with each batch of samples. Reference materials supplied by QUASIMEME were used to supplement limited availability of Certified Reference Materials.

73. Most of the shellfish samples were collected from sites on the south and west coasts of Ireland. The determinands included CB 28, 52, 101, 138, 153 and 180, DDT-p,p', DDE-p,p', DDT-o,p', DDT-p,p', dieldrin, hexachlorobenzene, gamma-hexachlorocyclohexane, *trans*-nonachlor, *trans*-chlordane and *cis*-chlordane.

74. b. *France:*

The data presented by France on the concentrations of chlorinated hydrocarbons (Appendix 6.4) in molluscs were partly obtained within framework of the Réseau National d'Observation – RNO coordinated by Ifremer, and made in part fulfilment of national and international monitoring requirements. The results allow the identification of ranges of concentrations of relatively low contaminated areas in OSPAR Regions II and IV (English Channel and Biscay Bay) along French coasts.

75. The determinands included: CB 28, 52, 101, 118, 153, 105, 138, 156, 180, α-HCH, γ-HCH, p,p'-DDE, p,p'-DDD, p,p'-DDT.

76. The selected results for background or low concentration assessment of organic contaminants in shellfish samples corresponds to the recent data, obtained in 2001, on the RNO database. This is also considered to be representative of the much larger RNO data base which eventually should be also considered when making further assessment. The shellfish samples and results used in this report were collected in 1999 and 2001.

77. All the organic contaminant data presented by France was subject to quality assurance. Analyses of Standard Reference Materials (SRM 1491, SRM 2977 from the National Institute of Standards and Technology –NIST- and EC-2 from National Water Research Institute –NWRI) were routinely incorporated into each batch of samples and used to control overall accuracy of the method. The method detection limits of analytes were individually calculated for the sample and depended on the size of the sample used for extractions, the final dilution of the extract, injection technique, and the relative response factor of the analytes. The laboratory proficiency for organic contaminant analysis is also evaluated through participation in the QUASIMEME (Quality Assurance of Information for Marine Environmental Monitoring in Europe) intercomparison exercises. Internal QA/QC procedures included also laboratory and field blanks, analyses of replicate samples for precision determination, use of internal recovery standards added to each sample before extraction allow to control losses of analytes during the entire sample work-out.

78. Relevant references for the French data are presented at the end of Appendix 6.4.

79. c. *Literature:*

Data was also collected from a number of papers. An example of the type of paper from which data was extracted is:

Green, N.W. and Knutzen, J. (2003) Organohalogens and metals in marine fish and mussels and some relationship to biological variables at reference localities in Norway. *Marine Pollution Bulletin*, **46**, 362 – 377.

80. The goals of the study outlined in this paper were to define, for the Norwegian coast, "high background" levels of micropollutants routinely monitored within the Oslo and Paris Commission Joint Assessment and Monitoring Programme, and to reassess the present Norwegian reference levels used as the basis for a classification of environmental quality.

7.5 Organic Compounds in Sediment

81. Data covering polycyclic aromatic hydrocarbons (PAHs), chlorinated biphenyls (CBs or PCBs) and selected pesticides were gathered from the ICES database, the literature, papers submitted to the Workshop and from Workshop participants (for a full list of compounds see Appendix 6.3).

1. Chlorinated biphenyls

82. The CB data incorporated South Norway/Skagerak (Region II; from ICES database), Iceland/Norwegian Sea (Region I; from ICES database), Scottish Coast (Region III) and Bay of Biscay (Region IV). The data was reported on either a dry weight or organic carbon basis. There was some discussion, both at the Workshop and in the papers provided to the Workshop, on the approach to estimating background concentrations in sediments. There are two main approaches. The first depends on the analysis of core samples, with a view to determining concentrations preserved in a historical record. The second involves the estimation of concentrations in current surface sediments in areas relatively remote from contamination, In both cases, the underlying geology and mineralogy of the sediment will influence the observed concentrations. The data for the Bay of Biscay was from core samples, while that from the Scottish coast was surface sediments. Thus there is the opportunity to compare the two approaches.

2. Polycyclic aromatic hydrocarbons (PAHs)

83. A significant amount of data for PAHs in dated core samples from the Bay of Biscay offshore of France was incorporated into the data set. The sediment samples were collected with stainless steel Reyneck sediment box corer in Biscay Bay in 1999 and 2002 (Tronczynski *et al*. 2004)[5]. The background concentrations for PAHs in sediments derived from the analysis of dated pre-industrial sediment core samples (ca. 1700 to 1830). These data can be used as the background concentrations of PAHs in sediments as proposed by France.

[5] Tronczynski J., C. Munschy, K. Moisan, N. Guiot, I. Truquet, N. Olivier, S. Men, and A. Furaut (2004) Contamination of Biscay Bay by Polycyclic Aromatic Hydrocarbons – PAHs - after the *Erika* Oil Spill (submitted to Aquatic Living Resources 2004).

Table 7.6. Concentrations (µg kg^{-1} dry weight) sediment; Ranges for Réseau National d'Observation 1999 Background concentrations proposed by France for PAHs in sediments. OSPAR Region IV: Golfe de Gascogne, Biscay Bay French Coast from 48°07.03 N; 4°17.00 W to 43°21.60 N; 1°46.60 W

Determinand	BC (ca. 1700 – 1830)
Naphthalene*	0,07 - 0,32
Fluorene*	0,14 - 0,24
Phenanthrene	1,20 - 1,67
Anthracene	0,16 - 0,29
Fluoranthene	1,11 - 1,50
Pyrene	0,69 - 1,00
Benz[*a*]anthracene	0,37 - 0,50
Chrysene/Tri	0,69 - 0,88
Benzo[*b*]fluoranthene	1,75 - 2,49
Benzo[*k*]fluoranthene	0,42 - 0,56
Benzo[*e*]pyrene	0,57 - 0,71
Benzo[*a*]pyrene	0,26 - 0,49
Indeno[1,2,3-*cd*]pyrene	1,17 - 1,75
Dibenz[*a,h*]anthracene	0,14 - 0,17
Benzo[g,h,i]perylene	0,93 - 1,30

84. The basis of this data is presented in detail in Table 10 of Appendix 6.4.

85. Other data was again surface sediments. Definition of the background concentrations of PAH presents particular problems. Concentrations in surface sediments can vary greatly from area to area, even where the areas appear not to be receiving discharges containing PAHs. Recent surveys of PAH in Scottish inshore waters (west coast sea lochs, Shetland voes, Orkney coastal waters)[6] that would be considered distant from recognised major sources of PAH have found large systematic differences in concentrations between sampling areas. Total PAH concentrations in excess of 5000 ng/g have been found in areas that were expected to be free from contamination. The underlying reasons for this are not clear, but may be related to the ways in which areas respond to atmospheric inputs of PAH (for example onto catchment areas), in addition to local factors such as PAH from road traffic, and marine transport activity. In this context, there is need for further discussion and consideration of such issues and specifically if surface sediment data could be used to derive Background Concentrations for PAHs.

3. Outputs and Recommendations

86. The Group presented its overall outputs and recommendations to the final plenary session of the workshop. These have been incorporated within the 'Outputs and Recommendations' section of this report.

[6] Webster, L., Fryer, R.J., Dalgarno, E.J., Megginson, C. and Moffat, C.F. (2001) The polycyclic aromatic hydrocarbon and geochemical biomarker composition of sediments from voes and coastal areas in the Shetland and Orkney Islands. *J. Environ. Monit.* **3**, 591-601.
Webster, L., Fryer, R.J., Megginson, C., Dalgarno, E.J., McIntosh, A.D. and Moffat, C.F. (2004) The polycyclic aromatic hydrocarbon and geochemical biomarker composition of sediments from sea lochs on the west coast of Scotland. *J. Environ. Monit.* **6**, 219-228.

Appendix 6.1: Effective environmental standards

Rob Fryer
Fisheries Research Services, Aberdeen, UK

Relevance and effectiveness

1. An environmental standard should be both

- relevant – it measures the right thing
- effective – it can be used for environmental management: specifically, it can be tested against

2. Typically, most effort is spent ensuring relevance and effectiveness is only an afterthought. However, the end use of an environmental standard ought to be an integral part of its development. Often there is some conflict between relevance and effectiveness and some iteration / compromise between the two is required.

3. The resources available for monitoring should also be considered. There is no point in setting an environmental standard that is so exacting that one can only demonstrate compliance with unrealistic monitoring effort.

Populations and summary statistics

4. An environmental standard should be defined in a way that lends itself to statistical hypothesis testing. In particular, it should be easy to relate some summary statistic of a population of interest to the environmental standard.

5. It is relatively easy to make inferences about means or medians. It is harder statistically, and more demanding on resources, to make inferences about the tails of a distribution (e.g. the 90^{th} percentile).

Construction B/RCs

6. B/RCs should be constructed

- at the same population scale
- using the same summary statistic (e.g. the mean concentration)

as will later be used for testing.

7. Hopefully, data will be available from several (many) 'background' populations. The mean concentration can be estimated from each population, and the range of these mean values used to give a plausible range of B/RCs. Alternatively, a mixed model might estimate the variation in mean concentration between background populations.

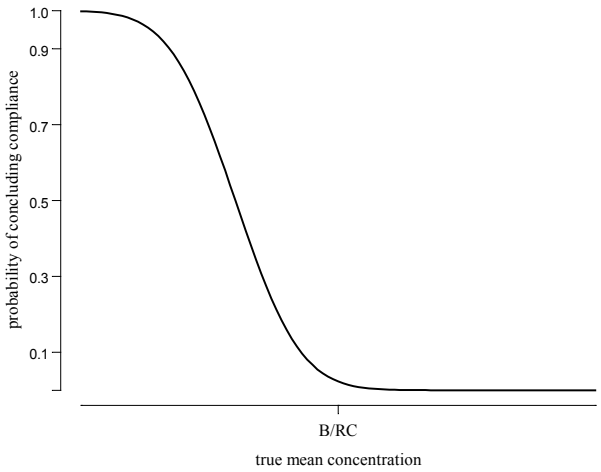
Green tests

8. However, although B/RCs are useful in a broad sense, they cannot be used directly to demonstrate that concentrations in some population of interest are at background. MON 02/4/2 shows that the precautionary approach requires the use of a *green* test of the form

$$H_0: \mu > \text{B/RC}$$
$$H_1: \mu \leq \text{B/RC}$$

where μ is (for example) the mean concentration in the population. Thus, we assume levels are above background unless we can demonstrate otherwise. The onus is on the monitoring programme to demonstrate compliance.

9. The problem is that the tests of this hypothesis are only likely to demonstrate compliance when the true mean concentration μ is *below* background (see below) and this cannot happen by definition.

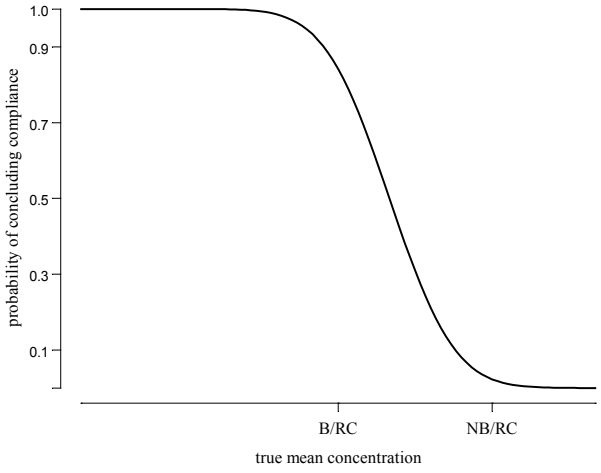


Modified green tests

10. A solution (MON 02/4/2) is to define a near-background concentration NB/RC (!!) and use a modified green test of the form

$$H_0: \mu > \text{NB/RC}$$
$$H_1: \mu \leq \text{NB/RC}$$

11. If the near-background concentration is selected sensibly, there can be high power of demonstrating compliance when levels are genuinely at background (below).



12. The disadvantage is that some populations where concentrations are above background (but below near-background) will also comply.

Relevance and effectiveness

13. The near-background concentration should be:

- relevant (sufficiently close to background to satisfy environmental managers)
- effective (sufficiently far away from background so that we can demonstrate compliance with reasonable monitoring resources)

14. Setting the near-background concentration is going to be tough. But here is one possible way forward. Suppose we have an annual monitoring programme, with the dual aims of trend detection and testing for compliance with background. Suppose the monitoring programme is designed to detect a 10% annual change in concentration over ten years with 90% power. And suppose we are modelling the data the OSPAR way (yearly indices of median log-concentration, smoothers with seven year-window, etc.). Then the design implies that the yearly indices will have a residual standard deviation of 0,24 or less.

15. Now suppose that we want to have 90% power to demonstrate compliance with the near-background concentration when the true concentration is at background. Then a residual standard deviation of 0,24 or less implies that the near-background concentration should be set at 1,8 times the background concentration.

16. Of course, there are many caveats to the above. What about year-skipping strategies when levels have been historically low? We would want to ensure that the assessment methodology and the NB/RC were still compatible. And what about those contaminants where the residual standard deviation of 0,24 cannot be achieved – trend detection might be unlikely, but testing for compliance with some near-background concentration would still be desirable.

Appendix 6.2: The use of Background Concentrations in the assessment of CEMP data

Rob Fryer
Fisheries Research Services, Aberdeen, UK

1. Introduction

1. The OSPAR policy objective for hazardous substances is

… achieving concentrations in the environment near background values for naturally occurring substances and close to zero for man-made synthetic substances

(OSPAR, 1998). Two questions that follow are:

- How do we quantify *near background* and *close to zero*?
- How do we test whether the objective has been met?

2. MON 02/4/2 describes a precautionary test for assessing the OSPAR policy objective and shows how it can be incorporated in the current OSPAR methodology for assessing CEMP data. Section 2 describes the precautionary test. The test relies on the setting of *Background Assessment Concentrations*[7] that quantify what is meant by *near background* and *close to zero*. Section 3 shows how provisional Background Assessment Concentrations (BACs) might be established based on the precision achieved by the CEMP.

2. Testing whether concentrations are near background or close to zero (MON 02/4/2)

3. Suppose that we wish to compare the mean concentration [c] of a contaminant in a matrix at a monitoring site to the Background Concentration (BC). The traditional way of testing is to assume that the mean concentration is at background (i.e. $[c] \leq BC$) unless there is statistical evidence to show that it is above background (i.e. $[c] > BC$). Formally, the test involves a null hypothesis H_0 that states that

H_0: $[c] \leq BC$ (i.e. concentrations at the site are at background)

4. The alternative hypothesis H_1 states that

H_1: $[c] > BC$ (i.e. concentrations at the site are above background)

5. We conclude that concentrations are at background unless there is sufficient statistical evidence to show that concentrations are above background (i.e. we accept H_0 unless there is sufficient statistical evidence to reject it in favour of H_1).

6. To make the test, we need to use monitoring data to estimate the mean concentration and put confidence limits around the mean[8]. The test itself uses the lower confidence limit. We conclude that concentrations are at background if the lower confidence limit is below the BC (e.g. site 1 in Figure 1). We conclude that concentrations are above background if the lower confidence limit is above the BC (e.g. site 2 in Figure 1).

7. This test is sometimes called a *brown* test because the benefit of doubt is against the environment. To illustrate, if the mean concentration is estimated with poor precision there can be a large chance of concluding that concentrations are at background even when the mean concentration is actually much greater than the BC

[7] called *near-background concentrations* in the original document.

[8] The current OSPAR methodology for assessing the CEMP data does this by fitting a smoother to annual contaminant indices and using the pointwise confidence bands around the fitted smoother.

(e.g. site 3 in Figure 1). As such, brown tests are counter to the precautionary principle advocated by OSPAR (OSPAR 1998).

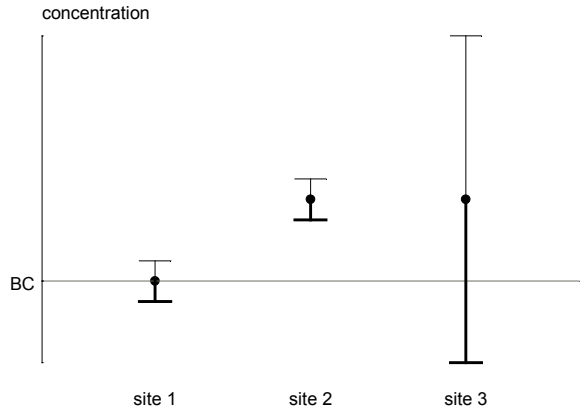


Figure 1. Illustration of the brown test; the dots indicate the estimated mean concentration and the bold bars indicate the lower confidence limit. We conclude that concentrations at site 2 are above background and that concentrations at site 1 and 3 are at background.

8. A precautionary or *green* test is one where the burden of demonstrating that concentrations are at background rests with the monitoring programme. The test is obtained by reversing the order of the hypotheses in the brown test. In the green test, we assume that the mean concentration is above background unless there is statistical evidence to show that it is at background. The null and alternative hypotheses are:

H_0: [c] > BC (i.e. concentrations above background)

H_1: [c] ≤ BC (i.e. concentrations at background)

9. The test now uses the upper confidence limit. We conclude that concentrations are above background if the upper confidence limit is above the BC. We conclude that concentrations are at background if the upper confidence limit is below the BC. The precautionary nature of the test is illustrated in Figure 2 where we conclude that concentrations are above background at site 3. However, the green test also concludes that concentrations are above background at site 1 (Figure 2) so the test is too precautionary.

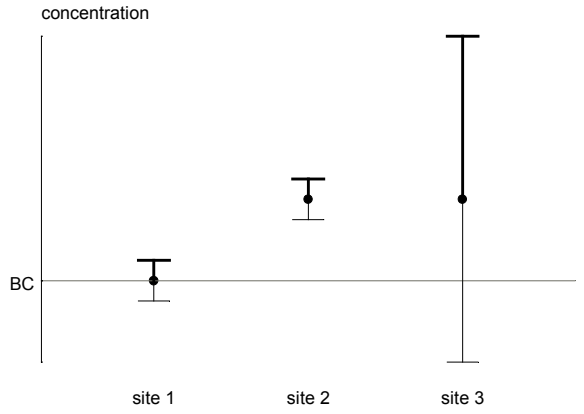


Figure 2. Illustration of the green test; the dots indicate the estimated mean concentration and the bold bars indicate the upper confidence limit. We conclude that concentrations are above background at all three sites.

10. A solution is to use a *modified green* test in which some environmental protection is sacrificed for a more effective test. The modified green test assumes we can establish a *Background Assessment Concentration* (BAC) below which concentrations can be considered *near background*. We now assume that the mean

concentration is above background[9] (i.e. [c] > BAC) unless there is statistical evidence to show that it is near background (i.e. [c] ≤ BAC). The null and alternative hypotheses are now:

H_0: [c] > BAC (i.e. concentrations above background)

H_1: [c] ≤ BAC (i.e. concentrations near background)

11. The test again uses the upper confidence limit. We conclude that concentrations are above background if the upper confidence limit is above the BAC. We conclude that concentrations are near background if the upper confidence limit is below the BAC. To illustrate, we now conclude that concentrations at site 1 are near background, but that concentrations at sites 2 and 3 are above background (Figure 3).

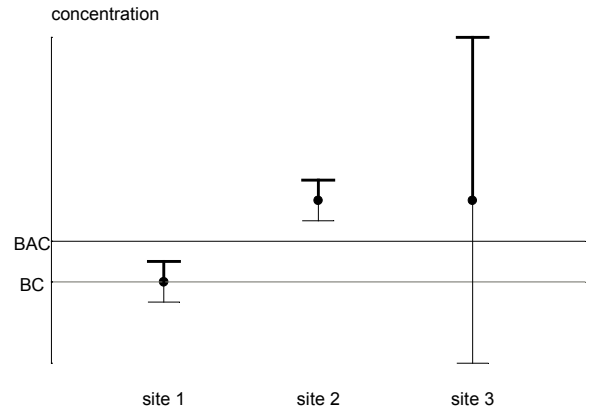


Figure 3. Illustration of the modified green test; the dots indicate the estimated mean concentration and the bold bars indicate the upper confidence limit. We conclude that concentrations are above background at sites 2 and 3 and near background at site 1.

[9] strictly, above near-background.

3. Setting Background Assessment Concentrations

12. The main practical difficulty with the modified green test is setting a suitable Background Assessment Concentration. The BAC should be both:

- relevant – low enough to reflect near background concentrations
- effective – high enough that we are likely to conclude that concentrations are near background when [c] = BC.

13. To illustrate effectiveness, consider site 1 (in Figures 1-4) where concentrations are at background (i.e. [c] = BC). If the BAC is set too close to the BC relative to the precision of the monitoring programme, we are likely to conclude, incorrectly, that concentrations at site 1 are above background (Figure 4). On the other hand, if the BAC is compatible with the precision of the monitoring programme, we are likely to conclude, correctly this time, that concentrations at site 1 are near background (Figure 3).

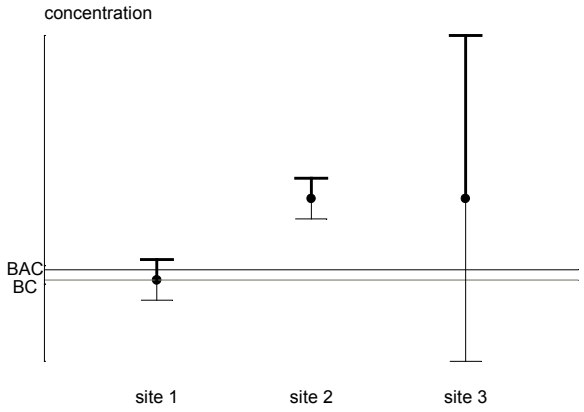


Figure 4. If the BAC is set too close to the BC relative to the precision of the monitoring programme, we are unlikely to ever conclude that concentrations are near background (see site 1).

14. In an ideal world, the BAC would be set on environmental / ecotoxicological grounds. The monitoring programme would then be designed with sufficient precision to give a high probability of concluding that concentrations are near background when [c] = BC. However, in practice, there is often no firm environmental / ecotoxicological basis for setting the BAC and monitoring budgets will limit the achievable precision.

15. A pragmatic way forward is to consider what is achievable under the CEMP. CEMP data can be assessed to evaluate the precision of the programme. Provisional BACs can then be set to give a high probability of concluding that concentrations are near background when [c] = BC. However, these BACs should only be agreed if they are relevant. One way of considering relevance would be to compare them to lower EACs.

16. To illustrate the process, we considered temporal monitoring data from the UK National Marine Monitoring Programme. The table gives the precision of the programme[10] summarised by contaminant group and matrix.

[10] expressed as the % coefficient of variation on the estimated mean concentration in the final monitoring year; it is assumed that there are annual data over a ten-year period and that the data are modelled following the current OSPAR methodology using median log concentrations as the annual index, a LOESS smoother, and a seven-year fixed window; the % coefficient of variation is then $100\psi\sqrt{(SS')_{TT}}$ where S is the smoothing matrix, the subscript TT denotes the elements corresponding to the final monitoring year; and ψ is the residual standard deviation about the fitted smoother.

	Sediment	Shellfish	Fish	Water
Metals	11%	14%	21%	11%
CBs	32%	30%	36%	
PAHs	21%	27%		

17. Figure 5 shows the corresponding probability[11] (power) of concluding that concentrations are near background when [c] = BC as the BAC increases relative to the BC. Thus, for metals, setting the BAC to be twice the BC would give at least 90% power of concluding that concentrations are near background when [c] = BC. Comparable power for PAHs and CBs would be achieved by setting the BAC to be 2,5 times and 3,5 times the BC respectively. Of course, different multipliers could be used for contaminant group / matrix combination, or indeed for each contaminant / matrix combination, if appropriate.

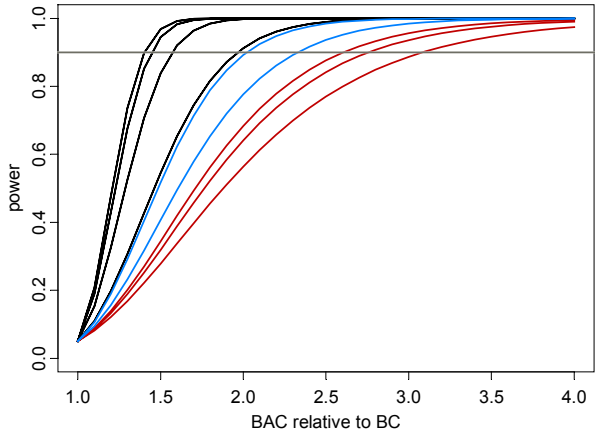


Figure 5. The power of concluding that concentrations are near background when [c] = BC for different values of BAC based on UK monitoring data. Running from left to right, the black lines are for metals in sediment, water, shellfish and fish; the blue lines are for PAHs in sediment and shellfish; and the red lines are for CBs in shellfish, sediment and fish.

18. Now need to illustrate further with real BCs and real EACs….

[11] assuming a one-tailed t-test at the 5% significance level (i.e. using the upper 95% confidence limit).

Appendix 6.3: The Basis of the Dataset

1. During the Workshop, data was gathered from a variety of sources including:
   - The ICES database
   - National monitoring programmes
   - Peer reviewed literature
   - Previous OSPAR Workshops on B/RCs
2. In addition, Workshop participants provided data from their laboratories and research programmes. Some of this required manipulation and this was undertaken at the Workshop prior to being added to the dataset.
3. The dataset is not a database, but is an Excel spreadsheet. The main headings under which information was collected were:

CONTAM	COMPART	SOURCE	TYPE	LOCATION	OSPAR R*	UNIT	BASE	QF	VALUE	DEF
BaA	WATER	ICES	MONIT	Northeast Atlantic	I	ng/l	tw		0,001	MAX
BaP	WATER	ICES	MONIT	Northeast Atlantic	I	ng/l	tw		0,001	MAX
PER	WATER	ICES	MONIT	Northeast Atlantic	I	ng/l	tw	<	0,001	MAX
DBacA	WATER	ICES	MONIT	Northeast Atlantic	I	ng/l	tw	<	0,001	MAX
ANT	WATER	ICES	MONIT	Northeast Atlantic	I	ng/l	tw		0,001	MIN
BaA	WATER	ICES	MONIT	Northeast Atlantic	I	ng/l	tw		0,001	MIN
BbF	WATER	ICES	MONIT	Northeast Atlantic	I	ng/l	tw		0,001	MIN
BkF	WATER	ICES	MONIT	Northeast Atlantic	I	ng/l	tw		0,001	MIN
BaP	WATER	ICES	MONIT	Northeast Atlantic	I	ng/l	tw		0,001	MIN

Limited data was collected under the headings:

SAMPLE S	ERROR	ERROR DEF	COFACT	CF VALUE	CF UNIT	REFERENCE	EXTRA INFO

*OSPAR R – OSPAR Region

4. *Definitions and descriptions of the headers.* Under each heading were a numbed of defined parameters as follows:

a. **CONTAM**: Name of the contaminant. The following codes were applied:

Names	Codes
Naphthalene*	NAPH
Fluorene*	FL
Phenanthrene	PHEN
Anthracene	ANT
Fluoranthene	FLU
Pyrene	PYR
Benz[a]anthracene	BaA
Chrysene/Tri	CHR
Benzo[b]fluoranthene	BbF
Benzo[k]fluoranthene	BkF
Benzo[e]pyrene	BeP
Benzo[a]pyrene	BaP
Indeno[1,2,3-cd]pyrene	I123P
Dibenz[a,h]anthracene	DBahANT
Benzo[g,h,i]perylene	BghiP
C1-naphthalenes*	NAPHC1
C2-naphthalenes*	NAPHC2
C3-naphthalenes*	NAPHC3
C4-naphthalenes*	NAPHC4
C1-fluorenes*	FLC1
C2-fluorenes*	FLC2
C1-phenanthrenes	PHENC1
C2-phenanthrenes	PHENC2
C3-phenanthrenes	PHENC3
C1-pyrenes/fluoranthenes	PYRFLC1
C2-pyrenes/fluoranthenes	PYRFLC2
C1-chrysene	CHRC1
C2-chrysene	CHRC2
C1- Benzofluoranthenes	BFC1
C1-phenanthrenes/anthracenes	PH/ANTC1
C2-phenanthrenes/anthracenes	PH/ANTC2
C3-phenanthrenes/anthracenes	PH/ANTC3
Acenaphthylene	ACY
Acenaphthene	ACE
Benzo[*b-k*]fluoranthene	Bb-kF
Perylene	PER
a-HCH	HCHA
g-HCH	HCHG
p,p'-DDE	DDEPP
p,p'-DDD	DDDPP
p,p'-DDT	DDTPP
CB 110/77	PCB-110/77
CB 187	PCB-187
CB 156	PCB- 156
CB 105	PCB- 105
Dibenzothiophene	DIBTH
C1-dibenzothiophenes	DIBTHC1
C2-dibenzothiophenes	DIBTHC2
C3-dibenzothiophenes	DIBTHC3
Benzonaphthothiophenes	BNATH
C1-benzonaphthothiophenes	BNATHC1
$SPCB_7$	SUM7CB

For CBs (also designated PCBs) the abbreviation used was PCB – XXX, where XXX is the congener specific number.

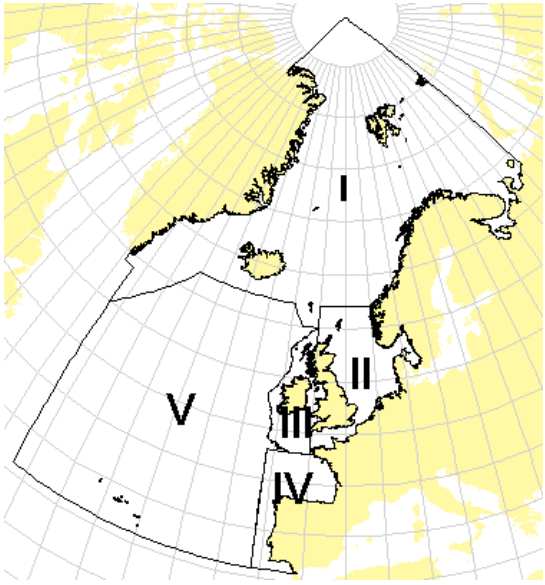
b. **COMPART:** Specific compartment to which the data refers. The headings included:
- Biota
- Sediment
- SPM (suspended particulate material)
- Water

c. **SOURCE:** This describes the origin of the data and includes:
- ICES
- A specific country
- Literature
- JAMP Monitoring

d. **TYPE:** Describes either the position in the water column form which a sample was taken or whether or not the data was gathered as part of a research or monitoring programme. The headings included:
- Core
- Deep water
- Intermediate (water)
- LDW (Lower Deep Water; 3000 – 4500 m)
- Monitoring
- NEACW (North East Atlantic Central Waters; 200 – 500 m)
- NEADW (North East Atlantic Deep Waters; 1250 – 3000 m)
- Research
- Surface (refers to SPM, sediments and water (< 200 m for water))

e. **LOCATION:** Geographical description of the origin of the sample. This may also contain information about depth.

f. OSPAR **R**: Refers to the OSPAR Region.



Region I -	Arctic Waters
Region II -	Greater North Sea
Region III -	Celtic Seas
Region IV -	Bay of Biscay and Iberian Coast
Region V -	Wider Atlantic

g. **UNIT:** Details the original units used to report the data. This included %, µg/kg, fg/l, mg/kg, ng/g, ng/kg, ng/l, pg/g and pg/l.

h. **BASE:** This details the basis on which the data was reported and includes:
- Dissolved
- dw (dry weight)

- lw (lipid weight)
- Organic C (organic carbon)
- tw
- ww (wet weight)

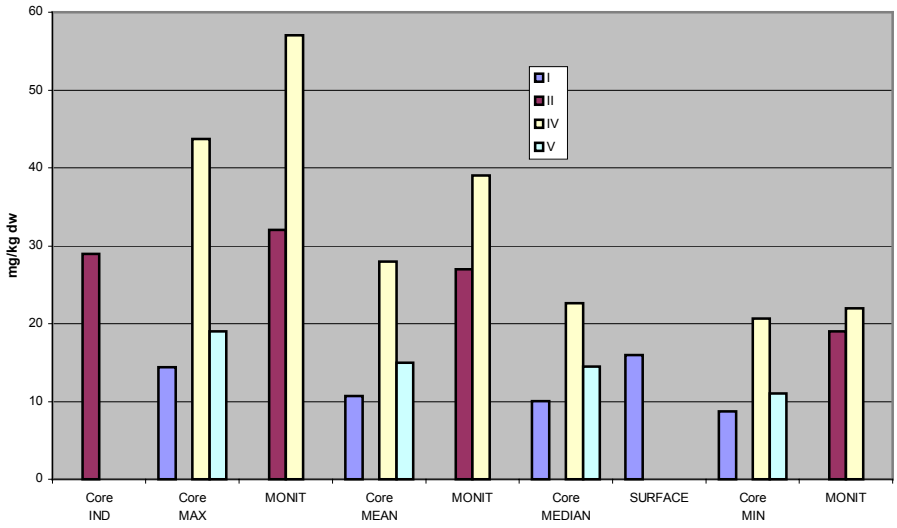
i. **VALUE:** The actual numerical value provided.

j. **DEF:** A definition of the data. This included:
- BC
- IND
- MAX (maximum)
- MEAN
- MEDIAN
- MIN (minimum)
- UNKN (unknown)

k. The additional data provided under the second group of headings (SAMPLES, ERROR, EREOR DEF, COFACT, CFVALUE, CF UNIT, REFERNCE and EXTRA INFO) were less well populated. These included information on the standard deviation of the data and the cofactor (COFACT) if one had been used.

5. Graphical Presentations of the Data

The data can be reviewed through graphical presentation, an example of which is given below.



The concentration of Pb in sediment (mg/kg normalised to 50 g/kg Al) plotted on the basis of the type of data and by OSPAR Region (IND individual results, Core data from deep sediment cores, MONIT monitoring data, SURFACE surface sediments data).

Appendix 6.4: Data on selected organic contaminants: classification of current conditions and current reference concentrations (CRCs) and background reference concentrations (BRCs) OSPAR zones II and IV: French coast

J. Tronczynski
Ifremer, Chemical Pollutants Division, 44 311 Nantes, France

The purpose of this document is to present recent data on the selected organic contaminants in molluscs, sediments and seawater samples collected along French coast in OSPAR zones II and IV (English Channel and Biscay Bay). These results provide a means for the assessment of current conditions of the levels of chemical contamination, including reference concentrations for selected substances in these regions.

Sampling and chemical analysis were carried out within framework of the Réseau National d'Observation – RNO coordinated by Ifremer, and made in part of the fulfilment of the international monitoring requirements. The shellfish samples and results used in this report were collected in 2001 (zone II N = 17, and zone III N = 27). The surface sediment samples were collected using a Reyneck sediment box corer in 1999 (zone III N = 92). The sediments cores were collected at the selected stations. This sediments were dated.

For water and suspended particulate matter (SPM) the stations were sampled at off-shore and coastal sites during different sampling cruises.

A short introductory note presents the adopted procedure of data classification and of the proposed current and background reference concentrations.

Procedures for environmental quality assessment

Procedures for environmental quality assessment are being developed by many countries and international organisations (Norway, Sweden, EU, OSPAR, OECD…). Systems that are easy to understand and use, yet scientifically sound, are needed so as to provide better environmental planning and management. These systems should also allow the derivation of local and regional environmental objectives. Generally, the environmental assessments involve two aspects: (1) an appraisal of whether current conditions may be associated with deleterious environmental/biological effects; (2) an appraisal of the magnitude of deviation of current conditions from a "reference value".

Other, more elaborated systems develop concepts of environmental indicators in order to establish relationship between environmental effects, their causes and measures (e.g. WFD, PSR, DPSIR…). The results of an appraisal of environmental quality are often expressed on a scale from 1 to 5 allowing classification of environmental monitoring and the placing of the results into classes, where Class 1 indicates no environmental effects and low or no deviation from reference values and Class 5 indicates significant effects and important deviation from reference values. It is in such classifications that "reference values" find their use. In practice, sometimes the assessment of the chemical data on contaminant concentrations is based on a statistical distribution. The examples of such simple classifications of environmental data are the Swedish and Norwegian Environmental Quality Criteria systems.

In this report we present an example of such classification of recent (1999 – 2001) chemical data applied to selected organic contaminants in shellfish collected along the French coast in OSPAR Region II and IV (English Channel and Biscay Bay). The method of the classification and definition of current reference and background reference concentrations proposed for this set of data is given below. Background reference concentrations are reported for dated sediment layers of ca. 1700 to 1830. Concentrations in water samples of dissolved determinands are communicated for off-shore high salinity seawater.

This is presented to support discussion at the OSPAR/ICES 2004 workshop on the evaluation and update of Background Reference Concentrations (BRCs).

Classification of current conditions
Current reference concentrations (CRC)
Background reference concentrations BRCs

Classification of organic contaminants in shellfish presented in this report is based on measured concentrations for the French coast. This classification reflects current conditions of chemical contamination and classes from 1 to 5 indicate an increasing level of contamination.

The limits between classes are as follow:

- 2 and 3 is equal to the 5th percentile of the data set;
- 3 and 4 has been calculated by multiplying the 5th percentile by the square root of 95th percentile divided by 5th percentile; and
- 4 and 5 is equal to 95th percentile.

Class 1 is considered as " current reference concentrations" or as "background reference concentration - BRCs". The term of current reference concentration is proposed for PAHs in marine organisms (shellfish) i.e. organic contaminants recognised as having certain natural sources. It was calculated by dividing by a factor of 2 the minimal concentration of the data set.

Only two classes are presented for sediments. Class 1, the background reference concentrations for PAHs in sediments derived from the analysis of dated pre-industrial sediment core samples (ca. 1700 to 1830) collected in Biscay Bay, and Class 5 > 95th percentile.

The background reference concentrations for anthropogenic organic contaminants such PCB and organochlorine pesticides have been set at nil.

Quality control

Internal QA/QC procedures, including laboratory and field blanks, analyses of replicate samples for precision determination and the use of internal recovery standards added to each sample before extraction allow control of losses of analytes during the entire sample work-out. Analyses of Standard Reference Materials (SRM 1491, SRM 2977 from the National Institute of Standards and Technology –NIST- and EC-2 from National Water Research Institute – NWRI) were routinely incorporated into each batch of samples and used to control overall accuracy of the method. The method detection limits of analytes were individually calculated for the sample and depended on the size of the sample used for extractions, the final dilution of the extract, injection technique, and the relative response factor of the analytes. The laboratory proficiency for organic contaminant analysis is also evaluated through participation in the QUASIMEME (Quality Assurance of Information for Marine Environmental Monitoring in Europe) Laboratory Performance Scheme.

Data and Tables

Table 1. List of parent and alkyl-substituted PAHs and sulphur-PAHs determined, abbreviations, molecular weights, and internal standards used as references for quantification

Compound name	Abbreviation	Molecular Weight	Internal standard
PAHs and alkyl substituted homologues			
Naphthalene	Naphthalene	128	Acenaphthene d10
C1*-naphthalenes	C1-N	142	Acenaphthene d10
C2-naphthalenes	C2-N	156	Acenaphthene d10
C3-naphthalenes	C3-N	170	Acenaphthene d10
C4-naphthalenes	C4-N	184	Acenaphthene d10

Acenaphthylene	Acenaphthylene	152	Acenaphthene d10
Acenaphthene	Acenaphthene	154	Acenaphthene d10
Fluorene	Fluorene	166	Fluorene d10
C1-fluorenes	C1-F	180	Fluorene d10
C2-fluorenes	C2-F	194	Fluorene d10
Phenanthrene	Phenanthrene	178	Fluorene d10
C1-phenanthrenes/anthracenes	C1-P	192	Fluorene d10
C2-phenanthrenes/anthracenes	C2-P	206	Fluorene d10
C3-phenanthrenes/anthracenes	C3-P	220	Fluorene d10
Anthracene	Anthracene	178	Fluorene d10
Fluoranthene	Fluoranthene	202	Pyrene d10
Pyrene	Pyrene	202	Pyrene d10
C1-pyrenes/fluoranthenes	C1-PY	216	Pyrene d10
C2-pyrenes/fluoranthenes	C2-PY	230	Pyrene d10
Benz[a]anthracene	B[a]anthr	228	Benz[a]anthracene d12
Chrysene/Tri	Chrysene	228	Benz[a]anthracene d12
C1-chrysene	C1-CHR	242	Benz[a]anthracene d12
C2-chrysene	C2-CHR	256	Benz[a]anthracene d12
Benzo[b]fluoranthene	B[b +j]Fl	252	Benz[a]anthracene d12
Benzo[k]fluoranthene	B[k]Fl	252	Benz[a]anthracene d12
C1- Benzofluoranthenes	C1-BFLs		Benz[a]anthracene d12
Benzo[e]pyrene	B[e]py	252	Benz[a]anthracene d12
Benzo[a]pyrene	B[a]py	252	Benz[a]anthracene d12
Perylene	Perylene	252	Benz[a]anthracene d12
Indeno[1,2,3-cd]pyrene	Indeno[cd123]P	276	Benz[a]anthracene d12
Dibenz[a,h]anthracene	DBA	278	Benz[a]anthracene d12
Benzo[g,h,i]perylene	B(ghi)perylene	276	Benz[a]anthracene d12
Sulphur-heterocyclic compounds and alkyl substituted homologues			
Dibenzothiophene	DBT	184	Fluorene d10
C1-dibenzothiophenes	C1-DBT	198	Fluorene d10
C2-dibenzothiophenes	C2-DBT	212	Fluorene d10
C3-dibenzothiophenes	C3-DBT	226	Fluorene d10
Benzonaphthothiophenes	BNTs	234	Pyrene d10
C1-benzonaphthothiophenes	C1-BNTs	248	Pyrene d10

*C1, C2, C3, C4 for mono, di, tri and tetra alkyl – substituted PAHs.

Table 2.
OSPAR Region II (La Manche English Channel French Coast from 51°00.20 N; 2°00.00 E to 48°16.90 N; 4°15.50 W)

STATISTICAL CLASSIFICATION OF CURRENT CONDITIONS for selected unsubstituted polycyclic aromatic hydrocarbons (PAHs) in marine molluscs tissue (mussel *Mytilus edulis* and oyster *Crassostera gigas*)

CONCENTRATIONS in μg kg^{-1} wet weight tissue; Ranges for RNO – Réseau National d'Observation 2001 – Reference Concentration proposed by France

Determinand		**Class 1**	**Class 2**	**Class 3**	**Class 4**	**Class 5**
Contamination level		**CRC**				
			Low	**Moderate**	**High**	**Very High**
Naphthalene*	Naphthalene	< 0,1	0,1 - 0,2	0,2 - 0,5	0,5 - 1,1	> 1,1
Fluorene*	Fluorene	< 0,1	0,1 - 0,2	0,2 - 0,5	0,5 - 1,4	> 1,4
Phenanthrene	Phenanthrene	< 0,6	0,6 - 1,2	1,2 - 3,2	3,2 - 8,8	> 8,8
Anthracene	Anthracene	< 0,1	0,1 - 0,2	0,2 - 0,6	0,6 - 2,3	> 2,3
Fluoranthene	Fluoranthene	< 0,5	0,5 - 1,4	1,4 - 6,4	6,4 - 29,2	> 29,2
Pyrene	Pyrene	< 0,4	0,4 - 0,9	0,9 - 5,4	5,4 - 32,7	> 32,7
Benz[a]anthracene	B[a]anthr	< 0,1	0,1 - 0,2	0,2 - 1,7	1,7 - 13,3	> 13,3
Chrysene/Tri	Chrysene/Tri	< 0,5	0,5 - 1,0	1,0 - 5,6	5,6 - 29,6	> 29,6
Benzo[b]fluoranthene	B[b +j]Fl	< 0,6	0,6 - 1,5	1,5 - 7,9	7,9 - 41,0	> 41,0
Benzo[k]fluoranthene	B[k]Fl	< 0,2	0,2 - 0,4	0,4 - 1,7	1,7 - 7,3	> 7,3
Benzo[e]pyrene	B[e]py	< 0,6	0,6 - 1,3	1,3 – 7,0	7,0 - 36,2	> 36,2
Benzo[a]pyrene	B[a]py	< 0,1	0,1 - 0,2	0,2 - 1,3	1,3 - 7,1	> 7,1
Perylene	Perylene	< 0,1	0,1 - 0,2	0,2 - 0,7	0,7 - 2,9	> 2,9
Indeno[1,2,3-cd]pyrene	Indeno[cd123]P	< 0,2	0,2 - 0,5	0,5 - 1,5	1,5 - 4,6	> 4,6
Dibenz[a,h]anthracene	DBA	< 0,1	0,1 - 0,2	0,2 - 0,7	0,7 – 2,0	> 2,0
Benzo[g,h,i]perylene	B(ghi)perylene	< 0,3	0,3 - 0,7	0,7 - 2,4	2,4 – 8,0	> 8,0

*compounds prone to evaporative losses during sample work-up

Table 3.
OSPAR Region II (La Manche English Channel French Coast from 51°00.20 N; 2°00.00 E to 48°16.90 N; 4°15.50 W)

STATISTICAL CLASSIFICATION OF CURRENT CONDITIONS for selected alkyl substituted polycyclic aromatic hydrocarbons (C- PAHs) in marine molluscs tissue (mussel *Mytilus edulis* and oyster *Crassostera gigas*)

SUMMED CONCENTRATIONS in µg kg^{-1} wet weight tissue; Ranges for RNO – Réseau National d'Observation 2001 – Reference Concentration proposed by France

Determinand		**Class 1 CRC**	**Class 2**	**Class 3**	**Class 4**	**Class 5**
Contamination level			**Low**	**Moderate**	**High**	**Very High**
C1-naphthalenes*	C1-N	< 0,1	0,1 - 0,2	0,2 - 0,6	0,6 - 1,3	> 1,3
C2-naphthalenes*	C2-N	< 0,2	0,2 - 0,3	0,3 - 0,8	0,8 - 1,9	> 1,9
C3-naphthalenes*	C3-N	< 0,2	0,2 - 0,5	0,5 –2,0	2,0 - 7,4	> 7,4
C4-naphthalenes*	C4-N	< 0,1	0,1 - 0,2	0,2 - 1,5	1,5 -13,4	> 13,4
C1-fluorenes*	C1-F	< 0,1	0,1 - 0,4	0,4 - 1,3	1,3 - 4,2	> 4,2
C2-fluorenes*	C2-F	< 0,1	0,1 - 0,3	0,3 - 1,9	1,9 - 11,7	> 11,7
C1-phenanthrenes/anthracenes	C1-P	< 1,0	1,0 - 2,3	2,3 - 6,7	6,7 - 19,8	> 19,8
C2-phenanthrenes/anthracenes	C2-P	< 0,6	0,6 - 1,6	1,6 - 9,5	9,5 - 57,3	> 57,3
C3-phenanthrenes/anthracenes	C3-P	< 0,4	0,4 - 1,2	1,2 - 8,8	8,8 - 62,2	> 62,2
C1-pyrenes/fluoranthenes	C1-PY	< 0,2	0,2 - 0,7	0,7 - 4,9	4,9 - 34,2	> 34,2
C2-pyrenes/fluoranthenes	C2-PY	< 0,5	0,5 - 1,8	1,8 - 6,9	6,9 - 26,4	> 26,4
C1-chrysene	C1-CHR	< 0,2	0,2 - 0,4	0,4 - 3,3	3,3 - 27,2	> 27,2
C2-chrysene	C2-CHR	< 0,2	0,2 - 0,3	0,3 - 2,1	2,1 - 14,5	> 14,5
C1- Benzofluoranthenes	C1-BFLs	< 0,3	0,3 - 0,6	0,6 - 2,5	2,5 - 10,3	> 10,3

*compounds prone to evaporative losses during sample work-out

Table 4.
OSPAR Region II (La Manche English Channel French Coast from 51°00.20 N; 2°00.00 E to 48°16.90 N; 4°15.50 W)

STATISTICAL CLASSIFICATION OF CURRENT CONDITIONS for selected sulphur heterocyclic aromatic compounds and their alky substituted homologues in marine molluscs tissue (mussel *Mytilus edulis* and oyster *Crassostera gigas*)

SUMMED CONCENTRATIONS in µg kg^{-1} wet weight tissue (except for DBT); Ranges for RNO – Réseau National d'Observation 2001 – Reference Concentration proposed by France

Determinand		**Class 1**	**Class 2**	**Class 3**	**Class 4**	**Class 5**
Contamination level		**CRC**				
			Low	**Moderate**	**High**	**Very High**
Dibenzothiophene	DBT	< 0,1	0,1 - 0,2	0,2 - 0,4	0,4 - 0,8	> 0,8
C1-dibenzothiophenes	C1-DBT	< 0,1	0,1 - 0,4	0,4 - 1,1	1,1 - 2,8	> 2,8
C2-dibenzothiophenes	C2-DBT	< 0,3	0,3 - 0,8	0,8 - 4,2	4,2- 21,9	> 21,9
C3-dibenzothiophenes	C3-DBT	< 0,2	0,2 - 0,6	0,6 - 4,4	4,4 – 30,0	> 30,0
Benzonaphthothiophenes	BNTs	< 0,1	0,1 - 0,2	0,2 - 1,2	1,2 - 9,3	> 9,3
C1-benzonaphthothiophenes	C1-BNTs	< 0,4	0,4 - 0,77	0,8 - 3,4	3,4 - 15,1	> 15,1

Table 5.
OSPAR Region IV: Golfe de Gascogne Biscay Bay French Coast from 48°07.03 N; 4°17.00 W to 43°21.60 N; 1°46.60 W

STATISTICAL CLASSIFICATION OF CURRENT CONDITIONS for selected unsubstituted polycyclic aromatic hydrocarbons (PAHs) in marine molluscs tissue (mussel *Mytilus edulis* and oyster *Crassostera gigas*)

CONCENTRATIONS in μg kg^{-1} wet weight tissue; Ranges for RNO – Réseau National d'Observation 2001 – Reference Concentration proposed by France

Determinand		**Class 1**	**Class 2**	**Class 3**	**Class 4**	**Class 5**
Contamination level		**CRC**	**Low**	**Moderate**	**High**	**Very High**
Naphthalene*	Naphthalene	< 0,05	0,05 - 0,1	0,1 - 0,3	0,3 - 0,6	> 0,6
Fluorene*	Fluorene	< 0,1	0,1 - 0,2	0,2 - 0,4	0,4 - 1,2	> 1,2
Phenanthrene	Phenanthrene	< 0,5	0,5 - 1,0	1,0 - 2,6	2,6 - 7,2	> 7,2
Anthracene	Anthracene	< 0,1	0,1 - 0,2	0,2 - 0,8	0,8 - 3,5	> 3,5
Fluoranthene	Fluoranthene	< 0,7	0,7 - 2,0	2,0 - 5,1	5,1 - 12,5	> 12,5
Pyrene	Pyrene	< 0,6	0,6 - 1,6	1,6 - 4,3	4,3 - 11,1	> 11,1
Benz[a]anthracene	B[a]anthr	< 0,1	0,1 - 0,4	0,4 - 0,9	0,9 - 2,2	> 2,2
Chrysene/Tri	Chrysene/Tri	< 0,7	0,7 - 1,9	1,9 - 4,0	4,0 - 8,6	> 8,6
Benzo[b]fluoranthene	B[b +j]Fl	< 0,4	0,4 - 0,9	0,9 - 2,7	2,7 - 7,5	> 7,5
Benzo[k]fluoranthene	B[k]Fl	< 0,1	0,1 - 0,3	0,3 - 0,9	0,9 - 2,8	> 2,8
Benzo[e]pyrene	B[e]py	< 0,4	0,4 - 0,9	0,9 - 2,3	2,3 - 5,7	> 5,7
Benzo[a]pyrene	B[a]py	< 0,05	0,05 - 0,1	0,1 - 0,2	0,2 - 0,3	> 0,3
Perylene	Perylene	< 0,1	0,1 - 0,3	0,3 - 0,8	0,8 - 2,4	> 2,4
Indeno[1,2,3-cd]pyrene	Indeno[cd123]P	< 0,1	0,1 - 0,3	0,3 - 0,5	0,5 - 0,9	> 0,9
Dibenz[a,h]anthracene	DBA	< 0,1	0,1 - 0,2	0,2 - 0,3	0,3 - 0,4	> 0,4
Benzo[g,h,i]perylene	B(ghi)perylene	< 0,2	0,2- 0,4	0,4 - 0,7	0,7 - 1,3	> 1,3

*compounds prone to evaporative losses during sample work-out

Table 6.
OSPAR Region IV: Golfe de Gascogne Biscay Bay French Coast from 48°07.03 N; 4°17.00 W to 43°21.60 N; 1°46.60 W

STATISTICAL CLASSIFICATION OF CURRENT CONDITIONS for selected alkyl substituted polycyclic aromatic hydrocarbons (C-PAHs) in marine molluscs tissue (mussel *Mytilus edulis* and oyster *Crassostera gigas*)

SUMMED CONCENTRATIONS in µg kg^{-1} wet weight tissue; Ranges for RNO – Réseau National d'Observation 2001 – Reference Concentration proposed by France

Determinand		**Class 1**	**Class 2**	**Class 3**	**Class 4**	**Class 5**
Contamination level		**CRC**	**Low**	**Moderate**	**High**	**Very High**
C1-naphthalenes*	C1-N	< 0,1	0,1 - 0,2	0,2 - 0,3	0,3 - 0,8	> 0,8
C2-naphthalenes*	C2-N	< 0,05	0,05 - 0,1	0,1 - 0,5	0,5 - 1,9	> 1,9
C3-naphthalenes*	C3-N	< 0,05	0,05 - 0,2	0,2 - 1,2	1,2 - 8,4	> 8,4
C4-naphthalenes*	C4-N	< 0,05	0,05 - 0,1	0,1 - 1,6	1,6 - 21,7	> 21,7
C1-fluorenes*	C1-F	< 0,05	0,05 - 0,1	0,1 - 0,6	0,6 - 3,9	> 3,9
C2-fluorenes*	C2-F	< 0,05	0,05 - 0,1	0,1 - 1,0	1,0 - 11,3	> 11,3
C1-phenanthrenes/anthracenes	C1-P	< 0,6	0,6 - 1,5	1,5 - 7,0	7,0 - 32,5	> 32,5
C2-phenanthrenes/anthracenes	C2-P	< 1,0	1,0 - 2,2	2,2 - 13,3	13,3 - 79,0	> 79,0
C3-phenanthrenes/anthracenes	C3-P	< 0,6	0,6 - 2,2	2,2 - 16,5	16,5 - 123,7	> 123,7
C1-pyrenes/fluoranthenes	C1-PY	< 0,2	0,2 - 1,4	1,4 - 4,6	4,6 - 14,8	> 14,8
C2-pyrenes/fluoranthenes	C2-PY	< 0,1	0,1 - 0,7	0,7 - 3,5	3,5 - 16,5	> 16,5
C1-chrysene	C1-CHR	< 0,1	0,1 - 1,2	1,2 - 4,2	4,2 - 15,0	> 15,0
C2-chrysene	C2-CHR	< 0,1	0,1 - 0,4	0,4 - 2,0	2,0 - 10,2	> 10,2
C1- Benzofluoranthenes	C1-BFLs	< 0,1	0,1 - 0,2	0,2 - 0,7	0,7 - 1,9	> 1,9

*compounds prone to evaporative losses during sample work-out

Table 7.
OSPAR Region IV: Golfe de Gascogne Biscay Bay French Coast from 48°07.03 N; 4°17.00 W to 43°21.60 N; 1°46.60 W

STATISTICAL CLASSIFICATION OF CURRENT CONDITIONS for selected sulphur heterocycle aromatic compounds and their alky substituted homologues in marine molluscs tissue (mussel *Mytilus edulis* and oyster *Crassostera gigas*)

SUMMED CONCENTRATIONS in µg kg^{-1} wet weight tissue (except for DBT); Ranges for RNO – Réseau National d'Observation 2001 – Reference Concentration proposed by France

Determinand		**Class 1**	**Class 2**	**Class 3**	**Class 4**	**Class 5**
Contamination level		**CRC**	**Low**	**Moderate**	**High**	**Very High**
Dibenzothiophene	DBT	< 0,1	0,1 - 0,2	0,2 - 0,3	0,3 - 0,7	> 0,7
C1-dibenzothiophenes	C1-DBT	< 0,05	0,05 - 0,1	0,1 - 0,6	0,6 - 2,9	> 2,9
C2-dibenzothiophenes	C2-DBT	< 0,2	0,2 - 0,5	0,5 - 3,4	3,4 - 25,4	> 25,4
C3-dibenzothiophenes	C3-DBT	< 0,2	0,2 - 0,9	0,9 - 5,7	5,7 - 35,7	> 35,7
Benzonaphthothiophenes	BNTs	< 0,1	0,1 - 0,3	0,3 - 1,0	1,0 - 3,0	> 3,0
C1-benzonaphthothiophenes	C1-BNTs	< 0,1	0,1 - 0,4	0,4 - 2,1	2,1 - 11,7	> 11,7

Table 8.
OSPAR Region II (La Manche English Channel French Coast from 51°00.20 N; 2°00.00 E to 48°16.90 N; 4°15.50 W)

STATISTICAL CLASSIFICATION OF CURRENT CONDITIONS for selected organochlorine compounds in marine molluscs tissue (mussel *Mytilus edulis* and oyster *Crassostera gigas*)

CONCENTRATIONS in μg kg^{-1} wet weight tissue; Ranges for RNO – Réseau National d'Observation – 2001, Reference Concentrations proposed by France

Determinand	**Class 1**	**Class 2**	**Class 3**	**Class 4**	**Class 5**
Contamination level	**None/BRC**	**Low**	**Moderate**	**High**	**Very High**
CB 28	0	0,01 - 0,03	0,03 - 0,25	0,25 - 2,00	> 2,0
CB 52	0	0,06 - 0,14	0,14 - 1,40	1,40 - 14,0	> 14,4
CB 101	0	0,14 - 0,33	0,33 - 3,21	3,21 - 30,8	> 30,8
CB 118	0	0,14 - 0,37	0,37 - 3,42	3,42, - 31,4	> 31,4
CB 153	0	0,44 - 0,95	0,95 - 8,85	8,85 - 82,6	> 82,6
CB 105	0	0,04 - 0,10	0,10 - 0,78	0,78 - 6,3	> 6,3
CB 138	0	0,20 - 0,64	0,64 - 6,16	6,16 - 59,6	> 59,6
CB 156	0	0,02 - 0,04	0,04 - 0,37	0,37 - 3,0	> 3,0
CB 180	0	0,03 - 0,09	0,09 - 0,75	0,75 - 6,48	> 6,5
ΣPCB_7	0	1,1 - 2,3	2,3 - 23,1	23,1 - 226,9	> 226,9
α-HCH	0	0,01 - 0,03	0,03 - 0,12	0,12 - 0,56	> 0,6
γ-HCH	0	0,07 - 0,17	0,17 - 0,44	0,44 - 1,14	> 1,1
p,p'-DDE	0	0,06 - 0,21	0,21 - 0,92	0,92 - 3,9	> 3,9
p,p'-DDD	0	0,01 - 0,05	0,05 - 0,29	0,29 - 1,85	> 1,9
p,p'-DDT	0	0,03 - 0,07	0,07 - 0,16	0,16 - 0,36	> 0,4

Table 9.
OSPAR Region IV: Golfe de Gascogne Biscay Bay French Coast from 48°07.03 N; 4°17.00 W to 43°21.60 N; 1°46.60 W

STATISTICAL CLASSIFICATION OF CURRENT CONDITIONS for selected organochlorine compounds in marine molluscs tissue (mussel *Mytilus edulis* and oyster *Crassostera gigas*)

CONCENTRATIONS in µg kg^{-1} wet weight tissue; Ranges for RNO – Réseau National d'Observation 2001 – Reference Concentration proposed by France

Determinand	**Class 1**	**Class 2**	**Class 3**	**Class 4**	**Class 5**
Contamination Level	**None/BRC**	**Low**	**Moderate**	**High**	**Very High**
CB 28	0	0,01 - 0,04	0,04 - 0,10	0,10 - 0,25	> 0,25
CB 52	0	0,05 - 0,13	0,13 - 0,33	0,33 - 0,83	> 0,83
CB 101	0	0,08 - 0,37	0,37 - 0,99	0,99 - 2,66	> 2,66
CB 118	0	0,19 - 0,39	0,39 - 1,16	1,16 - 3,43	> 3,43
CB 153	0	0,68 - 1,67	1,67 - 4,49	4,49 - 12,03	> 12,03
CB 105	0	0,05 - 0,12	0,12 - 0,31	0,31 - 0,78	> 0,78
CB 138	0	0,31 - 0,80	0,80 - 1,82	1,82 - 4,14	> 4,14
CB 156	0	0,01 - 0,03	0,03 - 0,08	0,08 - 0,22	> 0,22
CB 180	0	0,04 - 0,11	0,11 - 0,44	0,44 - 1,72	> 1,72
ΣPCB_7	0	1,4 - 3,7	3,7 - 9,2	9,2 - 22,7	> 22,70
α-HCH	0	0,02 - 0,04	0,04 - 0,10	0,10 - 0,28	> 0,28
γ-HCH	0	0,06 - 0,14	0,14 - 0,31	0,31 - 0,68	> 0,68
p,p'-DDE	0	0,15 - 0,32	0,32 - 0,82	0,82 - 2,11	> 2,11
p,p'-DDD	0	0,06 - 0,12	0,12 - 0,41	0,41 - 1,39	> 1,39
p,p'-DDT	0	0,01 - 0,02	0,02 - 0,10	0,10 - 0,41	> 0,41

Table 10.
OSPAR Region IV: Golfe de Gascogne Biscay Bay French Coast from 48°07.03 N; 4°17.00 W to 43°21.60 N; 1°46.60 W

STATISTICAL CLASSIFICATION OF CURRENT CONDITIONS for selected unsubstituted polycyclic aromatic hydrocarbons (PAHs) in sediments

CONCENTRATIONS in µg kg^{-1} dry weight sediment; Ranges for RNO – Réseau National d'Observation 1999 – Background reference concentration proposed by France

Determinand **Contamination level**		**Class 1** **BRC** **(ca. 1700 – 1830)**	**Class 5** **Very high**
Naphthalene*	Naphthalene	0,07 - 0,32	> 30,19
Fluorene*	Fluorene	0,14 - 0,24	> 22,92
Phenanthrene	Phenanthrene	1,20 - 1,67	> 151,05
Anthracene	Anthracene	0,16 - 0,29	> 36,50
Fluoranthene	Fluoranthene	1,11 - 1,50	> 317,45
Pyrene	Pyrene	0,69 - 1,00	> 331,45
Benz[a]anthracene	B[a]anthr	0,37 - 0,50	> 184,80
Chrysene/Tri	Chrysene/Tri	0,69 - 0,88	> 226,35
Benzo[b]fluoranthene	B[b +j]Fl	1,75 - 2,49	> 168,35
Benzo[k]fluoranthene	B[k]Fl	0,42 - 0,56	> 52,77
Benzo[e]pyrene	B[e]py	0,57 - 0,71	> 253,20
Benzo[a]pyrene	B[a]py	0,26 - 0,49	> 141,25
Indeno[1,2,3-cd]pyrene	Indeno[cd123]P	1,17 - 1,75	> 146,55
Dibenz[a,h]anthracene	DBA	0,14 - 0,17	> 33,30
Benzo[g,h,i]perylene	B(ghi)perylene	0,93 - 1,30	> 123,00

Table 11.
OSPAR Region IV: Golfe de Gascogne Biscay Bay French Coast

STATISTICAL CLASSIFICATION OF CURRENT CONDITIONS for selected unsubstituted dissolved polycyclic aromatic hydrocarbons (PAHs) in seawater

CONCENTRATIONS in pg l^{-1} of seawater; Reference concentration proposed by France

Determinand **Contamination level**		**Reference concentrations**
Naphthalene*	Naphthalene	188 - 709
Fluorene*	Fluorene	88 - 186
Phenanthrene	Phenanthrene	162 - 219
Anthracene	Anthracene	4 - 10
Fluoranthene	Fluoranthene	142 - 241
Pyrene	Pyrene	30 - 94
Benz[a]anthracene	B[a]anthr	3 - 15
Chrysene/Tri	Chrysene/Tri	22 - 46
Benzo[b]fluoranthene	B[b +j]Fl	12 - 28
Benzo[k]fluoranthene	B[k]Fl	4 - 10
Benzo[e]pyrene	B[e]py	10 - 25
Benzo[a]pyrene	B[a]py	2 - 27
Indeno[1,2,3-cd]pyrene	Indeno[cd123]P	2 - 8
Dibenz[a,h]anthracene	DBA	2
Benzo[g,h,i]perylene	B(ghi)perylene	2 - 9

Table 12.
OSPAR Region II (La Manche English Channel French Coast)

STATISTICAL CLASSIFICATION OF CURRENT CONDITIONS for selected unsubstituted dissolved chlorinated biphenyles (CB) in seawater

CONCENTRATIONS in pg l^{-1} of seawater; Reference concentrations proposed by France

Determinand **Contamination level**	**Reference concentrations**
CB31	2,9- 3,7
CB28	3,8 - 5,9
CB52	7,5 - 10,9
CB101	4,5 - 10,3
CB110/77	8,4 - 15,9
CB118	3,5 - 6,2
CB153	2,5 - 7,7
CB138	2,6 - 8,1
CB187	nd
CB174	nd
CB180	2,4
CB194	nd

Table 13.
OSPAR Region IV: Golfe de Gascogne Biscay Bay French Coast

STATISTICAL CLASSIFICATION OF CURRENT CONDITIONS for selected dissolved herbicides and their degradation products in seawater

CONCENTRATIONS in ng l^{-1} of seawater; Reference concentrations proposed by France

Determinand	
Contamination level	**Reference concentrations**
Simazine	0,6 - 1,3
Atrazine	1,5 - 3,0
Terbuthylazine	0,4 - 0,9
DIA	0,6 - 0,8
DEA	0,6 - 1,1

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Annex 7: Guidance document on the derivation and use of Environmental Assessment Criteria

Anders Bignert
Brian Miller
Janny Pijnenburg
Anders Ruus
Jakob Strand
John Thain
Chrystèle Tissier

Theo Traas (editor)

Executive Summary

1. OSPAR workshops in 1993, 1995 and 1996 developed Ecotoxicological Assessment Criteria (EACs) to assess chemical contaminant data generated through the Joint Assessment and Monitoring Programme (JAMP).
2. As a result of criticism of the current EACs and difficulties in their practical application, OSPAR recognised the need for these to be reviewed and evaluated, and for this reason a workshop was held in The Hague in February 2004.
3. This report presents the proposals of this workshop with respect to EACs. Several fundamental changes in EACs are proposed. The definition of EACs is changed from *Ecotoxicological Assessment Criteria* to *Environmental Assessment Criteria*. This change reflects the primary role of EACs as tools for the assessment of environmental data, for example OSPAR JAMP and CEMP data, and the need for integrated assessment of chemical and biological effects data.
4. The derivation of EACs has also been thoroughly reviewed and brought more into line with the approach taken for the derivation of Quality Standards (QS) for the Water Framework Directive. Although EACs are not equal to QS in the water framework, EACs are redefined to relate to them.
5. Adoption of EU methods (either from the EU Water Framework Directive or the EU new and existing substances directives) is recommended, allowing easy adoption of EU assessments for OSPAR purposes. EU methods for secondary poisoning can be used to improve the meaning of biota monitoring, with regard to toxicity for top predators.
6. The current range of EACs is no longer endorsed, but replaced by Lower-EAC and Upper-EAC values that have defined ecotoxicological meaning. A criticism of the previous EACs was that the ranges of values were difficult to use and interpret. Although two new EAC values are proposed at a lower and an upper level, it is important to recognise that these are in most cases independently derived and more robust than the previous values.
    - The lower EAC value is a concentration derived for protection of all marine species from chronic effects, including the most sensitive species.
    - The upper EAC is defined as the highest (transient) concentration that is expected not to cause acute toxic effects.

7. Interpretation of environmental assessment data is made easier using the new values, through the derivation of a "traffic light" system to allow contaminant concentrations to be used to assess the state of the environment and prompt environmental management options as suggested during the workshop.

   - Below the lower-EAC value, measured contaminant concentration should not give rise to any biological effects. No immediate management action would be required, monitoring frequency could be stopped or reduced.
   - Between the lower and the upper EAC value, biological effects are possible (e.g. as indicated by biomarker response, impaired growth, reproduction). Management actions could identify reason for elevated level(s), use expert judgement to assess significance, check trends and variability or introduce additional monitoring. This could eventually lead to resource or emission management.
   - Above the upper-EAC, long-term biological effects are likely (e.g. impaired growth, reproduction and survival), and acute biological effects (survival) are possible. Appropriate management actions could verify findings (additional analysis), identify reason(s) for elevated level(s), consider the re-designing of the monitoring strategy for specific elevated contaminants and consider resource or emission management issues.

8. Most sediment EACs are still based on equilibrium partitioning, due to insufficient ecotoxicological data. Such EACs are regarded as provisional and need validation with additional sediment toxicity tests and/ or co-occurrence data, especially for metals.

9. For biota, two different types of EACs were derived. The first type is based on the derived EACs for water or sediment, and transferred to biota using appropriate Bioconcentration Factor[12] (BCF). The second type takes into account that fish or mussels are food for predators. Concentrations in mussel or fish can be derived that protect against this so-called secondary poisoning using appropriate Biomagnification Factors[13] (BMF). It is recommended to calculate both types of biota EACs for comparison. Further research on biota standards based on critical tissue concentrations (lethal body burdens) is recommended.

10. For substances with a natural background, the added risk approach, as used in the WFD, can be adopted to avoid the problems of separating background values from lower EAC values. Further consultation is needed to decide on this issue.

11. Updating existing EACs needs further work, using existing EU assessments or assessments from OSPAR member states. A separate working group should review and validate updated factsheets for each individual substance.

12. New EACs for substances on the OSPAR priority substances list can be added using existing (EU) assessments and the methods proposed in this document.

[12] Bioconcentration is the net result of the uptake, distribution and elimination of a substance in an organism due to waterborne exposure (EU/ Technical guidance document).

[13] Biomagnification is the accumulation and transfer of chemicals via the food chain, resulting in an increase of the internal concentration in organisms at higher levels in the trophic chain. (EU/ Technical guidance document)

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1. Introduction

In 1993, 1995 and 1996 workshops were held to develop Ecotoxicological Assessment Criteria (EAC) for chemical data generated under the OSPAR Joint Assessment Monitoring Programme (JAMP). The aim of the first workshop was to develop the methodology and criteria for determining an EAC and to reach agreement on EAC for all matrices (water, sediment and biota) for selected heavy metals, PCB, PAH and TBT. The second and third workshops focused on providing additional assessment criteria for heavy metals (Cd, Hg, Pb, Cu) in mussels and fish liver; PAHs and PCBs in fish liver and mussel; and PAH compounds in sediments. The ultimate goal was to establish a complete set of assessment criteria for all chemical data under the JAMP. In 1997, OSPAR agreed to endorse the list of EAC resulting from the three workshops (OSPAR agreement 1977-15). OSPAR require EACs to improve the assessment of its chemical monitoring results and to develop a robust monitoring strategy within the OSPAR area. It was beyond the scope of the workshops to develop assessment criteria for the protection of human health.

In view of the OSPAR assessment to be undertaken in 2004, ASMO recognised the need to review BRCs and EACs, and a workshop was organised in The Hague in February 2004. The terms of reference (see Report Annex 1) included the need to evaluate existing EACs to narrow their range and update/expand them if possible, and the need to develop proposals on how EACs should be used when assessing CEMP data.

1.1 The Current Position on EACs

1.1.1 Available EACs

EACs currently available for chemical contaminants are shown in Appendix 2. These have been derived on the basis of existing ecotoxicological data (see Workshop Reports).

There are uncertainties in the derivation of EACs and in this respect distinctions were made between provisional and firm assessment criteria.

EACs are considered as firm when they have been derived from robust marine ecotoxicological data.

EAC are considered as provisional where:

- for biota, marine fish species other than those monitored were used to derive the EAC
- insufficient marine data are available so these have been supplemented with freshwater data

1.1.2 Cautionary Notes and Criticisms

Caution in the interpretation and application of EACs has been expressed in previous OSPAR workshop reports (OSPAR, 1996). In particular, the following points have been emphasised:

- Caution should be exercised in using generic, provisional assessment criteria in specific situations
- Their use does not preclude common sense and expert judgement
- EAC should not be used as a trigger for source directed action without further evaluation
- There are provisional and firm EAC, both presented as a range rather than a fixed value
- The relationship between assessment criteria and background concentrations has not been determined. Many of the values derived are close to "background values" particularly for non synthetic organic compounds
- For some substances and matrices EAC have not been derived because of the limited quantity of ecotoxicological data for marine species
- EAC have no legal significance and should only be used for preliminary assessment

- EAC should be used as an assessment tool specifically for the interpretation of monitoring data and the development of monitoring strategies
- In order to support the derivation of more reliable assessment criteria for the marine environment more toxicological data for marine species and a wide range of substances are needed
- EAC do not take into account specific long term bio effects such as carcinogenicity, genotoxicity and reproductive disruption and do not include combination toxicity, the assessment criteria in general, and especially for PAHs and PCBs should not be considered final goals or ultimate targets
- The application of extrapolation factors which were derived for freshwater species based on a broad spectrum of chemical structures has not been validated for marine species. Their use is hence subject to major uncertainty and can only be justified for the time being due to the lack of better data
- Assessment criteria for chemicals in biota, water and sediment are neither quality objectives nor safe levels
- Sediments may be a source of biomagnification and effects in higher organisms, but as yet no reliable method is available to carry out this type of assessment
- Secondary poisoning was understood as a tool for a better understanding of possible mechanisms and effects in food chains but there are doubts if this method truly reflects the reality under given conditions in the marine environment
- The scientific principles underlying the approach are problematical
- Expressing EAC as a range (usually extending of one order of magnitude in value) leads to confusion insofar that a choice of the upper or lower value is available
- No attention has been paid to the inter-compartmental tuning of assessment criteria

These cautionary notes and criticisms were considered at The Hague workshop. The proposals in this report are made in the light of these discussions.

1.2 Change in EAC Definition

1.2.1 Driver

The primary driver for the change in the definition of EACs from Ecotoxicological Assessment Criteria to Environmental Assessment Criteria is the need for EACs to be seen as tools for environmental assessments, such as for OSPAR JAMP and CEMP (Co-ordinated Environmental Monitoring Programme), through the integration of chemical contaminant data and biological effects.

1.3 Change in EAC Derivation

1.3.1 Drivers

The drivers for the change in derivation of the EACs were:

- The need to integrate OSPAR with WFD approaches
- The need for the EACs to have environmental relevance
- The need to discontinue the range in values
- The need to use EACs more easily for environmental assessment and to prompt appropriate environmental management actions.

1.3.1.1 THE NEED TO INTEGRATE OSPAR WITH WFD APPROACHES AND FOR THE EACS TO HAVE ENVIRONMENTAL RELEVANCE

The OSPAR EACs are needed to assess chemical contaminant data generated through the JAMP. The EACs are developed for the OSPAR priority substances which partly overlap with the substances of Annex 10 of the Water Framework Directive (WFD). The need to integrate OSPAR with WFD approaches is recognised. At this stage, this is proposed for the derivation of EACs for waters but the WFD also derives (non-binding) sediment and secondary poisoning standards. In order to be able to thoroughly assess the state of the marine environment, an extrapolation of EACs to sediments and biota is important and necessary to make the general marine monitoring operational.

The approach taken to derive the current EACs was based on the method used to calculate the Predicted No Effect Concentration (PNEC) from ecotoxicological data. PNECs are used in the frame of risk assessment and are regarded as the concentration below which unacceptable effects will most likely not occur. The PNEC value is calculated from ecotoxicological data (NOEC, L(E)C50) to which an assessment factor of 10, 100 or 1000 is applied. A concentration range spanning an order of magnitude around this value was then used as the EAC range. The meaning and interpretation of this range was confusing, and the end members had no ecotoxicological significance.

In the new approach, PNECs based on long-term and short-term ecotoxicological data and assessment factors are still used. However, following the approach adopted for the Water Framework Directive for the derivation of Quality Standards and recent developments in the methodology of risk assessment for the marine environment (EU-TGD), new assessment factors were used as well as statistical methods. This EQS or PNEC is designed to protect all species against long-term effects. It is proposed to derive the lower EAC value according to this methodology.

Similarly, the current proposal for the upper EAC value follows the WFD methodology for the derivation of MAC-QSs (Maximum Admissible Concentration Quality Standard) as documented in the WFD document (Lepper, 2002) or the EU-TGD for chemical risk assessment of intermittent releases (EU, 2003). This derivation involves the use of short-term ecotoxicological data and assessment factors. Therefore the MAC-EQS is based on the most sensitive acute toxicity data and is designed to protect against short-term episodic events. The upper EAC so derived is the highest transient concentration that is expected not to cause acute toxic effects. Above this concentration acute effects cannot be excluded.

1.3.1.2 THE NEED TO DISCONTINUE THE RANGE IN VALUES

This has been addressed through the derivation of two separate and independent values as the lower and upper EAC values, as outlined above. There is still a range but both the lower and the upper values have different ecological meanings.

1.3.1.3 THE NEED TO USE EACS MORE EASILY FOR ENVIRONMENTAL ASSESSMENT AND TO PROMPT APPROPRIATE ENVIRONMENTAL MANAGEMENT ACTIONS

The lower and upper EAC values mean that a "traffic light" system can be adopted for environmental assessment on the basis of the measured contaminant concentrations, as summarised below:

Colour	**Green**	**Yellow**	**Red**
Status	< lower value	Lower – upper	> upper value
Interpretation	No biological effects anticipated	Cause for concern	Immediate action required

Environmental assessment and management actions could include the following:

Contaminant concentrations below lower value

Environmental assessment

- Measured contaminant concentration should not give rise to any adverse biological effects

Management Actions

- No immediate action required
- Stop or reduce monitoring frequency

Contaminant concentrations between lower and upper values

Environmental Assessment

- Biological effects possible (e.g. biomarker response, impaired growth, reproduction)

Biomarkers in OSPAR are monitoring tools to address the possibility of chronic effects. Biomarkers reflect, by definition, effects at the individual level and are therefore not necessarily endpoints which can be linked to effects on populations.

Management Actions

- Identify reason(s) for elevated contaminant level(s)
- Use expert judgement to assess significance of results (e.g. relative to previous data in terms of scale and extent)
- Consider environmental management options related to emissions or resources
- Continue monitoring and check trends and variability
- Introduce additional monitoring (e.g. contaminant-specific or other focussed biological effects tests)

Contaminant concentrations above upper value

Environmental Assessment

- Long-term biological effects likely (e.g. impaired growth, reproduction), acute biological effects (mortality) possible

Management Actions

- Verify findings (e.g. through targeted biological effects or benthic community analysis)
- Identify reason(s) for elevated contaminant level(s)
- Consider re-designing monitoring strategy for specific contaminants found to be elevated
- Consider resource management issues (e.g. possible need to close fisheries, prohibit dredging activities, etc) and emission management.

Note: It has to be stressed that contaminant levels in biota cannot be related directly to the ecotoxicological definition of the upper EAC-value, because contaminant levels in these matrices are rather a time-integrated result of the exposure level than reflecting the exposure level in short-term episodic events. However, the upper EAC-value for biota still has a potential to be used as a tool specifically for the interpretation of monitoring data and the development of monitoring strategies.

2. Derivation of Environmental Assessment Criteria (EAC) and relation to existing EU frameworks

2.1 Background

- In 1996 OSPAR contracting parties agreed on a procedure for the determination of EACs for water, sediment, and biota (OSPAR, 1996).
- In order to determine the final EAC, the resulting extrapolated concentration was rounded to a range representing the nearest order of magnitude.
- The purpose of presenting a range rather than a single value was to express the uncertainty and variability of the data.
- In the light of all uncertainties within the process of setting the assessment criterion this rounding seemed more appropriate than setting a fixed concentration. The workshop held in 1993 in Scheveningen decided to use one order of magnitude intervals, for instance 0,01-0,1, 0,1-1 etc. and also intermediate intervals of 0,05-0,5, 0,5-5 etc., which depended on the extrapolated concentration that was derived for each micro-contaminant (OSPAR, 1994).

2.1.1 General procedure

The general procedure for the derivation of EACs in OSPAR was the derivation of an extrapolated concentration based on ecotoxicological information. Based on the method applied and the data available, the EAC is considered either firm or provisional. For all matrices, i.e. water, sediment and biota, a firm criterion may be changed into a provisional one due to:

a. the chronic mode of action not being reflected in the data set, so relevant parameters are not included, e.g. carcinogenicity;

b. the range being unrealistic or not applicable for some other reason, e.g. if the resulting EAC is lower than the natural background concentration.

EACs will only be derived when ecotoxicological data are available for at least 3 different species, being either marine or freshwater species (minimum data requirement). The lowest NOEC or L(E)C50 is selected from the toxicological data available. Depending on the extent of the data set, the following extrapolation factors (Table 1) are to be applied to calculate the extrapolated concentration:

Table 1. Extrapolation factors used by OSPAR

Extrapolation factor	Information
1000	applied to the lowest acute L(E)C50 when the data available are few, or the range of organisms is narrow
100	applied to the lowest acute L(E)C50 when there is an extensive data base covering a phylogenetically wide range of species, or to the lowest chronic EC50 or NOEC when few chronic data are available
10	applied to the lowest chronic NOEC for a sufficient and representative number of species

2.2 Determination of EACs for the water compartment

In the 1996 OSPAR workshop it was proposed that the EAC could be considered firm if ecotoxicological information was available on the chronic toxicity of the relevant compound for at least 3 marine species, including one fish, one invertebrate and one algal species. Since then the methodologies used to assess effects on organisms have been improved mainly in the field of risk assessment methodology. In 2003, in the framework of the EU regulation on existing and new chemicals, the Technical Guidance Document (TGD) used in support of risk assessment methodology was revised and adapted for the marine environment (EC, 2003). In this context, Predicted No Effect Concentrations (PNECs), regarded as concentrations below which an unacceptable effect will most likely not occur, are derived on the basis of a set of ecotoxicological data. This methodology was also used for the derivation of Environmental Quality Standards (EQS) in the context of the Water Framework Directive (WFD). As the methodology of effect assessment has been greatly improved since 1996, we decided to update the methods used to derive the EAC in order to be consistent with current relevant available methodologies.

The Lower-EAC, as defined previously, is based on the TGD and WFD frameworks for deriving PNECs or QS values.

The Upper-EAC, as defined previously, is based on the WFD framework for deriving MAC-QS values.

The Lower-EAC and the Upper-EAC can be derived according to two different methods depending on the number of ecotoxicological data available: assessment factors or statistical extrapolation.

2.2.1 Assessment factors method

This method is similar in its principles to the one used by OSPAR in 1996. However, the assessment factors used then are the same as those used to assess effects for the freshwater compartment. In the new version of the TGD, specific assessment factors are available for organisms living in saltwater. An additional assessment factor of 10 is applied compared to freshwater assessment factors. This is based on the observations that in the marine environment the biodiversity is wider ant that many groups occur only in saltwater. Therefore, it is necessary to consider whether the three-taxa model offers sufficient certainty that sensitive species will be covered using the assessment factors developed for the freshwater systems.

The TGD states that since it is not possible to make a clear judgement on the basis of available data, it is considered prudent to assume that this greater diversity of taxa will produce a broader distribution of species sensitivity. Thus, where only data for freshwater or saltwater algae, crustaceans and fish is available a higher assessment factor than that for freshwaters should be applied, to reflect the greater uncertainty in the extrapolation. Where data is available for additional taxonomic groups, for example rotifers, echinoderms or molluscs the uncertainties in the extrapolation are reduced and the magnitude of the assessment factor applied to a dataset can be lowered.

On the basis of current available data it was concluded that no marked difference in sensitivity between freshwater and saltwater biota appears that systematically applies across all three trophic levels considered (at least on the acute level) and that where differences in the apparent sensitivity of freshwater and marine biota were observed for individual compounds, such differences were consistently within a factor of 10 (<1 log unit) and usually somewhat less (except for metals and some pesticides). Therefore, the use of freshwater acute effects data *in lieu* of or in addition to saltwater effects data for risk assessment purposes is not contra-indicated by the empirical data reviewed. The use of pooled data is therefore recommended. Under such circumstances, the lower-EAC values should therefore be derived from the most sensitive endpoint regardless of the medium by using the assessment factors available in Table 2.

Table 2. Assessment factors used for the determination of the Lower-EAC

Data set	Assessment factor (AF)
Lowest short-term L(E)C50 from freshwater or saltwater representatives of three taxonomic groups (algae, crustaceans and fish) of three trophic levels	10 000
Lowest short-term L(E)C50 from freshwater or saltwater representatives of three taxonomic groups (algae, crustaceans and fish) of three trophic levels, + two additional marine taxonomic groups (e.g. echinoderms, molluscs)	1000
One long-term NOEC (from freshwater or saltwater crustacean reproduction or fish growth studies)	500
Lowest long-term NOECs from three freshwater or saltwater species (normally algae and/or crustaceans and/or fish) representing three trophic levels	100
Two long-term NOECs from freshwater or saltwater species representing two trophic levels (algae and/or crustaceans and/or fish) + one long-term NOEC from an additional marine taxonomic group (e.g. echinoderms, molluscs)	50
Lowest long-term NOECs from three freshwater or saltwater species (normally algae and/or crustaceans and/or fish) representing three trophic levels + two long-term NOECs from additional marine taxonomic groups (e.g. echinoderms, molluscs)	10

Deviation in the use of the assessment factors used in Table 2 is always possible depending on the available ecotoxicological dataset, however this should be clearly justified (see TGD, section on 'Marine effects assessment', section 4.3.1.3, part II).

Table 3. Assessment factors used for the determination of the Upper-EAC

Data set	Assessment factor (AF)
Lowest short-term L(E)C50 from freshwater or saltwater representatives of three taxonomic groups (algae, crustaceans and fish) of three trophic levels, + two additional marine taxonomic groups (e.g. echinoderms, molluscs)	100
Idem, but may be reduced if the existing acute data consists of many species and phyla, warranting a less strict AF*	10

* Inevitably, expert judgement is needed here. This may be avoided by using the statistical extrapolation method. At least the Upper-EAC must be higher than the lower-EAC.

The derivation of the Upper-EAC is based on acute toxicity data only. Based on the WFD guidance, we propose to use the assessment factors of Table 3 for the calculation of the Upper-EAC. Because the current WFD guidance only proposed tentative guidance, these factors should also be regarded as indicative. Deviation in the use of the assessment factors used in Table 3 is possible depending on the available ecotoxicological dataset, however this should be clearly justified (see TGD, section on 'intermittent releases, section 3.3.2 part II).

2.2.2 Statistical extrapolation method

For substances for which a large dataset of long-term tests for different taxonomic groups is available, the effect assessment can be supported by a statistical extrapolation. The main underlying assumptions of the statistical extrapolation methods are as follows (OECD, 1992d):

- The distribution of species sensitivities follows a theoretical distribution function
- The group of species tested in the laboratory is a random sample of this distribution.

In general, the methods work as follows: long-term toxicity data (for the lower-EAC) or acute toxicity data (for the Upper-EAC) are log-transformed and fitted according to the distribution function and a prescribed percentile of that distribution is used as criterion. Several distribution functions have been proposed. The EPA (1985) assumes a log-triangular function, Kooijman (1987) and Van Straalen and Denneman (1989) a log-logistic function, and Wagner and Løkke (1991) a log-normal function. Aldenberg and Slob (1993) refined the way to estimate the uncertainty of the 95th percentile by introducing confidence levels. The approach of statistical extrapolation is extensively discussed (Posthuma et al., 2002) and needs further validation. An advantage of these methods is that they use the whole sensitivity distribution of species in an ecosystem to derive the lower-EAC instead of taking always the lowest available toxicity test. However, such methods could also be criticised. Among the most common drawbacks, the reasons put forward are: the lack of transparency by using this method compared to the standard approach, the question of representativity of the selected test species, the comparability of different endpoints, and the arbitrary choice of a specific percentile. In response to these concerns it has been seen as necessary to provide some guidance on when and how to use such methods. The following recommendations should be therefore taken into account when using this approach:

- Minimum species requirements (fish, a second family in the phylum Chordata, crustacean, insect, a family of a phylum other than Arthropoda or Chordata, a family in any order of insect or any phylum not already represented, algae and higher plants).
- Database should contain at least 10 NOECs (preferably more than 15) for different species covering at least 8 taxonomic groups.
- In case of lack of fit to a known distribution, the SSD method should not be used.
- For pragmatic reasons it has been decided that the concentration corresponding with the point in the species sensitivity distribution (SSD) profile below which 5% of the species occur should be derived as an intermediate value in the determination of the lower-EAC (a 90% confidence interval (c.i.) associated with this concentration should also be derived).
- The final lower-EAC or Upper-EAC is calculated as the HC5 divided by an assessment factor between 1 and 5 based on expert judgement and quality of the database.

2.2.3 Added risk approach for substances with a natural background

For metals a specific approach was developed in the TGD since these compounds are naturally occurring substances it is proposed to adopt the "added risk" approach as used in the Netherlands for the derivation of PNEC or quality standards for metals. This approach facilitates to account for natural background concentrations in an appealingly simple manner: A maximum permissible addition (MPA) to the background level of a certain metal is calculated. The MPA is the amount of metal that maximally may be added to the background concentration of this metal without adversely affecting the assessed ecosystem.

$$\text{Lower-EAC}_{add} = C_{backg} + \text{MPA}$$
$$\text{Upper-EAC}_{add} = C_{backg} + \text{MPA}$$

Two assumptions are the basis of this approach:

1. It is not relevant to which extent the background concentration of a metal has an impact on ecosystem structure and function since any potential adverse or positive effect of the background concentration can be considered as effect contributing to the natural biodiversity of ecosystems.
2. As species in an ecosystem are adapted to the prevailing background level, it is assumed that the same amount of a metal added by human activities causes in principle the same effect, provided all environmental parameters determining metal toxicity are equal except the background level of the metal concerned (i.e. not the "absolute" level of a metal is decisive for the occurrence/extent of adverse effects but only the added amount).

The background concentration and the MPA are independently derived values. Real world background concentrations can be derived on the basis of monitoring data of relatively pristine areas or be based on calculations using geological and hydrological data (estimation of real world background levels for metals is beyond the scope of this study). For the purpose of quality standard setting, background levels may be defined and set by the competent bodies for any spatial level/resolution (e.g. EU, Member States, regions in MS) that is considered reasonable.

With regard to effects assessment, the added risk approach implies that the MPA is derived from toxicity data that are based on the added metal concentration in toxicity tests (i.e. the added metal concentration is considered 100% bioavailable). Thus, the maximum permissible addition and hence the lower-EAC derived by the added risk approach refer to the "bioavailable" fraction in "real world" samples.

The use of the added risk approach implies further that there is no risk for deficiency of essential metals at the level of the calculated lower-EAC, as the lower-EAC derived in this approach is defined as the maximum permissible addition to the background concentration. By definition, the background concentration in a given ecosystem provides the organisms in that ecosystem with the required essential metals (Lepper, 2002). This approach can be applied for both the water and the sediment compartment. If we consider the natural background not to contribute to toxicity, the same reasoning holds for the Upper-EAC and the added risk approach could be used here as well.

2.3 Sediment compartment

Three approaches were considered in the 1996 OSPAR workshop to derive Ecotoxicological Assessment Criteria (EAC): the spiked sediment bioassay, the equilibrium partitioning method and the use of co-occurrence data.

2.3.1 Derivation of sediment EACs

2.3.1.1 SPIKED SEDIMENT BIOASSAYS (SSB): if data from bioassays were available for at least 2 marine sediment-dwelling organisms from different taxonomic groups the EAC was considered firm. This is the preferred approach for organic contaminants but was considered not appropriate for metals primarily due to differences in bioavailability between laboratory and field conditions.

2.3.1.2 THE EQUILIBRIUM PARTITIONING METHOD (EQP): the second method taken into account was the equilibrium partitioning method (EqP), which was applied only for organics. For metals this method was not applied due to the large uncertainties in Kp values for metals.

2.3.1.3 USE OF CO-OCCURRENCE OF EFFECTS AND CHEMISTRY DATA: the third method proposed is the use of co-occurrence data and particularly the TEL and PEL values. The Threshold Effect Level (TEL) is the geometric mean of the lower 15^{th} percentile of the effects data set and the 50^{th} percentile of the no-effects data set. The Probable Effect Level (PEL) is the geometric mean of the 50^{th} percentile of the effect data set and the 85^{th} percentile of the no-effect data set. These two values were determined on the basis of effects and no-effects data compiled by the “North American Biological Effects database for Sediment” (BEDS).

The TEL can be regarded as a value below which adverse effects are expected to occur rarely, whereas above the PEL effects are predicted to occur frequently. Because different statistics are used to derive the TEL and that for the derivation of the TEL no-effect data are taken into account, it was agreed during the workshop that the use of an extrapolation factor on the TEL was not needed to derive an EAC (OSPAR, 1996).

In the context of chemical risk assessment and Water Framework Directive, it was decided to calculate a PNEC or an EQS values only for relevant chemicals. A log Koc or log Kow of ≥3 as a trigger value for sediment effects assessment in the TGD was used and a log $Kp_{sediment\text{-}water}$ ≥3 or log Kow of ≥3 trigger value was used in the WFD. The methodology developed in these frameworks was used to derive lower-EAC for the sediment compartment.

As for most existing chemicals the number of toxicity data on infaunal and epibenthic organisms will be limited, the equilibrium partitioning method can be used as a screening approach to compensate for the lack of toxicity data.

In the frame of chemical risk assessment, four situations can then be distinguished for deriving a lower EAC for sediment:

1. Where only results from acute tests with benthic freshwater organisms are available (at least one) the effect assessment is performed both on the basis of the tests and on the basis of the equilibrium partitioning method. The lowest lower-EAC_{marine} sediment is then used.

2. Where, in addition to the tests with freshwater benthic organisms, an acute toxicity test is performed with a marine benthic organism that is preferably representative of the same taxon that is judged to be the most sensitive in the freshwater tests. Under these circumstances an assessment factor of 1000 is applicable. A reduction of the assessment factor is only justified if sufficient long-term tests with sediment-dwelling organisms are available, and, if possible, where other evidence indicates that these tests include sensitive taxonomic groups. Also in this case a comparison with the screening approach has to be made and the lowest Lower-EAC sediment should be used.

3. Where long-term toxicity data are available for benthic freshwater organisms, the Lower-EACmarine sediment is calculated using assessment factors for long-term tests.

4. Where long-term toxicity data are available for benthic freshwater *and* a minimum of two marine organisms, a Lower-EAC for marine sediment is calculated using the lower assessment factors that are associated with data obtained from long-term tests. This is the preferred approach.

To calculate the Upper EAC for sediment, the same scheme as above is used, but modified for use in OSPAR frameworks (This scheme does not exist in the EU-TGD or WFD frameworks, but is analogous to the derivation of Upper-EACs for water).

1. Where only results from acute tests with benthic freshwater organisms are available (at least one) the effect assessment is performed both on the basis of the acute tests and on the basis of the equilibrium partitioning (EqP) method using the upper-EAC value for water. The lowest Upper-EAC_{marine} sediment is then used.

2. Where, in addition to the tests with freshwater benthic organisms, an acute toxicity test is performed with a marine benthic organism that is preferably representative of the same taxon that is judged to be the most sensitive in the freshwater tests. Under these circumstances an assessment factor of 100 is applicable. Also in this case a comparison with the EqP approach has to be made and the lowest Upper-EAC sediment should be used.

3. A reduction of the assessment factor to 10 is only justified if sufficient tests with marine sediment-dwelling organisms are available, and where other evidence indicates that these tests include sensitive taxonomic groups. Where acute toxicity data are available for benthic freshwater *and* a minimum of two marine organisms from different phyla, an Upper-EAC for marine sediment could be calculated using an assessment factor of 10.

2.3.2 Calculations of Lower- and Upper-EACs for marine sediment using the equilibrium method.

In the absence of any ecotoxicological data for sediment-dwelling organisms, the Lower-EACmarine sediment may provisionally be calculated using the equilibrium partitioning method. This method uses the Lower-EACsaltwater for aquatic organisms and the marine suspended matter/water partitioning coefficient (for the exposure assessment, the concentration in freshly deposited sediment is taken into account, therefore the properties of suspended matter are used). Based on the equilibrium partitioning the following equation is applied:

$$\mathrm{Lower_EAC}_{marine-sediment} = \frac{K_{susp-water}}{RHO_{susp}} \cdot \mathrm{Lower_EAC}_{saltwater} \cdot 1000$$

Explanation of symbols

$Lower\text{-}EAC_{marine_sediment}$	Lower Limit Environmental Assessment Criteria in marine sediment	[mg.kg^{-1}]
$Lower\text{-}EAC_{saltwater}$	Lower Limit Environmental Assessment Criteria in water	[mg.l^{-1}]
RHO_{susp}	bulk density of suspended matter	[kg.m^{-3}]
$K_{susp\text{-}water}$	partition coefficient suspended matter water	[m3.m-3] – check units

***Note**: for OSPAR purposes, it may be more relevant to use the Kp between water and sediment rather than the Kp between suspended matter and water, as in the previous version of the TGD. A comparison with monitoring data from OSPAR while updating the EACs should be done to decide on this.*

The equilibrium partitioning method considers uptake via the water phase, while uptake may also occur via other exposure pathways such as ingestion of sediment or direct contact with sediment. This may be important, especially for chemicals that have a tendency to adsorb to sediment organic matter, for example those with a log Kow greater than 3. Direct uptake from marine sediment is also observed in studies with marine benthic organisms and may significantly contribute to the uptake of organic contaminants such as PAHs (Kaag, 1998). There is also however evidence from studies in soil and in marine sediment that the proportion of the total dose taken up through intake of sediment particles remains low for chemicals with a log Kow up to 5. From other studies it is obvious that feeding mode also influences uptake of substances (via water or ingestion of sediment). Furthermore the absorption of contaminants in the gastrointestinal tract has been found to be increased compared with absorption from the surrounding water (Mayer *et al.*, 1996; Voparil et Mayer, 2000). However, no quantitative conclusions can be drawn from these studies regarding uptake of substances from sediment.

For substances with a log Kow greater than 5 (or with a corresponding Kpsed) the equilibrium partitioning method is used in a modified way in order to take account of possible uptake via ingestion of sediment. Thus the resulting Lower-EAC is divided by a factor of 10 for these compounds. It must be borne in mind that this approach can only be considered as a screening level of assessment and that this method is rarely used by itself and usually it is used in conjunction with other assessment methods.

This methodology was mainly developed for non-polar organic chemicals and makes the assumption that the system is at the equilibrium. Therefore this methodology cannot be applicable easily to metals for which partitioning coefficient depends on a number of factors such as the bioavailability of metals in oxic and anoxic sediment. . Co-occurrence data may help in the validation of the proposed EACs.

The upper EAC for marine sediment is calculated from the upper-EAC water, using the same approach and considerations as mentioned above for the lower-EAC.

$$\text{Upper_EAC}_{marine-sediment} = \frac{K_{susp-water}}{RHO_{susp}} \cdot \text{Upper_EAC}_{saltwater} \cdot 1000$$

Explanation of symbols

$Upper\text{-}EAC_{marine_sediment}$	Lower Limit Environmental Assessment Criteria in marine sediment	[mg.kg^{-1}]
$Upper\text{-}EAC_{saltwater}$	Lower Limit Environmental Assessment Criteria in water	[mg.l^{-1}]
RHO_{susp}	bulk density of suspended matter	[kg.m^{-3}]
$K_{susp\text{-}water}$	partition coefficient suspended matter water	[m3.m-3]

2.3.3 Calculation of Lower-EAC for marine sediment using assessment factors

If results from whole-sediment tests with benthic organisms are available the Lower-EACmarine sediment has to be derived using assessment factors.

Due to the generally long-term exposure of benthic organisms to sediment-bound substances, long-term tests with sub-lethal endpoints like reproduction, growth, emergence, sediment avoidance and burrowing activity are regarded as most relevant.

The different assessment factors used for the derivation of Lower-EACmarine sediment from short and long-term toxicity tests are reported respectively in Tables 4 and 5.

A Lower-EACmarine sediment is derived by application of the assessment factors reported in Table 4 to the lowest LC50 value from acute tests.

Table 4. Assessment factors for derivation of Lower-EACmarine sediment from short-term toxicity tests

Available test results	Assessment factor	Lower-EACmarine sediment
One acute freshwater or marine test	10000	Lowest of LC50 /10000 and equilibrium partitioning method
Two acute tests including a minimum of one marine test with an organism of a sensitive taxa	1000	Lowest of LC50 /1000 and equilibrium partitioning method

A Lower-EACmarine sediment is derived by application of the following assessment factors to the lowest NOEC/EC10 value from long-term tests as reported in Table 5.

Table 5. Assessment factors for derivation of Lower-EACmarine sediment from long-term toxicity tests

Available test results	Assessment factor[14]
One long term freshwater sediment test	1000
Two long term freshwater sediment tests with species representing different living and feeding conditions	500
One long term freshwater and one saltwater sediment test representing different living and feeding conditions	100
Three long term sediment tests with species representing different living and feeding conditions	50
Three long term tests with species representing different living and feeding conditions including a minimum of two tests with marine species	10

If a sufficient number of reliable ecotoxicological test results with sediment dwelling organisms is available, a statistical approach can be used (E.C., 2003), as for the aquatic EAC values.

[14] The general principles applied for the aquatic compartment shall also apply to sediment data when determining which assessment factors have to be used. Additionally, where there is convincing evidence that the sensitivity of marine organisms is adequately covered by that available from freshwater species, the assessment factors used for freshwater sediment data may be applied. Such evidence may include data from long-term testing of freshwater and marine aquatic organisms, and must include data on specific marine taxa.

2.3.4 Calculation of Upper-EAC for marine sediment using assessment factors

If results from whole-sediment tests with benthic organisms are available the Upper-EACmarine sediment has to be derived using assessment factors.

Due to the generally long-term exposure of benthic organisms to sediment-bound substances, long-term tests with sub-lethal endpoints like reproduction, growth, emergence, sediment avoidance and burrowing activity are regarded as most relevant.

The different assessment factors used for the derivation of Lower-EACmarine sediment from short and long-term toxicity tests are reported in Table 6.

A Upper-EACmarine sediment is derived by application of the assessment factors reported in Table 6 to the lowest LC50 value from acute tests and compared to the EqP method, for the Upper/EAC value.

Table 6. Assessment factors for derivation of Upper-EACmarine sediment from short-term toxicity tests

Available test results	Assessment factor	Lower-EACmarine sediment
At least one acute freshwater or marine test	100	Lowest of LC50 /100 and equilibrium partitioning method
Three long term tests with species representing different living and feeding conditions including a minimum of two tests with marine species	10	Lowest of LC50 /10 and equilibrium partitioning method

2.4 Biota

Three different methods were available to derive an EAC for biota in OSPAR 1996: the use of Critical Body Residues, direct effects on aquatic organisms and indirect effects (secondary poisoning).

Critical Body Residues
It was agreed that this method can be used and the results can be regarded as firm. However, this method could not be used for any of the substances considered for the workshop due to lack of data;

Based on direct effects on aquatic organisms
An extrapolated concentration can be derived by multiplying the extrapolated concentration in water with the appropriate BCF for fish or mussels (calculated BCF were used when no measured BCF were available). It was agreed that if sufficient ecotoxicological information for aquatic organisms and a measured BCF for fish or mussels is available the resulting EAC can be considered firm.

Based on indirect effects: secondary poisoning
It was agreed that for organic substances with a log Kow of > 5 and for certain metals like cadmium and mercury the potential adverse effects due to secondary poisoning should be taken into account. The method to be used is given in the report of the 1996 OSPAR workshop and in the EU/TGD (EC, 2003). It was agreed that if toxicity data are available for one bird and mammal species exposed via the food the resulting EAC can be considered firm.

Special attention should be given to the assessment of the EAC for biota. The two main methodologies used during the 1996 OSPAR workshop (direct effects and indirect effects) lead to two different values with different meanings.

The value derived from secondary poisoning takes into account the protection of predators and top-predators in the food chain whereas the values obtained based on direct effects of organisms represent in fact the

concentrations that should be measured into fish and mussels when these organisms are exposed to the concentration in water calculated for the Lower and Upper-EACwater.

To be protective we decided to use the secondary poisoning approach according to the EU-TGD to derive a single EACsecond_poisoning value in order to protect predators and top predators in the food chain. Lower and Upper-EACbiota$_{fish}$ and Lower and Upper-EACbiota$_{mussel}$ are also calculated on the basis of the Lower and Upper-EACwater. These two values should be regarded in a different way when interpreting monitoring data and be used as complementary EAC values data. Secondary poisoning is taken into account in the WFD for substances for which the BCF > 100.

2.4.1 Calculation of Lower and Upper-EACbiota$_{fish}$ and Lower and Upper-EACbiota$_{mussel}$

These concentrations represent concentrations that should be measured into fish and mussels when these organisms live in an environment at the level of contamination of the Upper-EACwater.

Lower-EACbiota$_{fish}$ (mg/kg fw) = Lower-EACwater (mg/L) × BCFfish (L/Kg fw)

Lower-EACbiota$_{mussel}$ (mg/kg fw) = Lower-EACwater (mg/L) × BCFmussel (L/Kg fw)

Upper-EACbiota$_{fish}$ (mg/kg fw) = Upper-EACwater (mg/L) × BCFfish (L/Kg fw)

Upper-EACbiota$_{mussel}$ (mg/kg fw) = Upper-EACwater (mg/L) × BCFmussel (L/Kg fw)

2.4.2 Secondary poisoning

2.4.2.1 GENERAL

The method proposed during the 1996 OSPAR workshop has been developed and improved since then, particularly for the marine environment, and is reported in the new version of the TGD (EU, 2003). This method was also used in the context of the WFD.

Accumulation of hydrophobic chemicals through the marine food chains may follow many different pathways along different trophic levels. This accumulation may result in toxic concentrations in predatory birds or mammals ingesting aquatic biota containing the chemical. This effect is called secondary poisoning and should in principle be assessed by comparing the measured or estimated concentrations in the tissues and organs of the top-predators with the no-effect concentrations for these predators expressed as the internal dose. In practice, most no-effect levels are expressed in term of concentrations of the food that the organisms consume (i.e. in mg kg $^{-1}$ food) and the no-effect level is based on studies with laboratory animals.

The principal endpoints for the secondary poisoning assessment are the predators and top-predators that prey on organisms that are in direct contact with the marine aqueous phase and receive the substances from this source. A relatively simple food-chain is modelled which consists of the marine water phase, marine food, marine fish and two separate levels of predators. This food chain is visualised in figure 1.

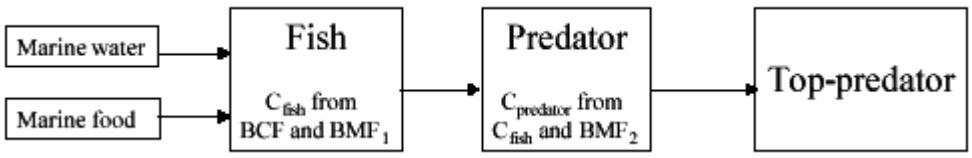

Figure 1: secondary poisoning food chain

From this food chain model different concentrations can be calculated. The concentration in the marine fish (Cfish) is obtained from bioconcentration of the substance from the aqueous phase and (for very hydrophobic substances) as a result of bioaccumulation from the food the fish consumes (which consists of different types of aquatic organisms). Therefore, both a bioconcentration factor (BCF) and a biomagnification factor (BMF1) are

used to calculate Cfish. Note that for the BCFfish also information for other organisms such as mussels may be considered.

$$\text{Cfish (mg/kg wwt)} = \text{Cwater (mg/L)} \times \text{BCF(L/Kg)} \times BMF_1$$

Since very hydrophobic substances may biomagnify in the tissue and organs of the predator, for the calculation of the internal concentration of the predator an additional biomagnification factor (BMF2) must be applied accounting for an extra trophic level.

$$\text{Cpredator (mg/kg wwt)} = \text{Cwater (mg/L)} \times \text{BCF (L/kg)} \times BMF_1 \times BMF_2$$

It is realised that food chains of the marine environment can be very long and complex and may consist of 5 or more trophic levels. The possible extent of bioaccumulation in marine food chains with more than the above three to four trophic levels should be evaluated case by case if necessary input data for such an evaluation is available, using the principles for the shorter food chain. Also if further data are available it may be possible to refine the assessment of secondary poisoning via marine food chains by employing more advanced modelling that takes the differences in for instance uptake and metabolic rates into account for the different trophic levels.

In the relatively simple food chain given above the concentration in the fish (i.e. the food for the fish-eater) ideally should take account of all possible exposure routes, but in most instances this will not be possible because it is not clear what contribution each potential exposure route makes to the overall body burden of a contaminant in fish species. Therefore for very hydrophobic substances a simple correction factor for potential biomagnification on top of the bioconcentration through the water phase is applied.

The biomagnification factors used should, ideally, be based on measured values. However, the limited availability of such data means that in most instances the default values described below may have to be used. The use of a default value represents a screening approach designed to identify substances for which it may be necessary to obtain more detailed information on the biomagnification factor.

Although there may be relationships between the magnitude of the BMF and the log Kow of the substance under defined conditions, the available data are not conclusive. Other more complex intrinsic properties of substances than the lipophilicity (log Kow) seems to be important as well as the species under consideration (e.g. its biology in relation to uptake, metabolism etc.). As a simple screening approach, however, it seems reasonable to assume that for organic substances with a log Kow up to 4,5 biomagnification seems generally to be low and thus BMF = 1. For higher log Kow the biomagnification increases up to around log Kow 7 and then it decreases again to be low around log Kow 9 (Fisk *et al*., 1998). Based on data published by Rasmussen *et al*. (1990), Clark and Mackay (1991), Evans *et al.* (1991) and Fisk *et al*. (1998), the default BMF values in Table 7 are suggested.

Table 7. Default BMF values for organic substances with different log Kow or BCF in fish

Log Kow BCF	BCF (fish)	BMF1	BMF2
<4,5	< 2000	1	1
4,5 - <5	2000-5000	2	2
5 – 8	> 5000	10	10
>8 – 9	2000-5000	3	3
>9	< 2000	1	1

The derivation of appropriate default BMFs can only, at this stage, be considered as preliminary for use in screening of chemicals for the purposes of identifying those that need further scrutiny. In reviewing the appropriateness of the BMF applied in any particular assessment, it should be recognised that factors other than the log Kow and BCF should also be taken into account. Such factors should include the available evidence that

may indicate a potential for the substance to metabolise or other evidence indicating a low potential for biomagnification.

2.4.2.2 CALCULATION OF THE EACSECOND_POISONING

The method used and described in the TGD is similar to the assessment factors method used for water and sediment compartment in the sense that it calculates a no effect concentration using toxicological data and assessment factors.

Only toxicity studies reporting on *dietary and oral exposure* are relevant as the pathway for secondary poisoning is referring exclusively to the uptake through the food chain. Secondary poisoning effects on bird and mammal populations rarely become manifest in short-term studies. Therefore, results from long-term studies are strongly preferred, such as NOECs for mortality, reproduction or growth. If no adequate toxicity data for mammals or birds are available, an assessment of secondary poisoning cannot be made.
Most of the time only NOAEL values (expressed as a dose and not a concentration in food) are available, conversion factors available in the TGD allow the conversion of NOAELs into NOECs.

The assessment factors (AForal) proposed in Table 8 take into account interspecies variation, acute/subchronic to chronic extrapolation and laboratory data to field impact extrapolation. Some specific considerations need to be made for the use of the assessment factor for predators. All these considerations are detailed in the TGD.

Table 8. Assessment factors for extrapolation of mammalian and bird toxicity data

TOXoral	Duration of test	AForal
LC50 bird	5 days	3000
NOECbird	Chronic	30
NOECmammal, food,chr	28 days	300
	90 days	90
	Chronic	30

Therefore,

$$EACsecond_poisoning = TOXoral / AForal$$

By using the equations detailed for the calculation of the concentrations into fish and predators it is possible to determine a safe concentration in water in order to protect marine organisms from secondary poisoning.

$$EACsecond_poisoning_water\ (mg/L) = EACsecond_poisoning / (BCF \times BMF_1 \times BMF_2)$$

Concentrations in fish and mussels can also be calculated according to the following equations.

$$EACsecond_poisoning_fish\ (mg/kg\ fw) = EACsecond_poisoning / BMF_2$$

$$EACsecond_poisoning_mussels\ (mg/kg\ fw) = EACsecond_poisoning / (BMF_1 \times BMF_2)$$

2.5 Recalculating Biota EACs

To make it possible to assess monitoring data from fish and mussels expressed in other matrices than the derived EACs for fish and mussels, monitoring values can be converted from e.g. wet wt to dry wt or whole tissue concentrations to lipid concentrations with default conversion factors. When appropriate measurements are available, conversions should preferably be based on measured properties, e.g. water content or lipid weights. Conversion factors are reported on working document 05 of this workshop: Recalculation of BRC and EAC values to allow interconversion and utilisation of data expressed on dry weight, wet weight or lipid weight bases (Ian Davies on behalf of OSPAR MON, 2004).

3. Updating and expanding EACs

To illustrate what the benefits/implications are of introducing the "updated" EAC-values based on the Quality Standards, i.e. EQS and MAC-QS, developed for the EU Water Frame Directive (WFD), two examples will be described in Appendix 3 and Appendix 4.

In Appendix 3, EAC for tributyltin (TBT) will be derived for water, sediment and biota and compared with the previously derived EAC-ranges from the Third OSPAR workshop on Ecotoxicological Assessment Criteria in 1996 (OSPAR, 1996).

In Appendix 4, EAC for penta-BDE, a brominated flame retardant compound, will be derived to illustrate how the risk assessment in the framework of the WFD also can be used for OSPAR priority substances, where EAC-values have not been previously derived.

In Appendix 2 an overview is presented of existing EU/EQS and EACs (1996 OSPAR workshop) for water, sediment and biota. *For illustration only*, also lower values EAC are presented calculated from 1996 OSPAR workshop toxicity data. Due to the differences in safety factors between the 1996 workshop methods and the proposed method and due to the fact that new data may be made available in EU/FHI and EU/Risk assessment reports, these values may change.

3.1 Updating existing EACs: TBT example

For TBT, the updated Lower EAC water is identical with the upper limit of the previously derived EAC-range, since both values were derived by applying an assessment factor of 10 to identical lowest NOEC-value. In comparison the updated Upper EAC is 15 times higher. These differences are referring to the EAC for water, sediment as well as biota (see Table 9), because they are all derived on basis of the WFD quality standards, which are set for protection of the pelagic community. However, secondary poisoning has not been taken into consideration in the derivation of EAC for biota, because no relevant data have been available for such an assessment.

Table 9. Comparison of the updated EAC-values for TBT in water, sediment and biota with the current EAC-ranges derived in 1996

TBT	Water (µg/l)	Sediment (mg/kg dw)	Fish (mg/kg fw)	Mussel (mg/kg dw)
Lower EAC	0,0001	0,00001	n.d.a.	0,012
Upper EAC	0,0015	0,00015	n.d.a.	0,175
Current EAC-range (OSPAR, 1996)	0,00001-0,0001	0,000005-0,00005	n.r.	0,001-0,01

n.d.a.: no data available

n.r.: not relevant

3.2 Adding new EACs: PBDE example

For penta-BDE, the upper EAC for water will correspond to the WFD MAC-QS. The upper EACs for sediment and fish are then calculated from the upper EAC_{water}.

Different lower EACs are suggested for all compartments. One not taking secondary poisoning into account and one taking secondary poisoning of top-predators into account (deduced from a biomagnification factor for fish, BMF_{fish}, and a biomagnification factor for predators, $BMF_{predator}$).

The resulting EACs are given in the table below.

The following values are calculated as an exercise for deriving EACs from WFD quality standards. All must be considered provisional until new EACs are derived.

Table 10. Comparison of the EAC-values for PBDE in water, sediment and biota. The Upper EAC biota for fish is very high

	Water (µg/l)	Sediment (µg/kg d.w.)	Fish (mg/kg w.w.)	Mussel (mg/kg w.w.)
lower EAC calculated without secondary poisoning	0,053	62	28	1,4
lower EAC calculated with secondary poisoning	0,00018	0,21	0,1	0,005
upper EAC	1,4	$1,6 * 10^3$	756	38

3.3 Findings and implications for updating and revising existing EACs

Updating and revising the EACs for TBT and PBDE have shown that current standards calculated in the EU can be easily converted into OSPAR EACs. Default values for recalculations, such as partition coefficients, physico-chemical properties and BCFs can be taken from the EU-TGD or the WFD guidance. However, if new or additional data are available, these should be compared to data reported in the available assessment documents. Expert judgement should be used to decide of new data can be used for the calculation of OSPAR EACs.

If EACs for sediment are not based on equilibrium partitioning (EqP) but on toxicity tests with benthic organisms, the Lower $EAC_{sediment}$ is based on these tests. It is suggested in Appendix 4 to use a modified partitioning approach to calculate the Upper $EAC_{sediment}$. Alternatively, the available toxicity data could be analysed for acute effects or different assessment factors used (see Chapter 2) to derive the Upper $EAC_{sediment}$ directly from the toxicity data.

Recalculating secondary poisoning standards from EU or WFD assessments to EACs for biota can be done according to the methods of Chapter 2. However, when Upper EACs for water are recalculated to biota using BCF and BMF values, very high biota standards may result (cf. Results for Pentabromo-diphenyl ether, Appendix 4). Upper biota standards, not based on secondary poisoning, should preferably be compared to measured or calculated critical tissue concentrations (lethal body burdens). This is done to ascertain that upper biota EACs are not above critical tissue levels, and thus without value for biomonitoring. It may be advisable to always calculate secondary poisoning EACs for biota.

4. Conclusions and recommendations

In view of criticism of the current EACs and the difficulties in their practical application, several fundamental changes in EACs are proposed:

a. that the definition of EACs is changed from Ecotoxicological Assessment Criteria to Environmental Assessment Criteria. This change reflects the primary role of EACs as tools for the assessment of environmental data, for example OSPAR JAMP and CEMP data, and the need for integrated assessment of chemical and biological effects data;

b. the methodology for derivation of EACs has also been thoroughly reviewed and brought more into line with the approach taken for the derivation of Quality Standards (QS) for the Water Framework Directive. Although EACs are not equal to QS in the water framework, EACs have been redefined to relate to them. The adoption of EU methods (either from the EU water framework directive or

the EU new and existing substances directives) is recommended, allowing easy adoption of EU assessments for OSPAR purposes. EU methods for secondary poisoning can be used to improve the meaning of biota monitoring, with regard to toxicity for top predators;

c. the old range of EACs is no longer endorsed, but replaced by Lower-EAC and Upper-EAC values that have defined ecotoxicological meaning. A criticism of the previous EACs was that the ranges of values were difficult to use and interpret. Although two new EAC values are proposed at a lower and an upper level, it is important to recognise that these are in most cases independently derived and more robust than the previous values. The values are derived as follows:

   i. the lower EAC value is a concentration derived for protection of all marine species from chronic effects, including the most sensitive species;

   ii. the upper EAC is defined as the highest (transient) concentration that is expected not to cause acute toxic effects;

d. interpretation of environmental assessment data is made easier using the new values, through the derivation of a "traffic light" system to allow contaminant concentrations to be used to assess the state of the environment and prompt appropriate environmental management options;

   i. below the lower-EAC value, measured contaminant concentration should not give rise to any biological effects. No immediate management action would be required, the monitoring frequency could be reduced or monitoring ceased;

   ii. between the lower and the upper EAC value, biological effects are possible (e.g. biomarker response, impaired growth, reproduction). Management actions could be to identify the reasons for elevated level(s), the use of expert judgement to assess significance, check trends and variability or the introduction of additional monitoring;

   iii. above the upper-EAC, long-term biological effects are likely (e.g. impaired growth, reproduction and survival), and acute biological effects (survival) are possible. Appropriate management actions could involve additional analysis to verify findings, identification of the reason(s) for elevated level(s), re-design of monitoring strategies for specific elevated contaminants and consider resource or emission management issues;

e. most sediment EACs have been based on equilibrium partitioning due to a paucity of ecotoxicological data. This lack of data has not been remedied. Such EACs should continue to be regarded as provisional and need validation with additional sediment toxicity tests and/ or co-occurrence data, especially for metals;

f. for biota, two different types of EACs were derived. The first type is based on the derived EACs for water or sediment, and transferred to biota using appropriate BCF. The second type takes into account that fish or mussels are food for predators. Levels in mussel or fish can be derived that protect against this so-called secondary poisoning. It is recommended to calculate both types of biota EACs for comparison;

g. where insufficient ecotoxicological data exists for marine species then freshwater data could be used but the EAC data should be regarded as provisional as in previous derivations;

h. for substances with a natural background, the added risk approach as used in the WFD could be adopted to avoid the problems of separating background values from lower EAC values. Further consultation is needed to decide on this issue;

i. an expanded set of EACs for additional substances on the OSPAR priority substances list could be developed using the methodology proposed and taking account of existing EU assessments under the Existing Substances Regulation and the Water Framework Directive. New substances of

interest to OSPAR have been identified where sufficient ecotoxicological data exists to allow EACs to be derived;

j. finalising the update of EACs will require further work, which should take into account existing EU assessments. Possible arrangements for the completion of this work are detailed in Appendix 5;

k. Statistical methods for checking compliance with OSPAR EACs should be harmonised with those used for use in monitoring of Background Reference Concentrations.

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Appendix 7.1: Overview of Water Framework QS and current EACs for OSPAR substances for priority action

This Appendix lists current OSPAR EAC for water and sediment, in comparison with the QS and MAC-QS values of the water framework directive (WFD). The first column lists the substance; the second column the QS water as derived for the WFD; the third column the MAC-QS value as derived for the WFD (only for water); the fourth column the current EAC range; and the fifth column lists lower EAC value, calculated according to the methods of Chapter 2. These lower values EAC are calculated from the 1996 OSPAR workshop toxicity data. These calculations are only meant to illustrate the change in approach from the current EAC methods to the new methods. No new data nor a new evaluation of the toxicity data was performed for this comparison.

Water

OSPAR List of Chemicals for Priority Action (Up-date 2003)

		According to WFD		OSPAR	
	Group of substances / substances	EQS water [ug/l]	MAC-QS [ug/l] for inland waters	EAC water – current range [ug/l]	Calculated Lower EAC[ug/l] (For illustration only!)
1	4-tert-butyltoluene				
2	cadmium	0,21(MPA)		0,01-0,1	0,056
3	lead and organic lead compounds	???		0,5-5	0,9
4	mercury and organic mercury compounds	???	0,07	0,005-0,05l	0,01
5	organic tin compounds	0,0001	0,0015	0,00001-0,0001	0,00005
6	neodecanoic acid, ethenyl ester				
7	perfluorooctanyl sulphonic acid and its salts (PFOS)				
8	tetrabromobisphenol A (TBBP-A)				
9	hexachlorocyclopentadiene (HCCP)				
10	1,2,3-trichlorobenzene	0,4	50		
11	1,2,4-trichlorobenzene	0,4	50		
12	1,3,5-trichlorobenzene	0,4	50		
13	brominated flame retardants (penta BDE)	0,00018	1,4		
14	polychlorinated biphenyls (PCBs)				
15	polychlorinated dibenzodioxins (PCDDs) polychlorinated dibenzofurans (PCDFs)				
16	short chained chlorinated paraffins (SCCP)	0,1	1,4		
17	4-(dimethylbutylamino) diphenylamin (6PPD)				
18	triphenyl phosphine				
19	hexamethyldisiloxane (HMDS)				
20	dicofol				
21	endosulphan	???			
22	hexachlorocyclohexane isomers (HCH)	0,01	0,9		
	lindane	0,002	0,04	0,0005-0,005	0,0017
23	methoxychlor				
24	pentachlorophenol (PCP)	0,22	1		
25	trifluralin	0,03	1		
26	clotrimazole				
27	2,4,6-tri-tert-butylphenol				
28	nonylphenol/ethoxylates (NP/NPEs) and related substances	0,033	2,1		
29	octylphenol	0,061	0,133		
30	certain phthalates: dibutylphthalate, diethylhexylphthalate (DEHP)	0,17			
31	polyaromatic hydrocarbons (PAHs): Benzo(a)pyrene	???	0,05	0,01-0,1	0,063
32	musk xylene				

- Chemicals where no background document is being prepared because they are intermediates in closed systems or because there is no current production or use interest are not listed.
- Grey shaded substances/groups of substances are also listed in Annex X of the WFD.
- The EQS are related to coastal and territorial waters. MAC-QS are only available for inland waters.

Further OSPAR substances of possible concern

		According to WFD		OSPAR	
	Group of substances / substances	EQS water [ug/l]	MAC-QS [ug/l] for inland waters	EAC water – current range [ug/l]	Calculated Lower EAC[ug/l] (For illustration only!)
1	Anthracene			0,001-0,01	0,0063
2	Diuron	0,2	1,8		
3	Fluoranthene	0,09	0,9	0,01-0,1	0,069
4	Naphthalene	1,2	80	5-50	7,5
5	Nickel			0,1-1,0	0,61
6	As			1-10	3,5
7	Cr			1-10	25
8	Cu			0,005 –0,05	0,02
9	Phenanthrene			0,5 – 5	1,8
10	Pyrene			0,05 – 0,5	0,25
11	Zn			0,5 – 5	1

Sediment

OSPAR List of Chemicals for Priority Action (Up-date 2003)

		According to WFD	OSPAR	
	Group of substances / substances	[mg/kg dw]	EAC sediment current range [mg/kg dw]	Calculated Lower EAC [mg/kg dw] (For illustration only!)
1	4-tert-butyltoluene			
2	cadmium	27,3	0,1 - 1	0,676
3	lead and organic lead compounds	80-800 (EqP)	5-50	0,0029
4	mercury and organic mercury compounds	360 ug/kg dw	0,05-0,5	0,13
5	organic tin compounds	10 ng/kg dw	5-50 ng/kg dw	20 ng/kg dw
6	neodecanoic acid, ethenyl ester			
7	perfluorooctanyl sulphonic acid and its salts (PFOS)			
8	tetrabromobisphenol A (TBBP-A)			
9	hexachlorocyclopentadiene (HCCP)			
10	1,2,3-trichlorobenzene			
11	1,2,4-trichlorobenzene			
12	1,3,5-trichlorobenzene			
13	brominated flame retardants (penta BDE)			
14	polychlorinated biphenyls (PCBs)		0,001 – 0,01	0,0026
15	polychlorinated dibenzodioxins (PCDDs) polychlorinated dibenzofurans (PCDFs)			
16	short chained chlorinated paraffins (SCCP)	0,198		
17	4-(dimethylbutylamino) diphenylamin (6PPD)			
18	triphenyl phosphine			
19	hexamethyldisiloxane (HMDS)			
20	dicofol			
21	endosulphan			
22	hexachlorocyclohexane isomers (HCH)			
	lindane	0,24 ug/kg fw		
23	methoxychlor			
24	pentachlorophenol (PCP)			
25	trifluralin			
26	clotrimazole			
27	2,4,6-tri-tert-butylphenol			
28	nonylphenol/ethoxylates (NP/NPEs) and related substances			
29	octylphenol			
30	certain phthalates: dibutylphthalate, diethylhexylphthalate (DEHP)			
31	polyaromatic hydrocarbons (PAHs): Benzo(a)pyrene	250ug/kg dw	0,1-1	0,089/0,76
32	musk xylene			

- Chemicals where no background document is being prepared because they are intermediates in closed systems or because there is no current production or use interest are not listed.
- Grey shaded substances/groups of substances are also listed in Annex X of the WFD.
- The EQS are related to coastal and territorial waters. MAC-QS are only available for inland waters.

Further OSPAR substances of possible concern

		According to WFD	OSPAR	
	Group of substances / substances		**EAC sediment current range [mg/kg dw]**	**Calculated Lower EAC[mg/kg dw] (For illustration only!)**
1	Anthracene	17,9 µg/kg dry wt	0,05-0,5	0,107
2	Diuron			
3	Fluoranthene	1247	0,5 – 5	1,9
4	Naphthalene		0,05-0,5	0,106
5	Nickel			
6	As		1 – 10	7,24
7	Cr		10 – 100	52,3
8	Cu		5 – 50	18,7
9	Phenanthrene		0,1 – 1	0,39
10	Pyrene			
11	Zn		50 – 500	124

Appendix 7.2: Tributyltin (TBT) as an example for derivation of Environmental Assessment Criteria (EAC) based on the Quality Standards developed for the EU Water Frame Directive (WFD)

This datasheet is intended to be regarded as an example for how OSPAR can take into account the developments in the EC draft Technical Guidance Document (TGD, 2003; Marine Chapter) and the EC process of setting water quality objectives. This includes using the effect assessment described in the substance datasheet for tributyltin compounds prepared by the Fraunhofer Institute (FHI, September 2003) for the EU WFD as a basis for derivation of "updated" OSPAR EAC-values.

The substance datasheet for TBT (FHI, September 2003) has at the OSPAR workshop in 2004 been accepted as an more extended effect assessment, because new toxicity data have been taken into account than in the risk assessment described in the report of the third OSPAR workshop on Ecotoxicological Assessment Criteria in 1996 (OSPAR, 1996).

1. Overall Quality Standards for TBT in seawater proposed for the WFD

There are many long-term no effect and short-term acute toxicity data for a broad range of species from different taxonomic groups available. Molluscs appear to be the most sensitive taxonomic group. However, the difference to the most sensitive species of other taxonomic groups such as fish, invertebrates and algae is only gradual on a very low exposure level (lowest reported NOECs for molluscs 1 ng/l and 10 – 50 ng/l for the other taxonomic groups mentioned) (OSPAR, 1996; FHI, 2003).

Table 1. Overall Quality Standards for TBT in seawater proposed for the WFD (FHI, 2003)

	Quality Standard	Comment
EQS for transitional, coastal and territorial waters:	0,0001 µg/l corresponding conc, in SPM: 0,011 µg/kg (dry wt)	Protection of the pelagic community. Tributyltin compounds are categorised as Priority Hazardous Substance. Therefore, the detection limit may serve as borderline quality standard in territorial waters in order to prevent pollution of the open sea. However, the suggested overall QS of 0,1 ng/l may be below the detection limit for TBT-compounds.
MAC-QS for transitional, coastal and territorial waters:	0,0015 µg/l	

EQS = 0,0001 µg TBT/l was derived by applying an assessment factor of 10 to the lowest NOEC-value for chronic effects available. Parallel to this approach a QS was derived based on SSD. The QS_{water} based on SSD method is 0,00018 µg/l whereas the suggested AF-based QS is 0,0001 µg/l. Hence the difference is only 0,08 ng/l. This is no significant difference and it is therefore deemed reasonable to use the concentration level determined as safe with the assessment factor method as overall QS (FHI, 2003).

The overall EQS is thereby identical with the upper-limit of the current EAC-range previously derived by OSPAR (OSPAR, 1996).

It is suggested to derive the MAC-QS on the basis of the lowest acute toxicity test available. This is a 8 days test with the marine crustacean species *Acartia tonsa.* The EC50 for effects on development is reported as 0,003 µg/l whereas the LC50 (mortality) is given as 0,015 µg/l. It seems reasonable to use the *Arcatia tonsa* LC50 of 0,015 µg/l as the relevant value for the derivation of the MAC-QS (the *Daphnia* EC50 may be lower for a standard exposure time of 48 h, the significance of the developmental effect on the population of *Arcatia* is unclear and it may not occur at short term concentration peaks). MAC-QS = 0,0015 µg TBT/l is derived by applying an assessment factor of 10 to the lowest acute effect level found relevant (FHI, 2002).

It is suggested that OSPAR adopt the EQS and the MAC-QS as, respectively, the "updated" values of Lower EAC and Upper EAC. These values should be accepted as firm.

2. Quality Standards for TBT in sediment proposed for the WFD

Table 2. Quality Standards for TBT in sediment proposed for the WFD (FHI, 2003)

	Quality Standard	Comment
EQS for sediments	0,0023 µg/kg wet wt 0,01 µg/kg dry wt	Tentative values derived by EP method.

To derive an extrapolated concentration for sediments a tentative quality standard QS = 0,01 µg TBT/kg dry wt has been derived by using an equilibrium partitioning method (FHI, 2003).

This QS is thereby two times higher compared to the upper-limit of the current EAC-range derived by OSPAR, which also was derived by an equilibrium partitioning method (OSPAR, 1996). It is suggested that OSPAR adopt the new value of Lower EAC sediment as these values are not that significant different from each other. Based on the MAC-QS and using the same equilibrium method a new value of Upper EAC sediment of 0,15 µg TBT/kg dry wt can be derived.

However, both Lower EAC and Upper EAC for sediment must still regarded as provisional, because they were calculated. If they should classified as firm it would require a risk assessment based on sediment toxicity data, which at present not seems to be available.

3. Derivation of Quality Standards for TBT in biota

No quality standards for biota have been suggested by the Fraunhofer Institute with the exception of seafood for human consumption.

Table 3. QS Referring to Food Uptake by Humans

Protection Objective	Quality Standard	Comment
Food uptake by man	15,2 µg/kg seafood (wet wt) corresponding conc. in water: 0,0025 µg/l	The WHO has proposed a tolerable daily intake for bis-tributyltin oxide of 0,25 µg/kg bw/d. In the TGD (2003) it is suggested that the ADI may not be exhausted for more than 10% by consumption of food originating from aquatic sources. For a person weighing 70 kg this results in an acceptable daily intake of 1,75 µg tributyltin per day when the average fish consumption of an EU citizen is 115 g/d

The OSPAR workshop 2004 has however found it very relevant also to include EAC, which address accumulation of TBT in biota with a special attention to mussels.

Calculation of the EAC for mussels is possible using three methods: The first method is multiplying the extrapolated concentration in water with the geometric mean BCF for mussels. For accumulation of TBT in the bivalve *Mytilus edulis*, a geometric mean of BCF = 116,000 l/kg dw has been estimated (OSPAR, 1996). This BCF value has also been used as an extrapolation factor for transforming the quality standards for TBT concentrations in seawater into "updated" EAC-values for TBT concentrations in *M. edulis*.

Lower EAC $Biota_{mussel}$ = 116,000 l/kg dw *0,0001 µg/l (EQS) = 12 µg TBT/kg dw

Upper EAC $Biota_{mussel}$ = 116,000 l/kg dw *0,0015 µg/l (MAC-QS) = 175 µg TBT/kg dw

However, the implication by introducing an extrapolated Upper EACbiota for mussels based on the MAC-QS for TBT in seawater has to be taken into account. The MAC-QS is intended to describe maximum concentration levels in peaking events in the water column, whereas the TBT concentration in mussels is mirroring a more time-integrated accumulation level.

The second method is based on secondary poisoning. Tributyltin has a BCF >> 100. Thus the trigger criterion to derive a quality standard referring to the protection of top predators from secondary poisoning is met (TGD, 2003).

Oral toxicity data such as NOECs in food or (sub)chronic NOAELs from feeding studies with mammals and birds were, however, not been provided to the consultants at the Frauenhofer Institute. Therefore a quality standard for the protection of top predators from secondary poisoning has not be derived by the Frauenhofer Institute (FHI, 2003).

The substance datasheet (FHI, 2003) does, however, made the comment that biomagnification of tributyltin compounds through the food chain may not occur as a study by Stäb et al. (1997) indicates. The authors investigated TBT levels in species representing different levels of the trophic net in a Dutch inland water ecosystem. Birds as top-predators in this ecosystem showed lower TBT body burdens than species lower in the food chain.

However, at the OSPAR workshop in 2004 it was argued that other studies, especially on coastal cetaceans, have demonstrated that biomagnification of TBT in the food web can be significant (Tanabe, 1999). Studies have also demonstrated that in some areas, significant accumulation levels of TBT also can occur in fish (Belfroid et al., 2000). The OSPAR workshop 2004 stresses that EAC for TBT in fish also should be taken into future consideration.

	Quality Standard	**Comment**
Predators (second. Poisoning)	not available	Derivation of a QS is required but due to lack of oral toxicity data for birds and mammals not possible **(**FHI, 2003).
Food uptake by man	15,2 µg/kg seafood (wet wt) corresponding conc. in water: 0,0025 µg/l	See above

An approach to derive EAC for TBT in fish based on the risk of secondary poisoning might be to use the same toxicological data as used in the derivation of quality standard for food uptake by man ($QS_{hum.}$). However, the relative proportions between the assessment factors applied for marine mammals ($AF_{m.m.}$) and humans ($AF_{hum.}$) as well as the differences in the amount of daily food intake of marine mammals ($I_{m.m.}$) and humans ($I_{hum.}$) have to be taken into account.

Thereby QS (second. poisoning) = $AF_{hum}/AF_{m.m.} * I_{hum}/I_{m.m..} * QS_{hum.}$

The third method is using data from a field experiment. In the Report of the OSPAR workshop in 1996 one example was put forward. TBT residues in the prosobranch gastropod *Nucella lapillus* exposed to <1,25 µg TBT/l in the field were not suffering of severe imposex causing sterility (Bryan & Gibbs, 1987). A factor of 3 was applied to estimate a NOEC as *N. lapillus* is probably one of the most sensitive species and the value is derived from field experiment. An assessment factor of 1 was applied to this NOEC leading to an extrapolated concentration of EAC = 65 µg TBT/kg dw (Critical body burden).

The lowest value of EAC = 11,6 µg TBT/kg dw derived on basis of EQS is used to set the Lower EACbiota. The EAC-values for mussels are classified as firm, because BCF has been measured and the EAC-value for seawater has also been set as firm.

However, the implication of introducing Upper EACbiota values, based on the Upper EACwater has to be further discussed within the forum of OSPAR.

4. Summary table

Table 4. Comparison of the updated EAC-values for TBT in water, sediment and biota with the current EAC-ranges derived in 1996. New EAC values are not yet ratified by OSPAR

TBT	Water (µg/l)	Sediment (mg/kg dw)	Fish (mg/kg fw)	Mussel (mg/kg dw)
Lower EAC	0,0001 (f)	0,00001 (p)	n.d.a.	0,012 (f)
Upper EAC	0,0015 (f)	0,00015 (p)	n.d.a.	0,175 (p)
Current EAC-range (OSPAR, 1996)	0,00001-0,0001(f)	0,000005-0,00005 (p)	n.r.	0,001-0,01 (f)

5. References

Belfroid et al., 2000. Organotin in seafood. Nar. Pollut. Bull. 40(3):226-232.

Bryan GW, Gibbs PE, Hummerstone LG, Burt GR (1986). The decline of the gastropod Nucella lapillus around South-West England: Evidence for the effect of tributyltin from antifouling paints. Journal of the Marine Biological Association of the United Kingdom 66: 611-640.

FHI, 2003. Substance Data Sheet: Tributyltin Compounds, DRAFT of 300903 prepared by the Frauenhofer Institute, Germany.

Stäb, JA et al., 1996. Determination of Organotin Compounds in the Foodweb of a Shallow Freshwater Lake in the Netherlands. Archives of Environ. Contam. And Toxicol. 31: 319-328.

Tanabe S., 1999. Butyltin contamination in marine mammals - a review. Mar Pollut Bull 39, 62-72.

TGD, 2003. Technical Guidance Document on Risk Assessment in Support of Commission Directive 93/67/EEC on Risk Assessment for New Notified Substances and Commission Regulation (EC) No 1488/94 on Risk Assessment for Existing Substances and Directive 98/8/EC of the European Parliament and the Council Concerning the placing of biocidal products on the market. Part II.

Appendix 7.3: Pentabromodiphenylether (penta-BDE) as an example for derivation of Environmental Assessment Criteria (EAC) based on the quality standards in the EU Water Framework Directive (WFD)

Table 1. The following values are calculated as an example of deriving EACs from WFD quality standards. All must be considered provisional until the review of EACs is finalised

	Water (µg/l)	Sediment (µg/kg d.w.)	Fish (mg/kg w.w.)	Mussel (mg/kg w.w.)
Lower EAC calculated without secondary poisoning	0,053	62	28	1,4
Lower EAC calculated with secondary poisoning	0,00018	0,21	0,1	0,005
Upper EAC	1,4	$1,6 * 10^3$	756	38

The deduction of the values are explained in the paragraphs below

1. WFD quality standards relevant to OSPAR EACs

Table 2. WFD specific quality standards relevant to OSPAR EACs

Protection Objective	Quality Standard	Comment:
Pelagic community (saltwater)	**0,053 µg/l**	See paragraph 2.1. (below) and the RAR[1]
Benthic community (marine sediment)	**62 µg/kg dry wt**	See paragraph 2.3. (below) and the RAR[1]
Predators (secondary poisoning, marine)[1]	**1 mg/kg** (tissue of prey, wet wt) corresponding conc. in water: **0,00018 µg/l**	See paragraph 2.4. (below) and the RAR[1]
MAC-QS	**1,4 µg/l**	Accounting for transient concentration peaks (see paragraph 2.2., below) and the RAR[1]

1. *In the WFD, the QS that refers to the prevention of secondary poisoning of top predators in the marine environment is applied as the overall QS for coastal and territorial waters.*

2. Explanation to the Quality standards deduced by the EU

2.1. Seawater

As 3 long-term toxicity tests representing 3 trophic levels are available the appropriate assessment factor (AF) is 100 and this AF is applied to the NOEC of the most sensitive species (*Daphnia magna,* 21 day NOEC, 5,3 µg/l):

$QS_{saltwater}$ = 0,053 µg Penta-BDE /l

(See the European Union Risk Assessment Report (RAR)[1]).

2.2. Accounting for transient concentration peaks

The MAC-QS (Quality Standard Accounting for transient Concentration Peaks) is derived on the basis of the E(L)C50s of 14 µg/l and the guidance given in the TGD (Technical Guidance Document) on the effects assessment for intermittent releases (section 3.3.2 of part II of [2]). The lowest acute toxicity value in the data set selected for risk assessment [1] is an EC50 of 14 µg/l for *Daphnia magna*.

It is suggested in the RAR[1] to use only a reduced assessment factor of 10 (instead of 100). This suggestion is supported by the values of the available NOECs (respectively EC10 for algae) in the data set, which are in the worst case 2 times higher than the proposed MAC-QS.

MAC-QS = 1,4 µg penta-BDE /l

2.3. Sediment

A $PNEC_{sediment}$ of 310 µg pentabromodiphenyl ether /kg sediment (dry weight) based on experimental toxicity data has been calculated in the EU risk assessment [1]. This value is equivalent to 1550 µg/kg standard sediment as defined in the TGD [2]. The PNEC is equivalent to the quality standard for freshwater sediment.

According to the provisions given in the TGD with regard to effects assessment for marine sediment (see section 5.1.6.2 of [3]), an assessment factor of 50 (instead of 10 for freshwater sediment) should be used for the $QS_{sediment}$ derivation as only long term toxicity data for 3 different freshwater species but no information regarding saltwater species is available. Thus:

$QS_{sediment.marine}$ = 62 µg penta-BDE /kg marine sediment (dry weight)

(corresponding to 310 µg/kg standard sediment as defined in the TGD).

2.4. Secondary poisoning of top predators

The relevant $PNEC_{oral}$ identified in the EU risk assessment [1] is 1 mg/kg food of the predator. The $PNEC_{oral}$ is the quality standard for biota tissue with respect to secondary poisoning of top predators as objective of protection.

$QS_{secpois.biota}$ = 1 mg penta-BDE /kg^{-} food (wet weight)

Pentabromodiphenyl ether has been shown to bioconcentrate to a large extent in fish. BCFs in fish between 14,350 and 27,400 have been obtained or calculated for commercial products. Taking into account the precautionary principle it appears justified to use the highest BCF for the calculation of the concentration in water that corresponds to the $QS_{secpois.biota}$.

According to the provisions given in the TGD [2] regarding the assessment of secondary poisoning of top predators, biomagnification factors (BMF) should be taken into account for the calculation of the PEC_{oral} of top predators. The use of default BMFs as proposed in the TGD is recommended, in the RAR, if the bioconcentration factor of the substance concerned exceeds certain levels and measured BMFs are not available (see sections 5.1.4 and 5.1.6.3 of the final report [3] or sections 3.8.3 and 4.4.3 of the TGD [2] for details).

The RAR states that for freshwater environments a BMF_{fish} has to be considered and for marine environments a BMF_{fish} and a $BMF_{predator}$, respectively. For substances with a BCF >5000 the default BMFs (fish and predator) are 10 [2].

The uptake of penta-BDE by fish has been investigated as part of a reproduction study with fish (Holm et al, 1993; full ref. in [1]). Bioaccumulation factors (BAFs - defined as concentration in fish (mg/kg wet weight)/concentration in food (mg/kg wet weight)) of around 16 – 20 have been derived, based on the initial concentration in food. Consequently, 20 is used as BMF_{fish}.

The $QS_{secpois}$ for freshwater and saltwater are thus calculated as follows:

$QS_{secpois.freshwater}$ = 1 [mg/kg] / 27400 [kg/l] * BMF_{fish} (20) = 0,0018 µg penta-BDE /l

$QS_{secpois.saltwater}$ = 1 [mg/kg] / 27400 [kg/l] * BMF_{fish} (20) * $BMF_{predator}$ (10) = 0,00018 µg penta-BDE /l

Thus, protection of top predators from secondary poisoning requires by far lower quality standards than the protection of the aquatic communities.

This is based on the following theory (quoted from the TGD [2]):

"1. *risks to marine fish:* No specific calculation needs to be performed for estimating the risk to marine fish as this is covered by the risk assessment for aquatic organisms.

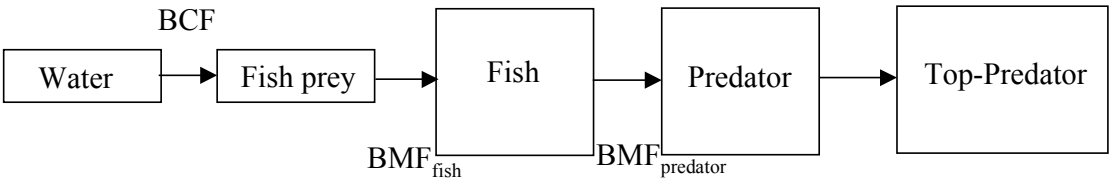
2. *risks to marine predators:* The risk to marine predators is calculated as the ratio between the concentration in their food (marine fish) and the no-effect concentration for oral intake (PNECoralpredator). *The concentration in the marine fish (Cfish) is obtained from bioconcentration of the substance from the aqueous phase and (for very hydrophobic substances) as a result of bioaccumulation from the food the fish consumes (which consists of different types of aquatic organisms). Therefore, both a bioconcentration factor (BCF) and a biomagnification factor (BMF1) are used to calculate Cfish. Note that for the BCFfish also information for other organisms such as mussels may be considered*.

3. *risks to marine top predators*: The risk to marine top-predators is calculated as the ratio between the concentration in their food (marine predators) and the no-effect concentration for oral intake (PNECoraltop predator). Since very hydrophobic substances may biomagnify in the tissue and organs of the predator, for the calculation of the internal concentration of the predator an additional biomagnification factor (BMF2) must be applied. Note that no additional BMF factor for the top predator itself is required since the comparison between PECoral and PNECoral is not based on internal concentrations but on intake rates."

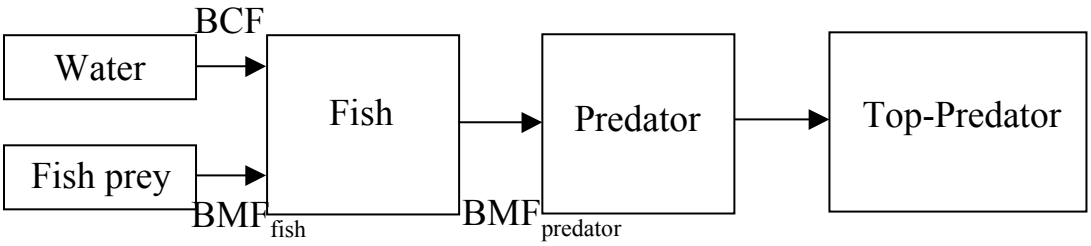
For the above formula for calculation of **$QS_{secpois.saltwater}$** to make sense, clearly the BCF must apply to the accumulation of Penta-PBDE from water to the prey of the fish (and that bioconcentration from water to the fish itself is assumed to be of less importance). The formula is written on the form:

$PEC_{oral\ topp\text{-}predator} = PEC_{water} * BCF_{fish} * BMF_{fish} * BMF_{predator}$

and this would apply to a food chain like:



and <u>not</u>:



because then BCF and BMF_{fish} would not be multiplied.

3. Translating EU Quality standards to OSPAR EACs

OSPAR EACs are given as concentrations in water, sediment, fish, and mussel[4]. For penta-BDE, no EACs are yet given from OSPAR. Suggestions for how to estimate such from the WFD QSs, according to the methodology described in Chapter 2.4, are given in the following:

3.1. Water

The lower EAC for water corresponds to the QS from the WFD and can be calculated without secondary poisoning taken into account:

Lower EACwater(1)= 0,053 µg/l

When secondary poisoning *is* taken into account, the value becomes:

Lower EACwater(2)= 0,00018 µg/l

An upper EAC for water will correspond to the WFD MAC-QS (see paragraph 2.2. above).
Secondary poisoning is not taken into account when setting the upper EAC:

Upper EAC_{water} = 1,4 µg/l

3.2. Sediment

In the case of Penta-BDE, sediment toxicity data were available and the standard for marine sediment was used to calculate a QS sediment of 62 µg/kg dry wt; normalised to 310 µg/kg dry wt for standard sediment as defined in the TGD.

The lower EAC for marine sediment corresponds to the QS from the WFD and can be calculated without secondary poisoning taken into account:

lower $EAC_{sediment\ (1)}$ = 310 µg/kg dry wt (standard sediment)

The WFD derives quality standards for sediment from quality standards for water, based on equilibrium partitioning coefficients:

$$QS_{sed} = \frac{K_{susp-water}}{RHO_{susp}} \cdot QS_{water} \cdot 1{,}000$$

where $K_{susp\text{-}water} = 13{,}921\ m^3/m^3$
$RHO_{susp} = 1{,}150\ kg/m^3$

Because we have several EAC values, a mechanism is needed to transfer the different EACs to the sediment compartment. Applying a partitioning approach suggests a constant (C) relationship between EAC_{water} and $EAC_{sediment}$:

C = Lower- $EACwater_{(1)}$ / Lower- $EACsediment_{r(1)}$

i.e.

C = 0,053 µg/L / (310 µg/kg dry wt.) = 1,71 *10^{-4} kg dry wt. /L

Thus, the lower EACs for sediment, taking secondary poisoning into account, can be deduced in the same way, using the lower EACs for water with secondary poisoning taken into account:

Lower $EAC_{sediment\ (2)}$ = lower $EAC_{water\ (2)}$ / C

i.e.

Lower $EAC_{sediment\ (2)}$ =0,00018 µg/l / (1,71 *10^{-4} kg dry wt./ L) = 1,1 µg/kg dry wt. standard sediment

An upper EAC for sediment can also be calculated from the constant (C) and the upper EAC for water (corresponding to the EUs MAC-QS):

Upper $EAC_{sediment}$ = Upper EAC_{water} / C

i.e.

Upper $EAC_{sediment}$ = 1,4 µg/l / (1,71 *10^{-4} kg dry wt./L) = 8,2 mg/kg dry wt. standard sediment

3.3. Fish

The BCF used for calculation of $QS_{secpois}$ in the EU risk assessment[1] is 27000 (see paragraph 2.4. above). Using this BCF and the Lower EACwater(1)(corresponding to EUs $QS_{saltwater}$) for calculation of a lower EAC gives (secondary poisoning not taken into account):

Lower $EAC_{biota,\ fish(1)}$ **= $EAC_{Water\ lower\ (1)}$ * BCF_{Fish} *BMF_{Fish}**

Lower $EAC_{biota,fish\ (1)}$ = 0,053 µg Penta-BDE /l * 27000 l/kg * 20 = 28 mg/kg w.w.

Taking secondary poisoning into account (using $QS_{secpois,saltwater}$ in the calculation) gives:

Lower $EAC_{biota,fish\ (2)}$ = 0,00018 µg Penta-BDE /l * 27000 l/kg * 20 = 0,1 mg/kg w.w.

or just:

Lower $EAC_{biota,\ fish\ (2)}$ **= 1 mg/kg / $BMF_{predator}$**

(1 mg/kg is the $PNEC_{oral}$, see paragraph 2.4 above), thus:

Lower $EAC_{fish\ lower\ (2)}$ **= 1 mg/kg / 10 = 0,1 mg/kg w.w.**

To calculate an upper boundary for the EAC_{fish}, according to the methodology described in Chapter 2.4, the following approach can be used:

Upper $EAC_{biota,\ fish\ (1)}$ **= Upper EAC_{water} * BCF_{fish} * BMF_{fish}**

i.e.

Upper $EAC_{biota,fish\ (1)}$ **= 1,4 µg/l * 27000 l/kg * 20 = 756 mg/kg wet wt.**

Note:
In general, the upper EAC values for fish seem exceptionally high. Additional evidence may be needed to ascertain whether these values are not already above critical tissue concentrations. Therefore, upper biota values (concentration in fish) should be regarded as provisional.

For substances with a high bioaccumulation potential, the lower EAC could in this case be defined by the $EAC_{biota(2)}$ calculated for secondary poisoning and the upper EAC defined by the $EAC_{biota\ (1)}$, calculated on the basis of the Lower EAC_{water}.

3.4 Mussel

The BCF_{fish} is used for the accumulation of penta-BDE from water to the fish prey (see above). Mussel may be considered as a bioconcentrating organism at the trophic level below fish. Therefore:

(not taking secondary poisoning into account):

Lower $EAC_{biota,mussel\ (1)}$ = BCF_{fish} * Lower $EAC_{water\ (1)}$

Lower $EAC_{biota,mussel\ (1)}$ **= 27000 l/kg * 0,053 µg Penta-BDE /l = 1,4 mg/kg wet wt.**

Taking secondary poisoning into account (using $QS_{secpois.saltwater}$ in the calculation) gives:

Lower $EAC_{biota,mussel\ (2)}$ = 27000 l/kg * 0,00018 µg Penta-BDE /l = 0,005 mg/kg wet wt.

or calculated directly from the $PNEC_{oral}$, BMF_{fish} and $BMF_{predator}$ (see paragraph 2.4. (above) and the RAR[1]):

Lower $EAC_{biota,mussel\ (2)}$ = 1 mg/kg / (20 * 10) = 0,005 mg/kg wet wt.

To calculate an upper boundary for the EAC_{mussel}, according to the methodology described in Chapter 2, the following approach can be used:

Upper $EAC_{biota,mussel\ (1)}$ = BCF_{fish} * Upper EAC_{water}
i.e.

Upper $EAC_{biota,mussel\ (1)}$ = 27000 l/kg * 1,4 µg/l = 38 mg/kg wet wt.

Note:
In general, the upper EAC values for mussel seem rather high. Additional evidence may be needed to ascertain whether these values are not already above critical tissue concentrations. Therefore, upper biota values (concentration in mussel) should be regarded as provisional.

For substances with a high bioaccumulation potential, the lower EAC could in this case be defined by the $EAC_{biota(2)}$ calculated for secondary poisoning and the upper EAC defined by the $EAC_{biota\ (1)}$, calculated on the basis of the Lower EAC_{water}.

4. References

[1] European Union Risk Assessment Report: DIPHENYL ETHER, PENTABROMO DERIVATIVE (PENTABROMODIPHENYL ETHER) CAS No.: 32534-81-9, final report, Luxembourg: Office for Official Publications of the European Communities, 2000, ISBN 92-894-0479-5.

[2] Technical Guidance Document on Risk Assessment in Support of Commission Directive 93/67/EEC on Risk Assessment for New Notified Substances and Commission Regulation (EC) No 1488/94 on Risk Assessment for Existing Substances and Directive 98/8/EC of the European Parliament and the Council Concerning the placing of biocidal products on the market. Part II. Draft version of February 2002 sent out to the Member States for final comments.

[3] Final Report of the Study: Identification of quality standards for priority substances in the field of water policy. Towards the Derivation of Quality Standards for Priority Substances in the Context of the Water Framework Directive.

[4] Report of the third OSPAR workshop on Ecotoxicological Assessment Criteria. The Hague: 25-29 November 1996.

Appendix 7.4: Priority actions: time needed and time frame for update and addition of relevant substances

In order to finalise this update of EACs, ASMO should be invited to consider what arrangements should be made for the following further work:

1. In order to facilitate the finalisation of the update of relevant EACs in time for their use in the forthcoming assessment of CEMP data, to develop draft updated EACs for CEMP substances only using the updated methodology based upon;

   i. the data used by the 1996 EAC workshop;

   ii. available data from ESR RAR reports; and

   iii. fact sheets for Water Framework Directive priority substances, where available.

   This would need 4-5 people familiar with the updated method to carry out preparatory work of 2 days each and to attend a 3 day meeting to finalise the update. (At SIME is proposed to do the further work following a written procedure under MIG).

2. Development of draft updated EACs using the updated methodology for an expanded group of substances on the OSPAR List of Chemicals for Priority Action (possibly those for which monitoring in the marine environment is required following the development of monitoring strategies) subject to the availability of data in EU Existing Substance Regulation RARs or Water Framework Directive fact sheets.

3. A review of the updated EACs by an appropriate ICES working group e.g. The Working Group on the Biological Effects of Contaminants (WGBEC).

4. Contracting Parties should be invited to consider whether they are able to provide resources either to lead or to contribute to this work.

Annex 8: Links to Presentations

Copies of the PowerPoint presentations are provided as individual Appendices 8.1 to 8.8 of this report as detailed:

Appendix 8.1: European Marine Strategy, A European Approach to Marine Protection by Ben van de Wetering (European Commission)

Appendix 8.2: Setting Targets BRCs by Remi Laane

Appendix 8.3: Background Reference Concentrations for trace metals: Problems and perspective by Geoff Millward

Appendix 8.4: Gain-size and contaminants in sediments by Foppe Smedes

Appendix 8.5: Determination of EAC for the Water Compartment. OSPAR Methodology, WFD and TGD Methodology by Chrystèle Tissier

Appendix 8.6: Derivation of Ecotoxicological Assessment Criteria for sediment: a Review by Chrystèle Tissier

Appendix 8.7: Approaches for deriving EACs biota by Janny Pijnenburg (talk given by T Traas)

Appendix 8.8: Effective Environmental Standards by Rob Fryer

Appendix 8.1: European Marine Strategy, A European Approach to Marine Protection

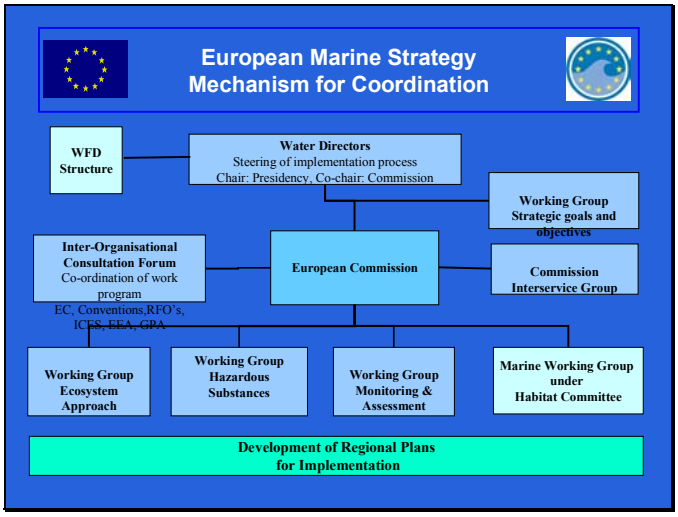
Ben van de Wetering

Slide 1

Slide 2

Slide 3

Slide 4



Slide 5

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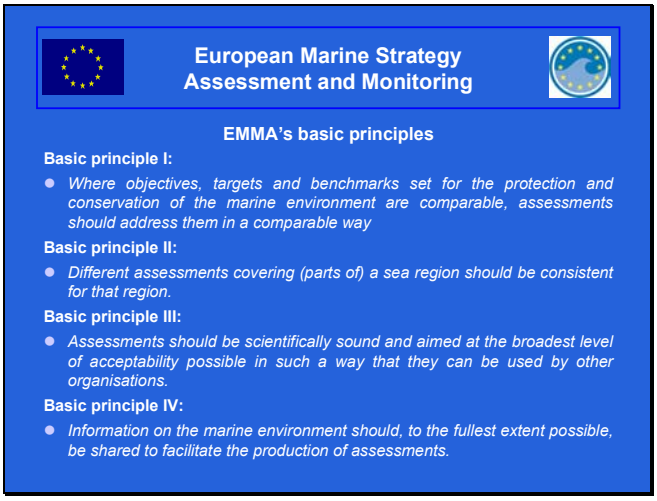
Slide 7



Slide 8

Appendix 8.2: Setting Targets BRCs

Remi Laane

Slide 1

Setting Targets BRCs

R. Laane

Slide 2

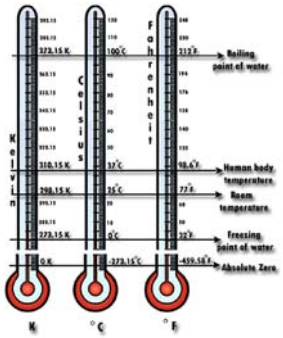
Evaluation & Update

- 1992: International workshop on concentrations of natural compounds (The Hague)
- 1996: OSPAR-ICES workshop on background/reference concentration for nutrients and for contaminants in seawater, biota and sediments (Hamburg)
- New literature, results, ideas, models, methodologies, ……

Slide 3

Anders Celsius (1701-1744)

1644-1710 Ole Roemer
scale of 60º
1686-1736 G. Fahrenheit
1741: scale A. Celsius
0 boiling point



Slide 4

Targets

- Scientific bone
  - Fahrenheit (1686-1736): alcohol, closed tube negative numbers, zero (coldest mixture ice, NaCl and NH_4Cl)
  - Ole Roemer (scaling and presentation)
  - Lord Kelvin (energy of atoms and molecules)
- Different approaches
- Change in time

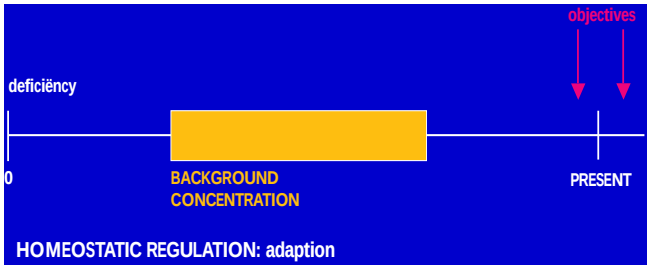
Slide 5

Background reference concentrations (definition)

- Background (fresh and marine)
  - 1992: no human impact (metals, radionuclides, nutrients, PAHs, dioxines)
    - Historical trends (cores and 'old' data)
    - Samples from pristine areas
    - Equilibrium and steady state models
    - Extrapolation and statistical models
  - Broad, generic ranges
    - Nearly no geographical differentiation

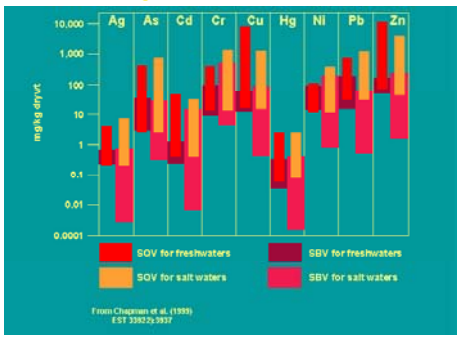
Slide 6

Yardstick for natural compounds



Slide 7

Quality values



Slide 8

- Background/Reference
  - 1996: Background concentration (all compounds)
    - Geological times
    - Historical times
    - Pristine areas
  - Metals, nutrients, radionuclides and organic compounds (PAHs and e.g. PCBs)
  - Agreement with results 1992
  - Additional data: marine and coastal sediments (Me/Al ratio)

Slide 9

1992 – 1996 – 2004
"new subjects"

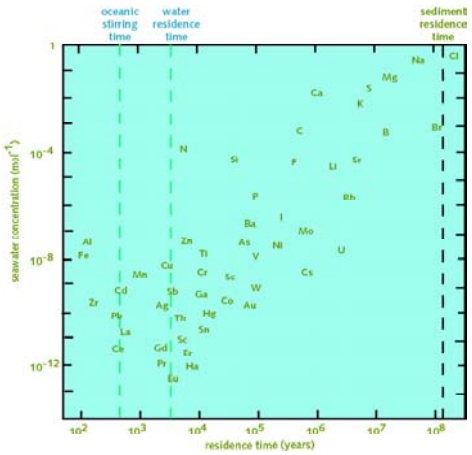
- Speciation

New data from

- Historical data (different EU projects)
- Geological data
- Different models

Link between BRC and EAC

Slide 10

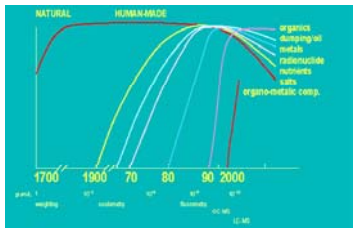


Different residence times of metals in sea water

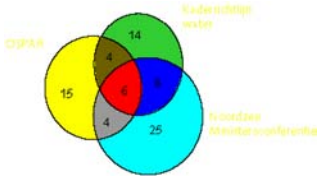
Slide 11

Compounds Selection?

150.000 compounds
Few Priority compounds



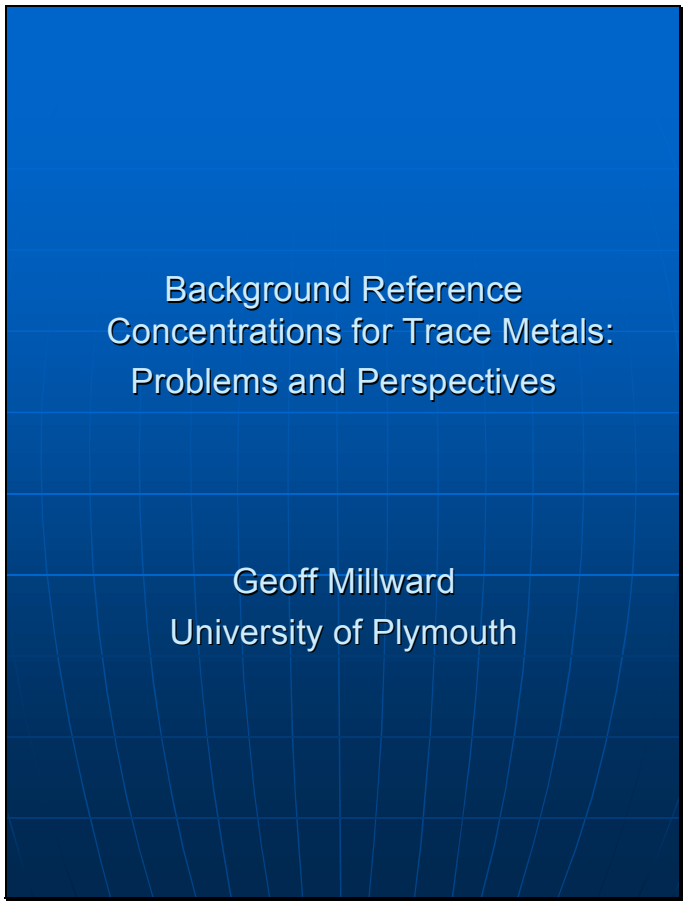
Only 250 toxicological targets
Overlap of 6 compounds
Detection of all compounds possible



Appendix 8.3: Background Reference Concentrations for Trace Metals: Problems and Perspectives

Geoff Millward

Slide 1



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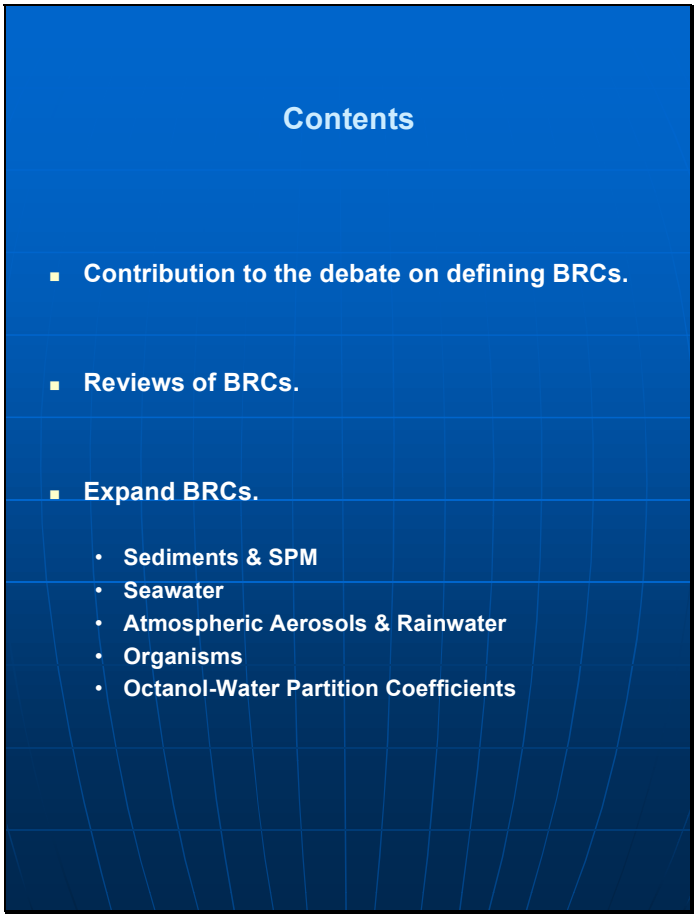

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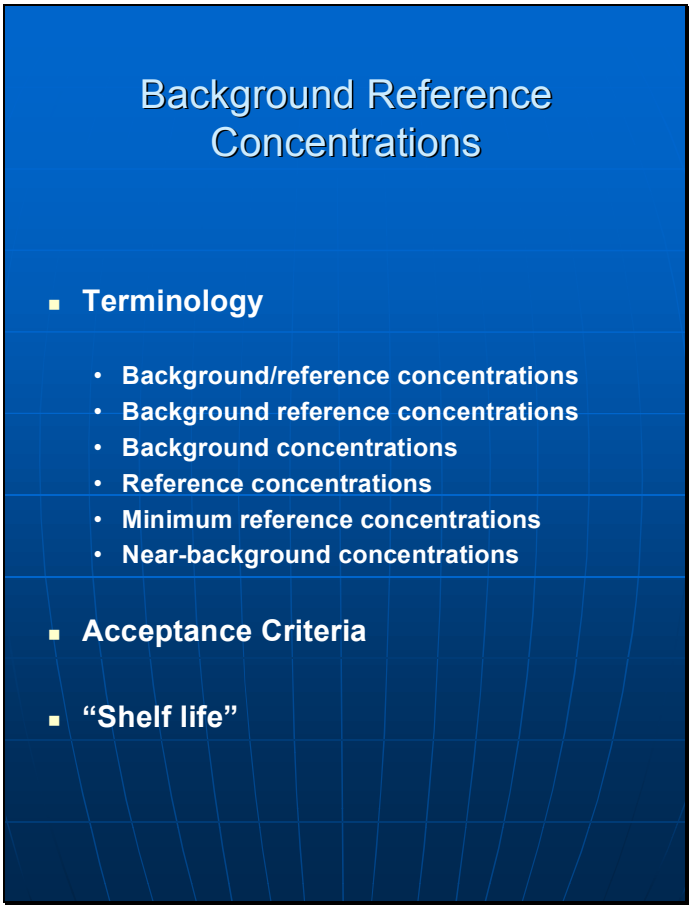

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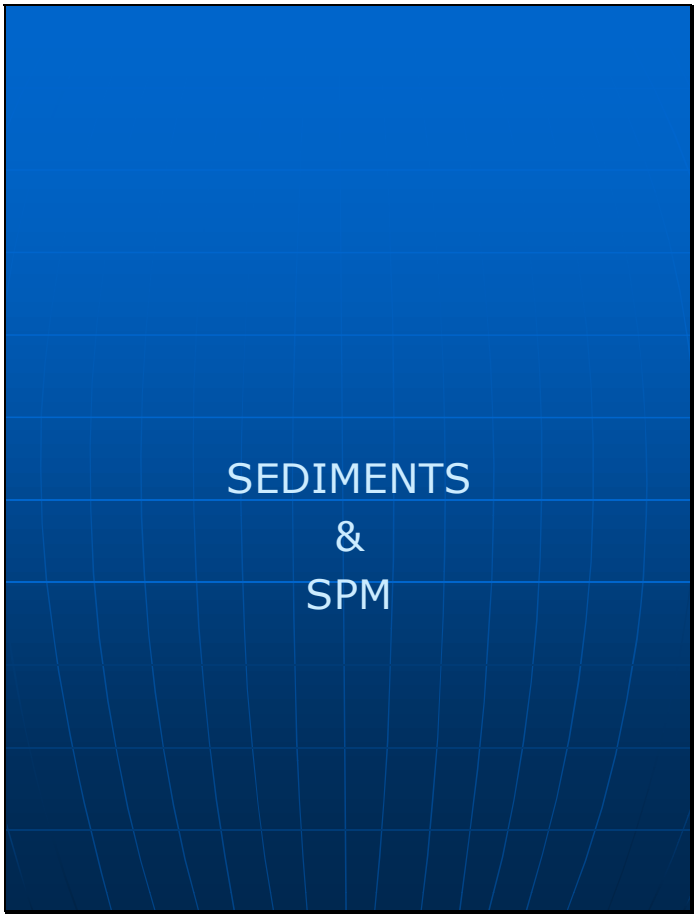

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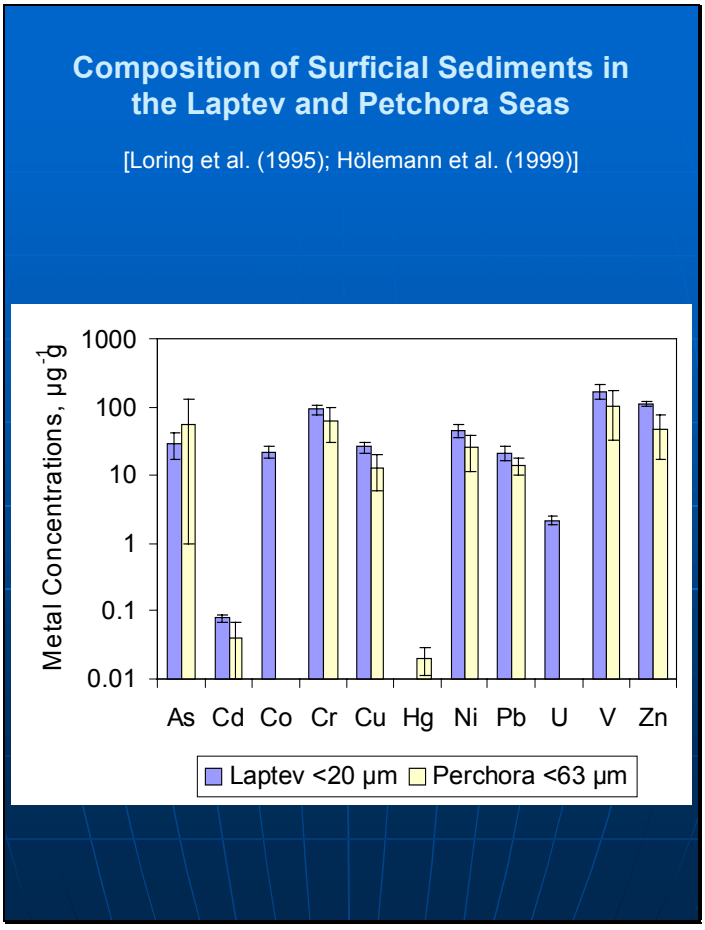


Slide 6

Mean Metal Concentrations and Metal/Al Ratios

Sea	Mean Al Conc. µg g^{-1}	Cu Conc. µg g^{-1}	Cu Cu/Al x10^{-4}	Zn Conc. µg g^{-1}	Zn Zn/Al x10^{-4}
Petchora	46,700	13	3.8	47	1.6
Laptev	68,439	26	2.8	111	1.0

Slide 7

Intrinsic Flaws of Element Enrichment Factors (EFs) in Environmental Geochemistry

[C. Reimann & P de Caritat (2000)]

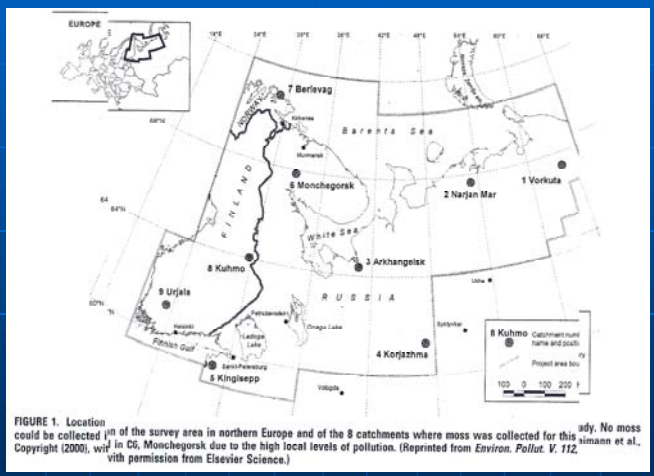


FIGURE 1. Location of the survey area in northern Europe and of the 8 catchments where moss was collected for this study. No moss could be collected in C6, Monchegorsk due to the high local levels of pollution. (Reprinted from *Environ. Pollut. V. 112*, Copyright (2000), with permission from Elsevier Science.)

Slide 8

Intrinsic Flaws of Element Enrichment Factors (EFs) in Environmental Geochemistry

[C. Reimann & P de Caritat (2000)]

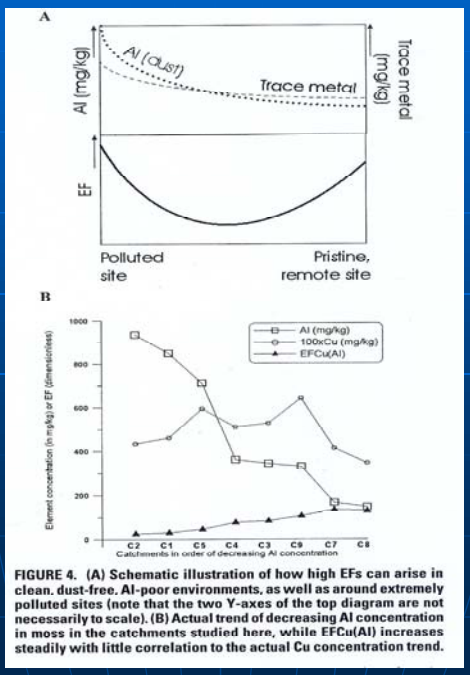


FIGURE 4. (A) Schematic illustration of how high EFs can arise in clean, dust-free, Al-poor environments, as well as around extremely polluted sites (note that the two Y-axes of the top diagram are not necessarily to scale). (B) Actual trend of decreasing Al concentration in moss in the catchments studied here, while EFCu(Al) increases steadily with little correlation to the actual Cu concentration trend.

Slide 9

$^{206/207}$Pb Isotopic Ratios Using High Resolution ICP-MS

- **Industrial Pb emissions**
  - **US** 1.190 - 1.210
  - **Western Europe** 1.115 – 1.135
- **Sources**
  - **Broken Hill (Australia)** ~1.04
  - **Mississippi Valley** ~1.28 – 1.33
  - **European soils** 1.195 – 1.233

Slide 10

Isotopic Tracing of Anthropogenic Pb in the Gulf of Lions (NW Mediterranean Sea)

[Ferrand et al. (1999)]

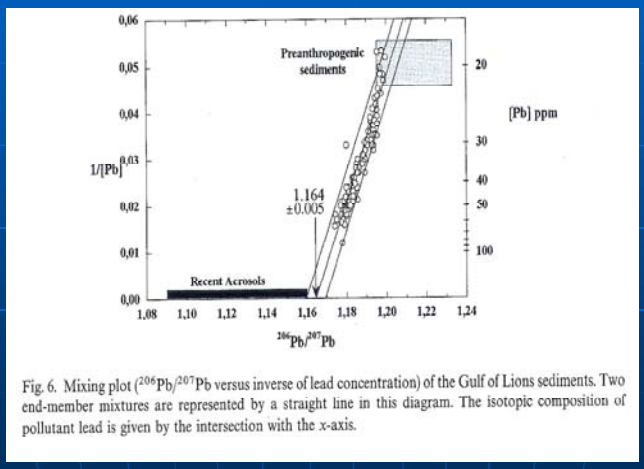
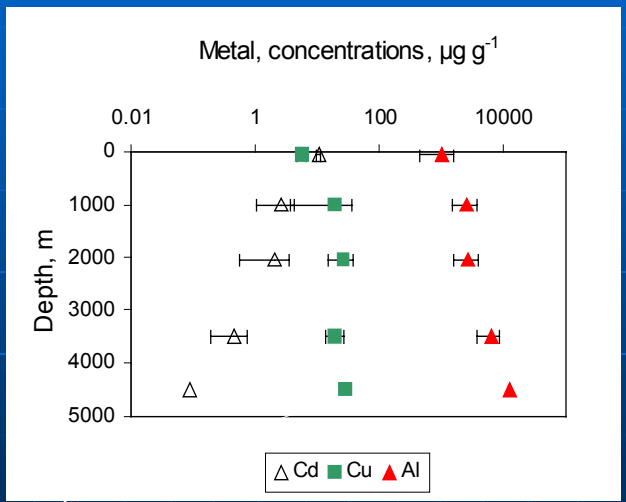


Fig. 6. Mixing plot ($^{206}Pb/^{207}Pb$ versus inverse of lead concentration) of the Gulf of Lions sediments. Two end-member mixtures are represented by a straight line in this diagram. The isotopic composition of pollutant lead is given by the intersection with the x-axis.

Slide 11

Particulate Trace Element (Al, Cd, Co, Cu, Fe, Mn, Ni, Ti, V, Zn) in Sediment Traps: Northeast Atlantic Ocean

[Kuss & Kremling (1999)]



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Slide 12

SEAWATER

Slide 13

Dissolved Lead in the Western North Atlantic Ocean

[Wu & Boyle, (1997)]

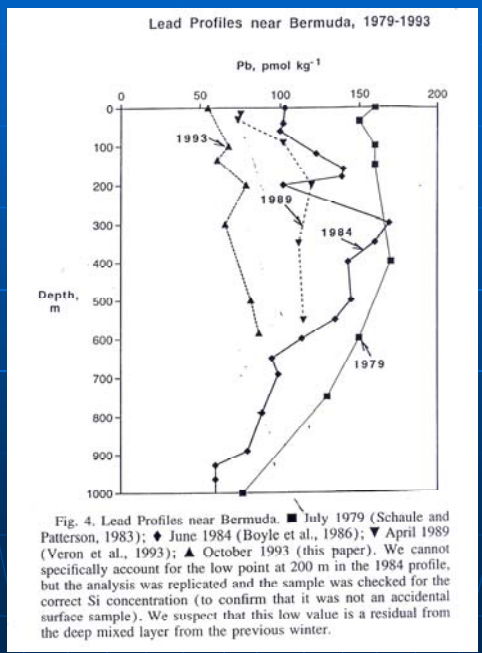
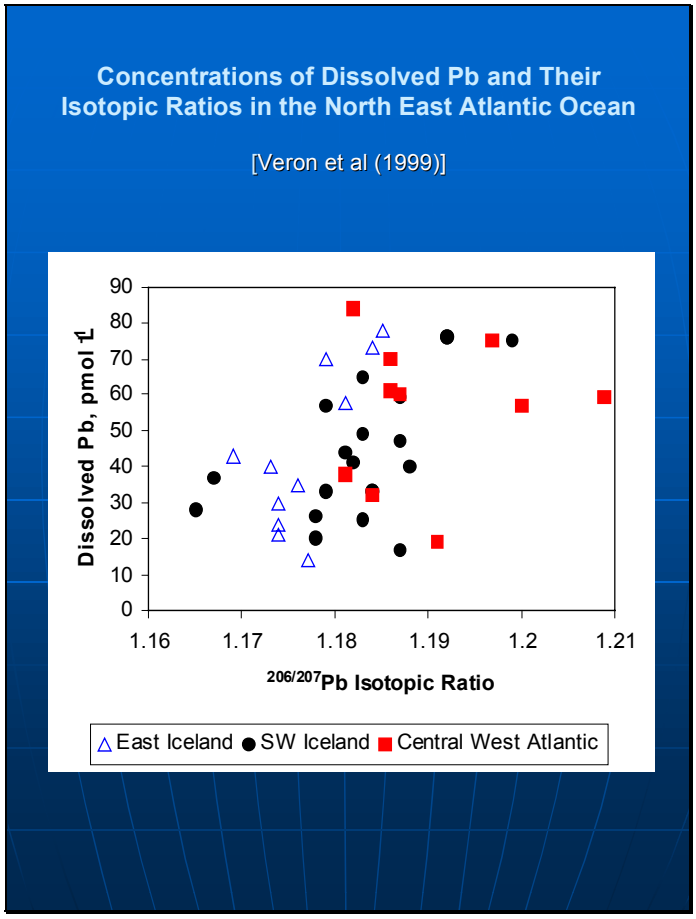
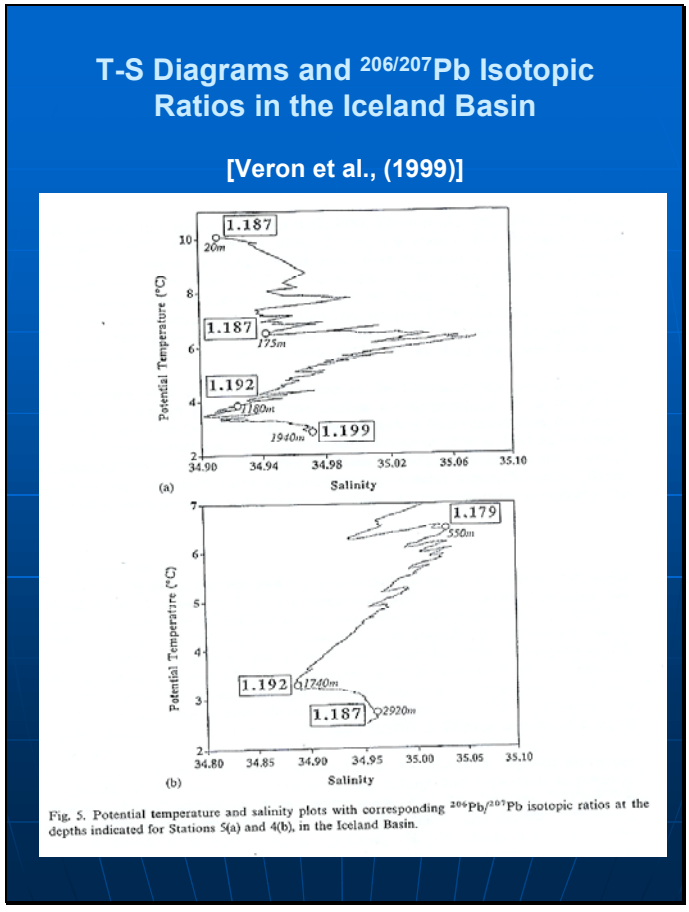


Fig. 4. Lead Profiles near Bermuda. ■ July 1979 (Schaule and Patterson, 1983); ♦ June 1984 (Boyle et al., 1986); ▼ April 1989 (Veron et al., 1993); ▲ October 1993 (this paper). We cannot specifically account for the low point at 200 m in the 1984 profile, but the analysis was replicated and the sample was checked for the correct Si concentration (to confirm that it was not an accidental surface sample). We suspect that this low value is a residual from the deep mixed layer from the previous winter.

Slide 14



Slide 15



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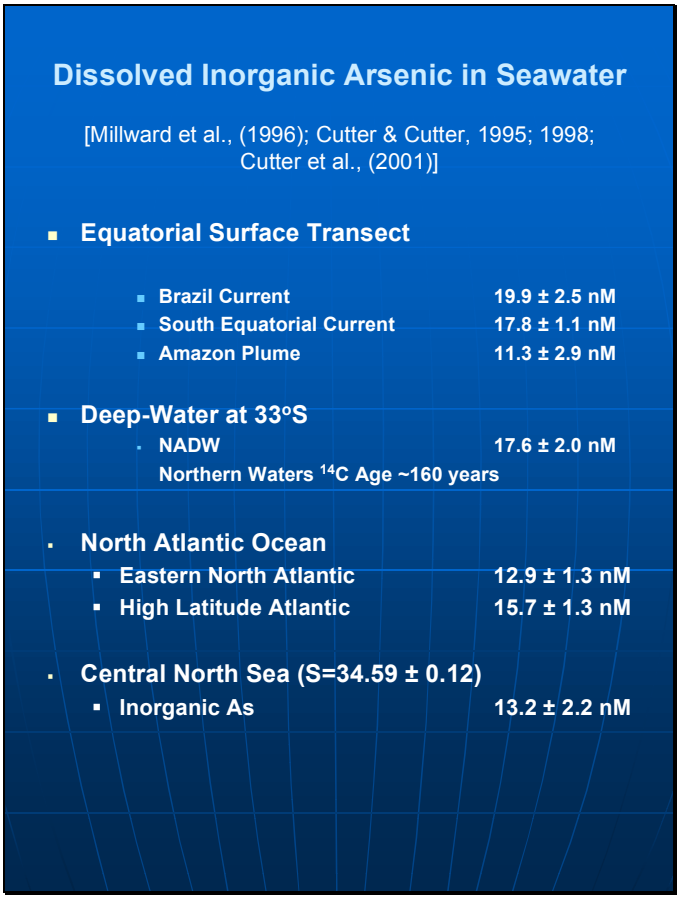

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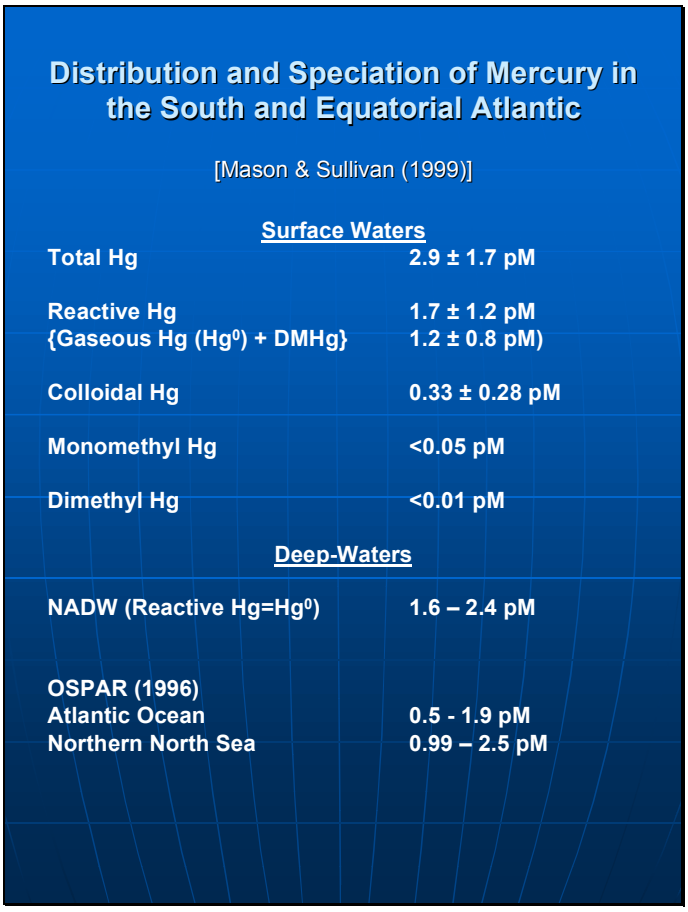


Slide 18

Dissolved Silver in the far North Atlantic Ocean

[Rivera-Duarte et al., (1999)]

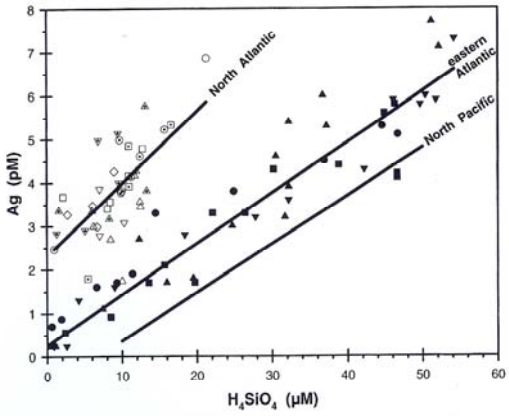
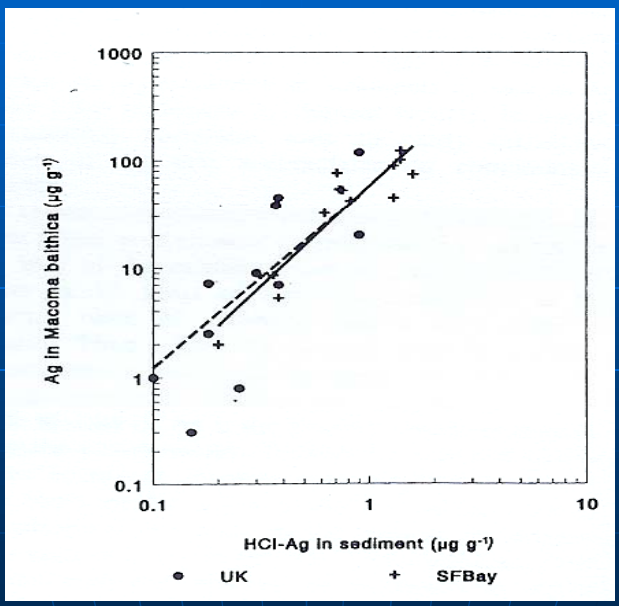


Fig. 4. Simple linear regressions between silver (pM) and silicate (µM) for the North Atlantic, eastern Atlantic (Flegal et al., 1995) and North Pacific (Martin et al., 1983; Flegal et al., 1995). The symbols for the North Atlantic stations are 2 (⊕), 3 (■), 4 (○), 5 (□), 7 (△), 11 (▽), 12 (◇), 13 (triangle up with crosshair) and 14 (triangle down with crosshair). The symbols for the eastern Atlantic stations are 4 (●), 5 (■), 7 (▲) and 9 (◆). Only a regression line is given for the Pacific. The simple linear correlations are: North Atlantic, Ag (pM) = 2.309 + 0.167 × H_4SiO_4 (µM) (R = 0.680) including all samples using averages and Ag (pM) = 2.449 + 0.162 × H_4SiO_4 (µM) (R = 0.733) excluding two statistical outliers, eastern Atlantic (Flegal et al., 1995) Ag (pM) = 0.685 + 0.107 × H_4SiO_4 (µM) (R = 0.916), and North Pacific (Martin et al., 1983; Flegal et al., 1995) Ag (pM) = − 0.691 + 0.111 × H_4SiO_4 (µM) (R = 0.897).

Slide 19

Concentrations of Ag in Tissues of *Macoma balthica* Compared to Ag in Sediment

[Luoma et al., (1995)]



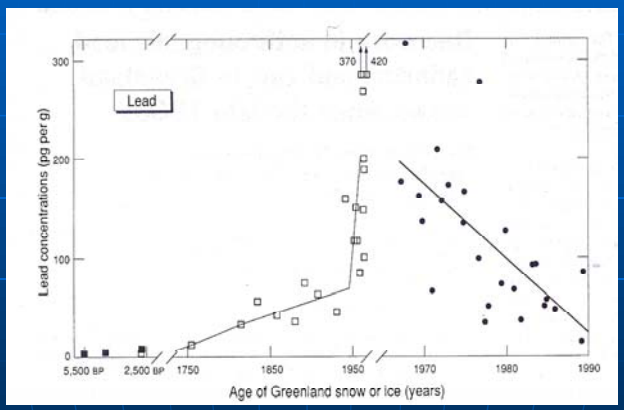
Slide 20

ATMOSPHERIC AEROSOLS
& RAINWATER

Slide 21

Decrease in anthropogenic lead, cadmium and zinc in Greenland snows since the late 1960s

[Boutron etal. (1991) Nature, 353. 153-156.]



Slide 22

Metals in Rainfall at a "Remote" Site

[Church et al., (1990); Halstead et al (2000)]

Location	Concentration, ng L^{-1}				
	Cd	Cu	Mn	Pb	Zn
Antarctica	0.2	2	---	2-7	4
Paradise (NZ)	0.36	13	73	20	38
Paradise (NZ)	$^{206/207}$Pb = 1.086 ± 0.002 (88% pollutant Pb)				
North Atlantic Ocean	29	540	1600	460	1600

Slide 23

Chemical Composition of Atmospheric Aerosols in the European Subarctic

[Virkkula et al. (1999)]

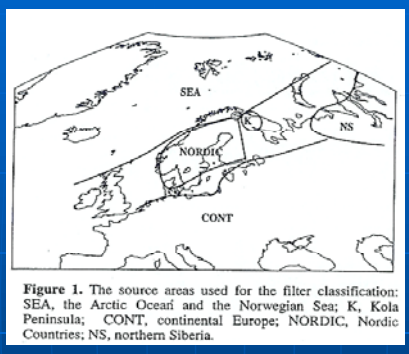
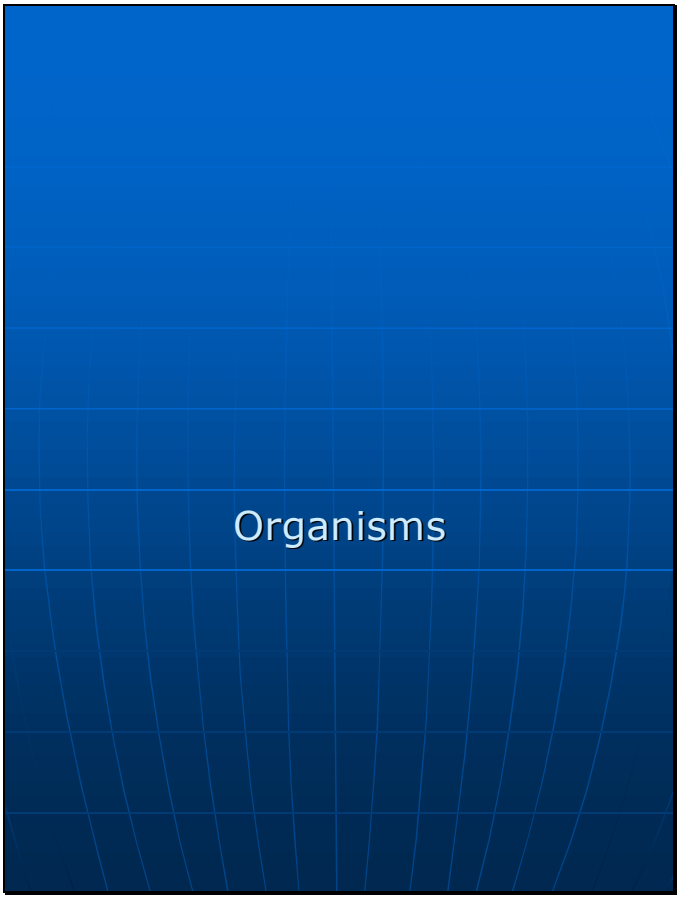


Figure 1. The source areas used for the filter classification: SEA, the Arctic Ocean and the Norwegian Sea; K, Kola Peninsula; CONT, continental Europe; NORDIC, Nordic Countries; NS, northern Siberia.

Metal	Concentration, ng m^{-3} (D<2.5 µm)	Concentration, ng m^{-3} (2.5<D<15 µm)
As	0.055 ± 0.026	0.033 ± 0.009
Cd	0.008 ± 0.008	<0.45
Pb	0.12 ± 0.11	<0.13
Zn	0.51 ± 0.33	0.24 ± 0.12

Slide 24



Slide 25

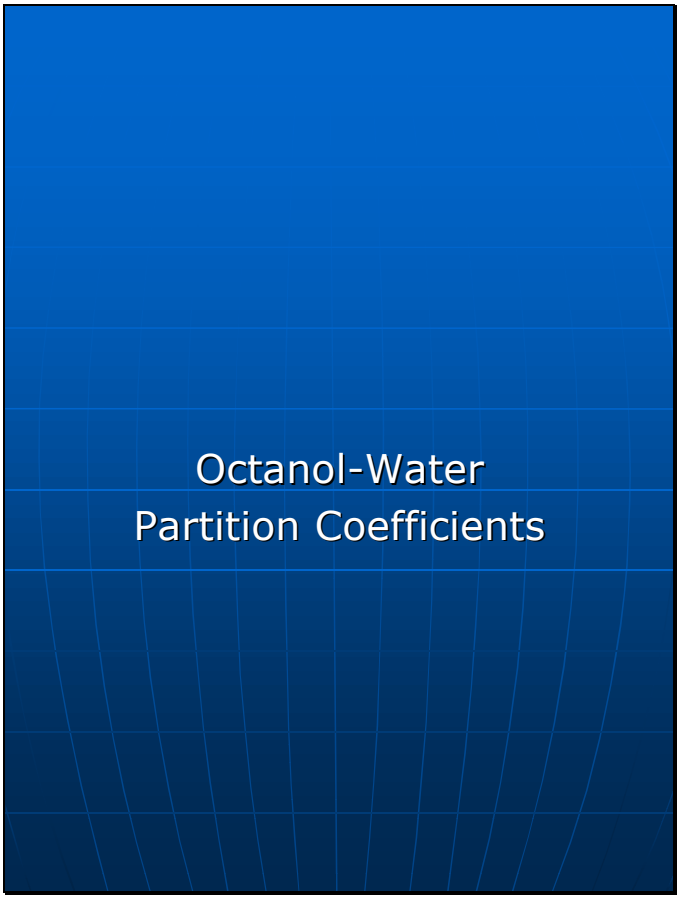
Trace Metals in *Mytilus Edulis*

[Riget et al., (1997); Zauke et al., (2003)]

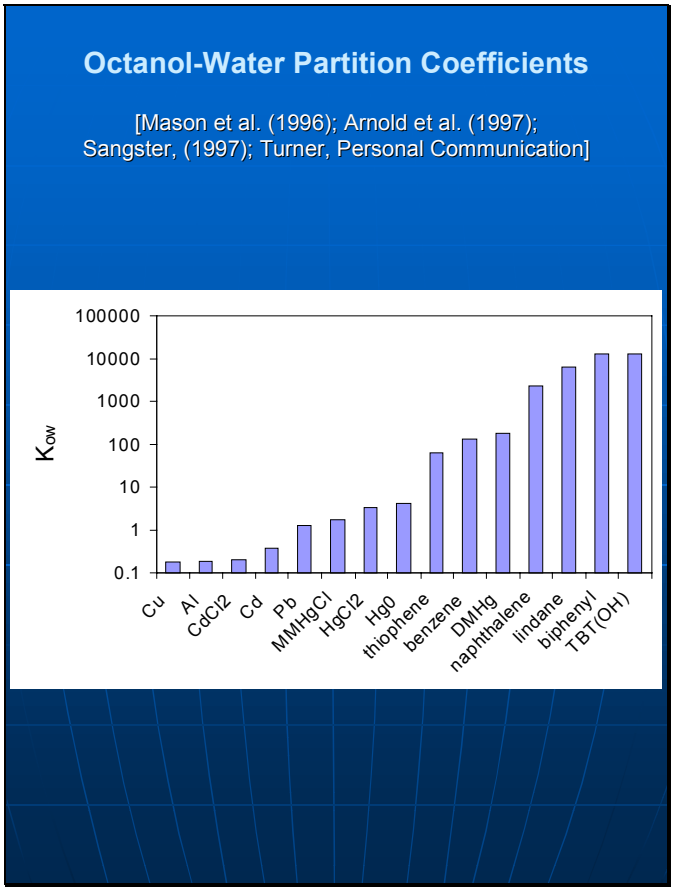
Site	Concentration, µg g^{-1}(dry wt.)				
	Cd	Cu	Pb	Zn	**Ni**
Barents Sea	2.0	8.9	1.6	89	2.9
Shannon	---	7.0	---	88	3.0
WMW	2.0	7.9	5.0	130	2.2

Site	Concentration, µg g^{-1} (wet wt.)			
	Cd	Hg	Pb	**Se**
Greenland 40-50 cm	0.692	0.014	0.072	0.94
Greenland 80-90 cm	1.11	0.016	0.104	0.72
Greenland 80-90 cm	1.09	0.016	0.115	0.53

Slide 26



Slide 27



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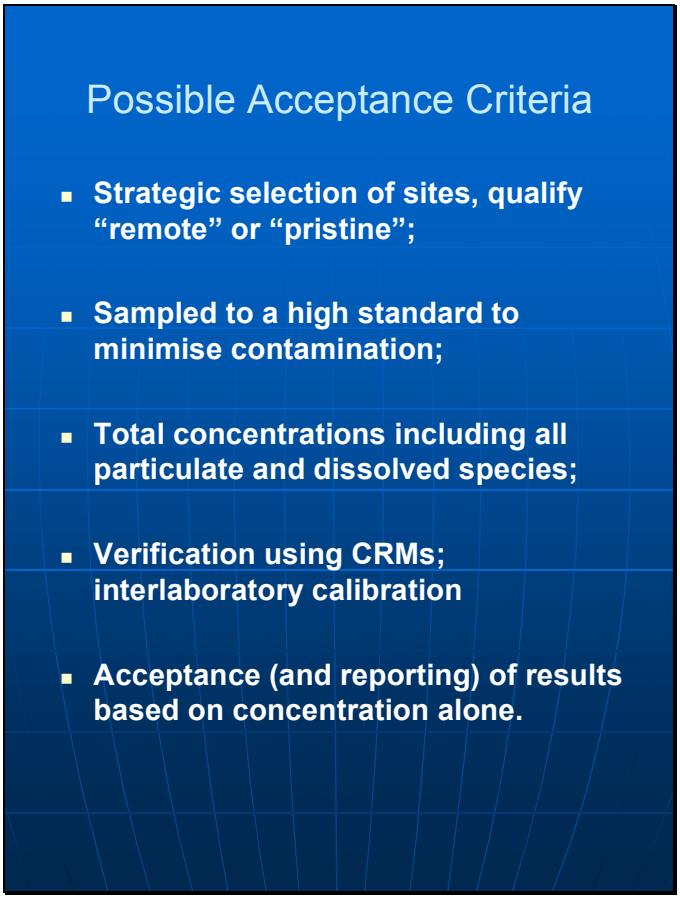

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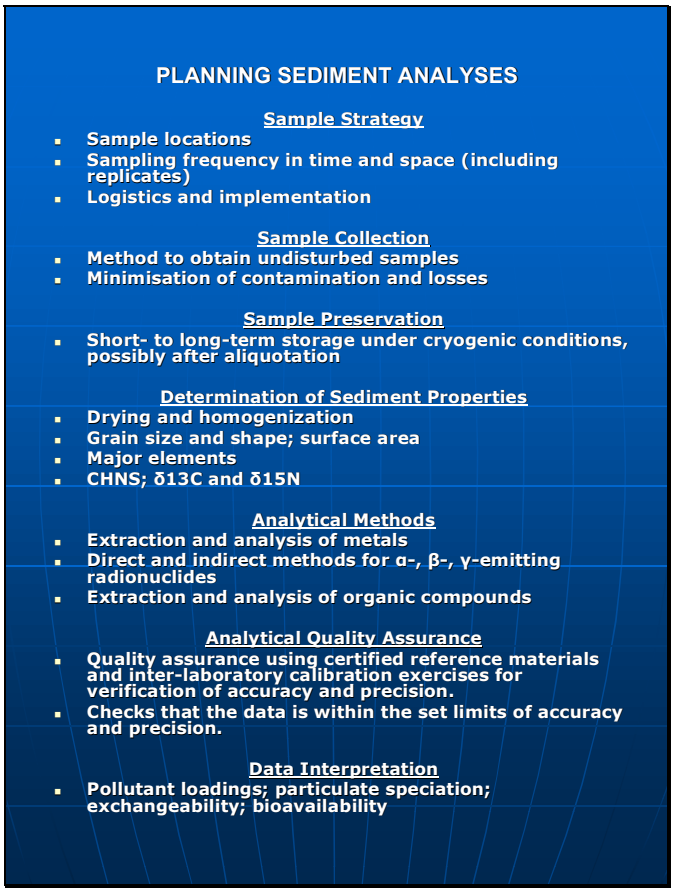


Slide 30

C:N Ratios, $\delta^{13}C$ and $\delta^{15}N$ (by IRMS) for Various Particle Types

[Last and Smol (2002); Graham et al. (2001)]

Particle Type	C:N Ratio	$d^{13}C$ (parts per thousand)	$d^{15}N$ (parts per thousand)
Soil Organic Matter*	12 to 20	-23 to -29	+5
Sediments from Stratified Lakes*	6 to 14	-20 to -33	-2 to +20
Sediments from Forth Estuary, UK**	21.7 ± 6.6	-24.0 ± 0.2	+5.6 ± 0.6
Marine Sediment**	11.3	-23.2	+5.9
Sewage**	12.6	-26.7	+2.3
Micro-phytoplankton**	6.3	-17.2 to -26.5	+0.5 to +8.2

*$d^{13}C = [(^{13}C/^{12}C)_{sample}/(^{13}C/^{12}C)_{PDB} - 1] \times 100$
$d^{15}N = [(^{15}N/^{14}N)_{sample}/(^{15}N/^{14}N)_{air} - 1] \times 100$

The equations give $d^{13}C$ values (per thousand) using Chicago PDB carbonate as the standard and $d^{15}N$ values (per thousand) with atmospheric nitrogen as the standard value.

Slide 31

Dissolved Metals in Water Masses of the North West European Shelf Break

[Le Gall et al., (1999); Veron et al., (1999); *OSPAR/ICES (1996)]

Water Mass	Concentration, ng L^{-1}			
	Pb	Cd	Cu	Ni
LSW (Hebridean Sea)	12.2-15.7	23.5	77.6	24.1
ENAW (Celtic Sea)	---	9.67± 2.59	64.2± 2.54	193 ± 16
Celtic Sea*	10-20	4-12	60-80	120-160

Slide 32

Silver in Sediment Cores

[Luoma et al., (1995)]

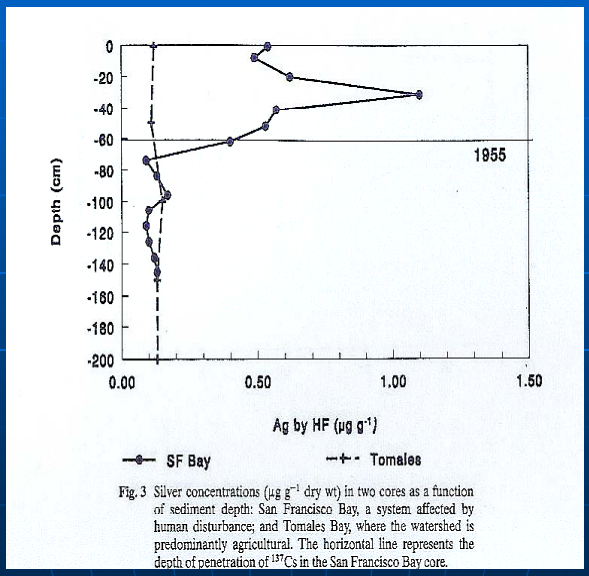


Fig. 3 Silver concentrations (µg g^{-1} dry wt) in two cores as a function of sediment depth: San Francisco Bay, a system affected by human disturbance; and Tomales Bay, where the watershed is predominantly agricultural. The horizontal line represents the depth of penetration of ^{137}Cs in the San Francisco Bay core.

Slide 33

Intrinsic Flaws of Element Enrichment Factors (EFs) in Environmental Geochemistry

[C. Reimann & P de Caritat (2000)]

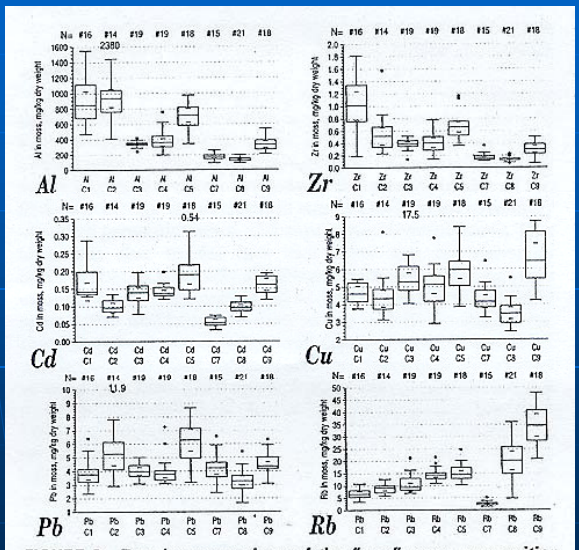


FIGURE 3. Boxplot comparison of the "raw" moss composition data from the 8 catchments for the elements discussed here—note the large local variation for some elements.

Slide 34

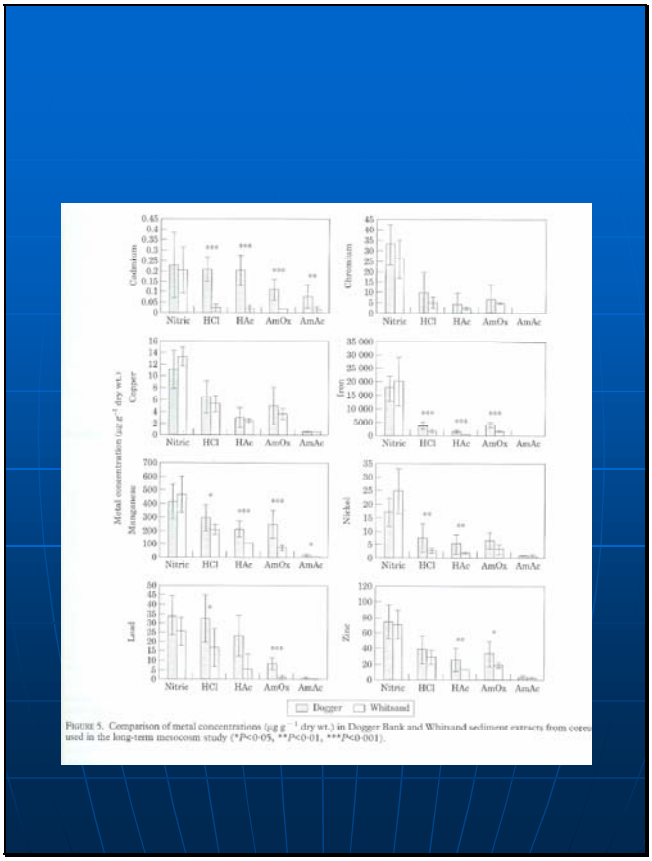
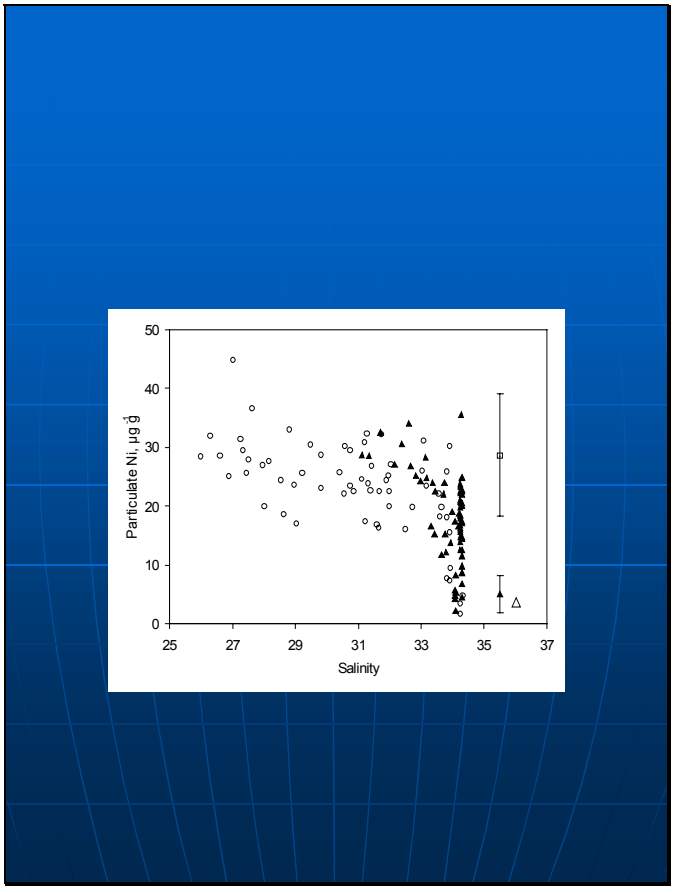
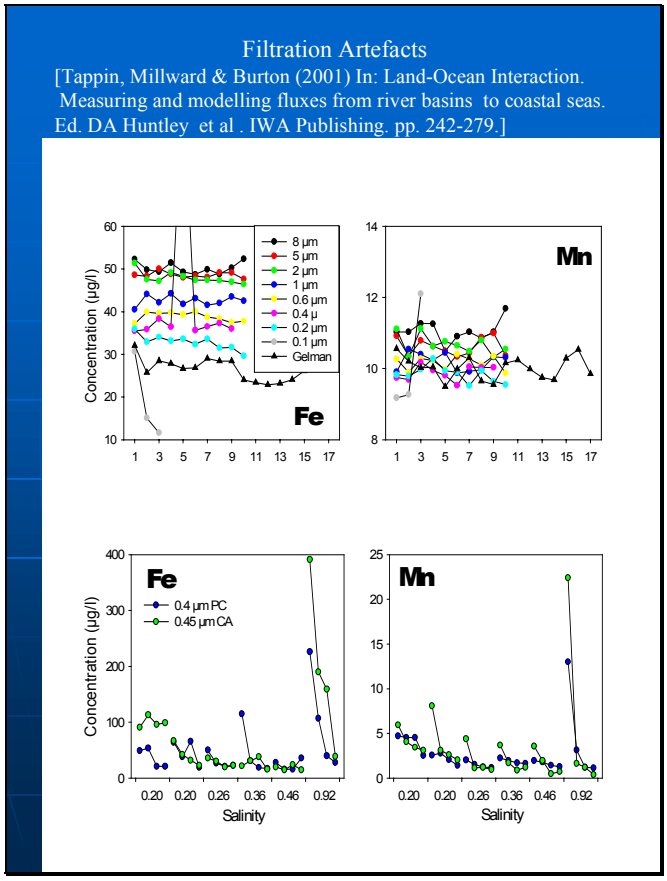


FIGURE 5. Comparison of metal concentrations (μg g^{-1} dry wt.) in Dogger Bank and Whitsand sediment extracts from cores used in the long-term mesocosm study (*P<0·05, **P<0·01, ***P<0·001).

Slide 35



Slide 36



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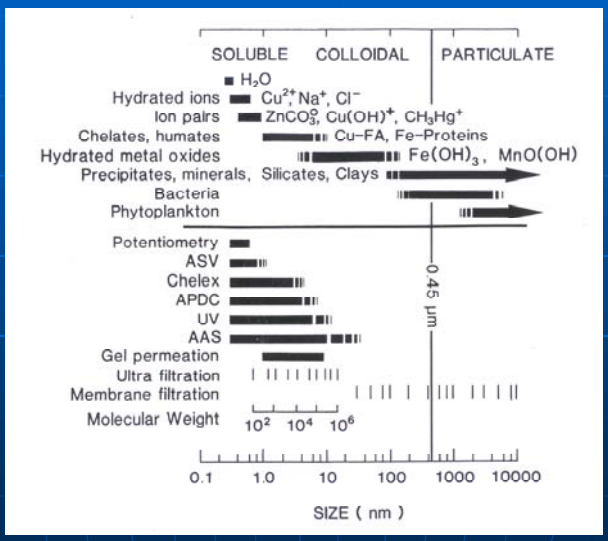


Slide 38

Particulate, Colloidal & Truly Dissolved Metals in the Garronne, France

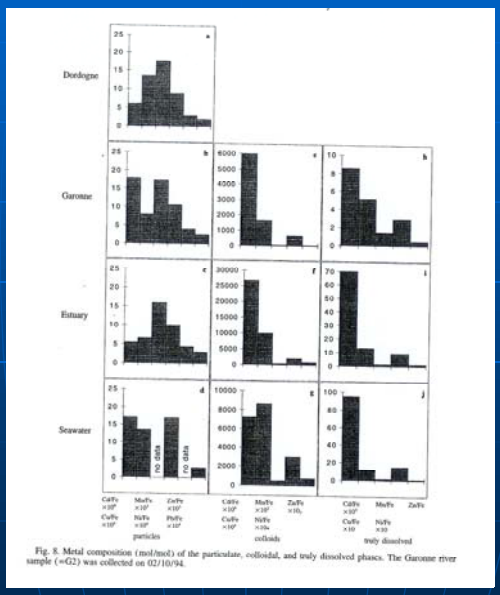


Fig. 8. Metal composition (mol/mol) of the particulate, colloidal, and truly dissolved phases. The Garonne river sample (=G2) was collected on 02/10/94.

Slide 39

Pb Isotopic Ratios in Greenland Snows
[Rosman et al., 1993]

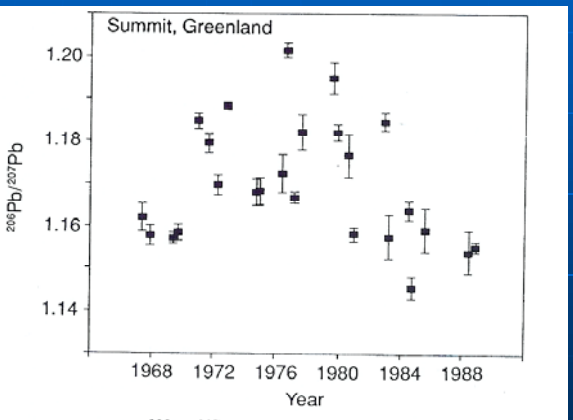
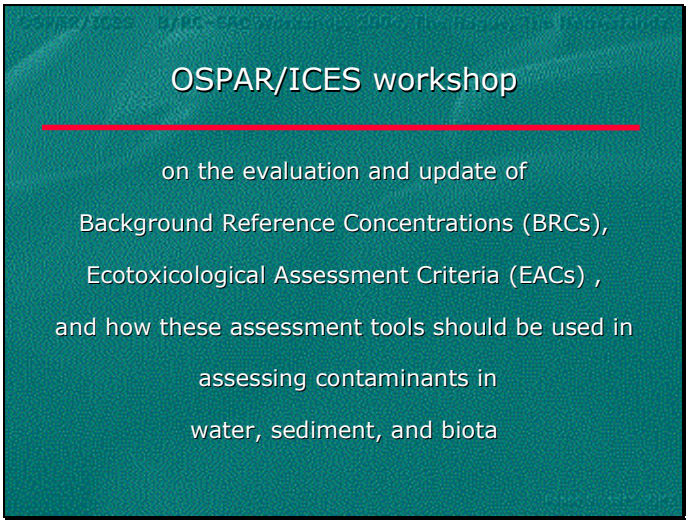


FIG. 1 Changes in the $^{206}Pb/^{207}Pb$ ratio in Greenland snow between 1967 and 1988. The uncertainties given are 95% confidence intervals. The crescent-shaped trend is mainly due to combined changes in both the isotopic composition and the consumption of leaded gasoline in the United States.

Appendix 8.4: Grain size and Contaminants in Sediments

Foppe Smedes

Slide 1



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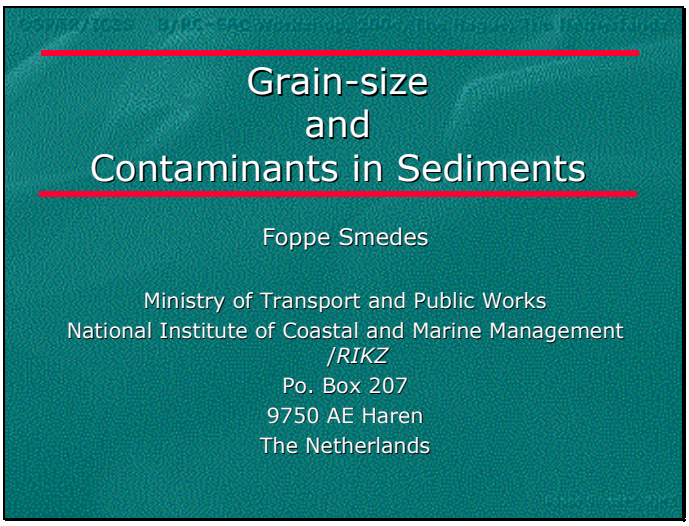

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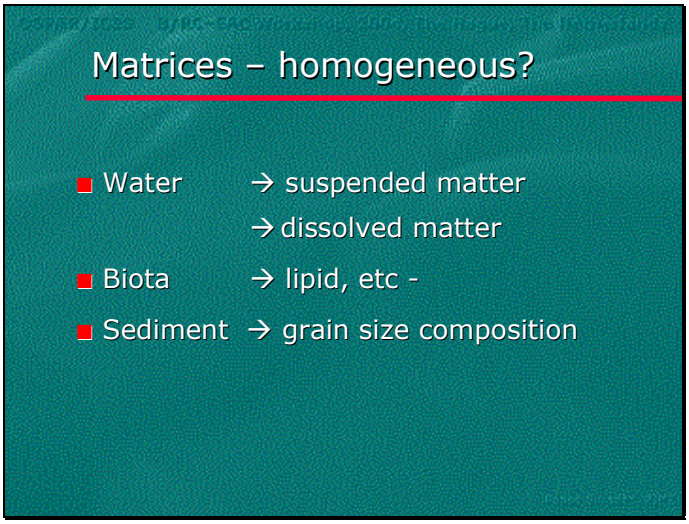

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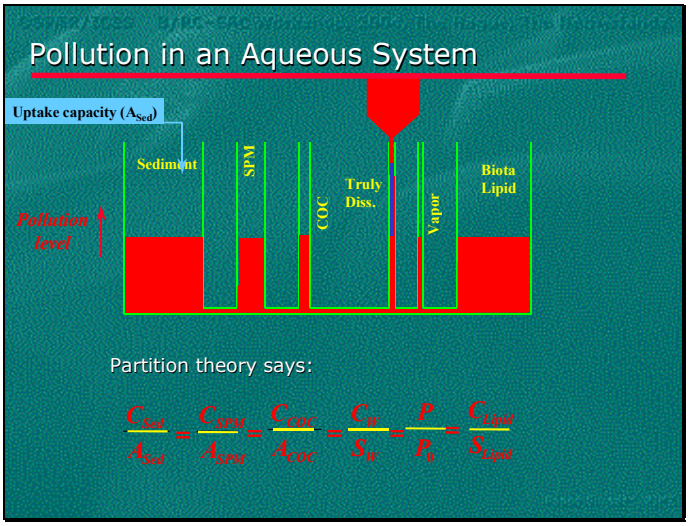

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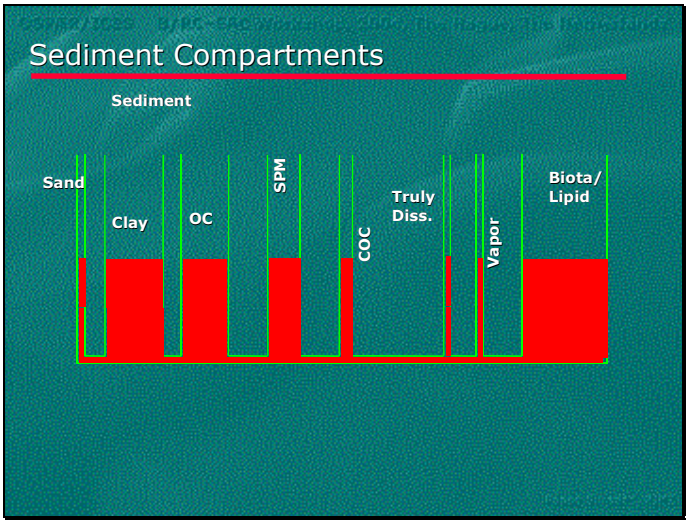

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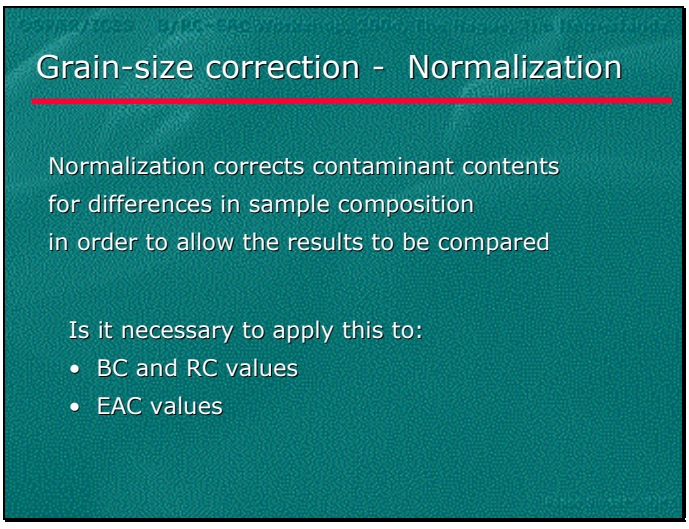

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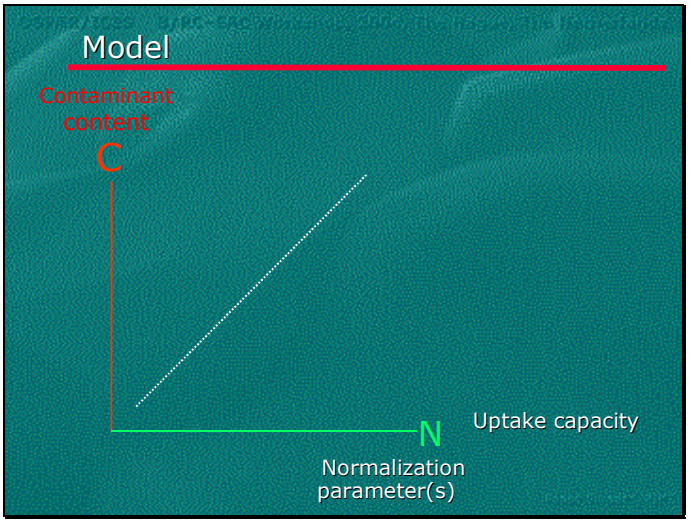

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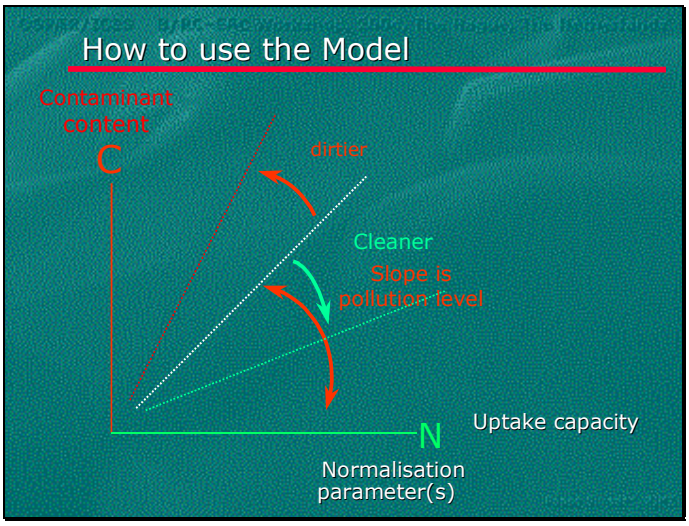

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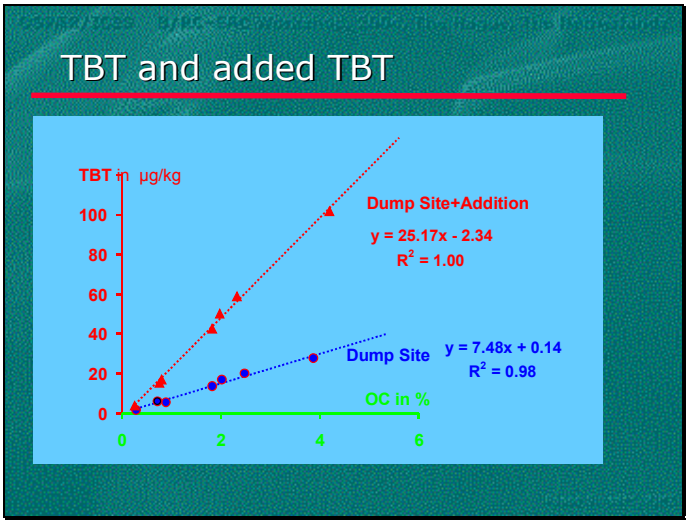

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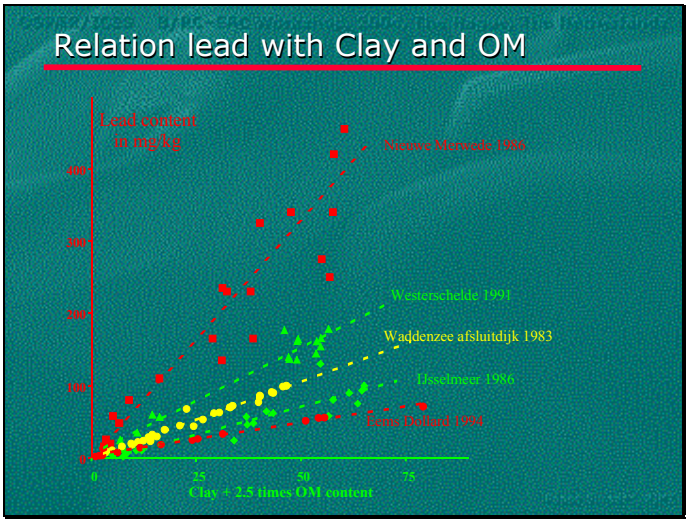

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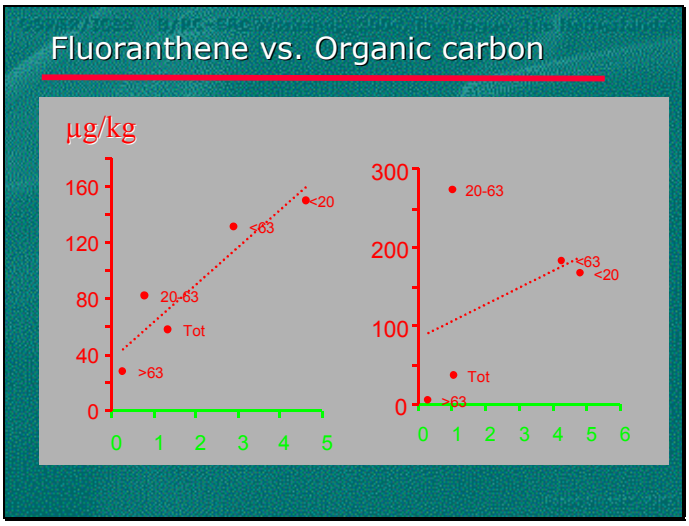

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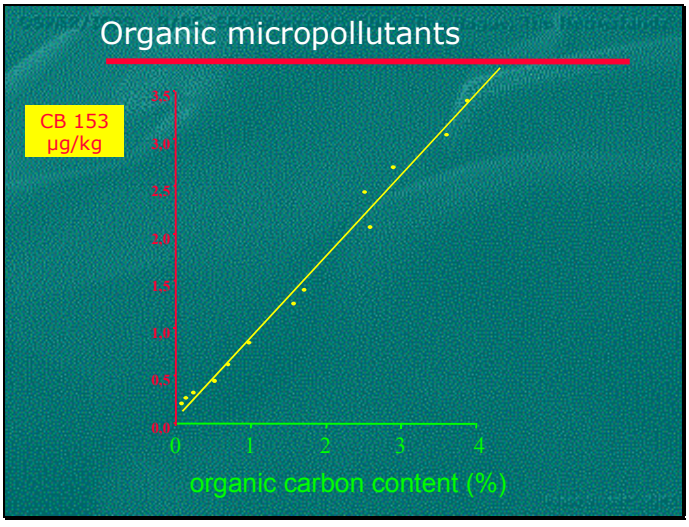

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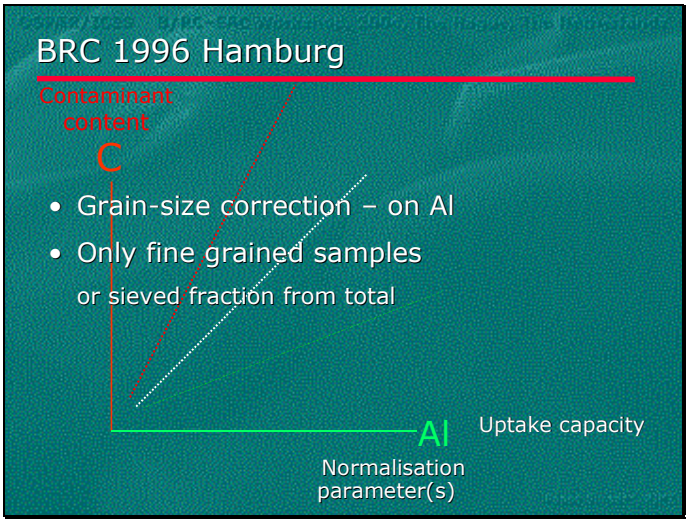

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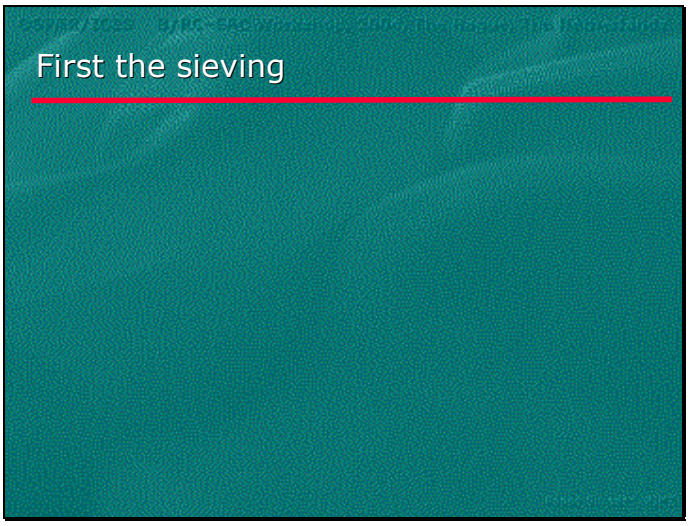

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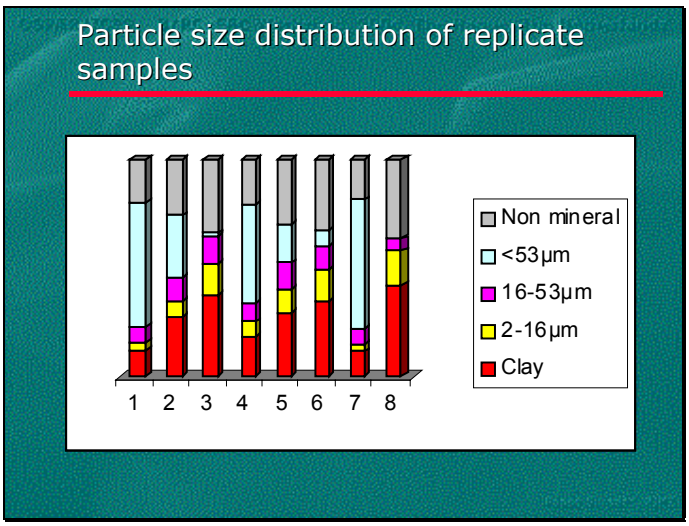

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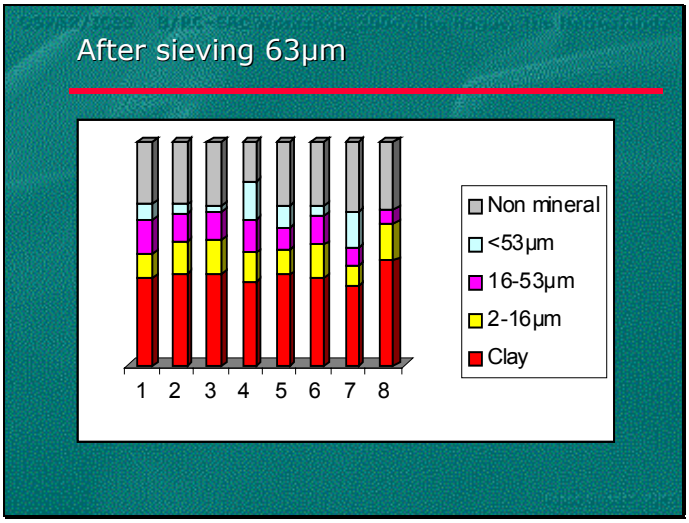

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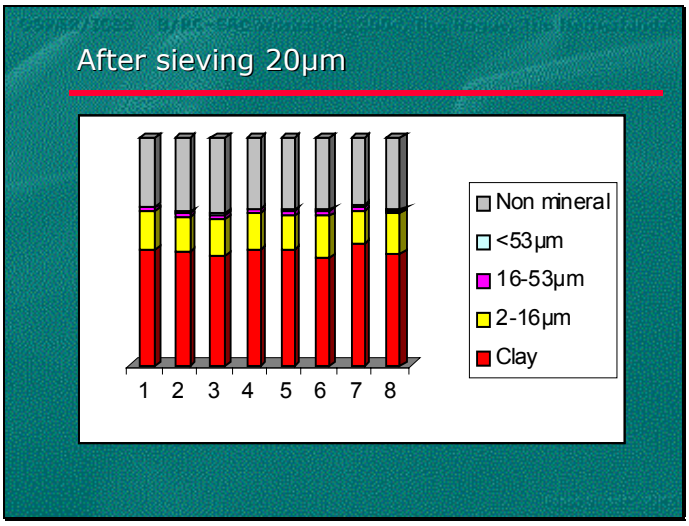

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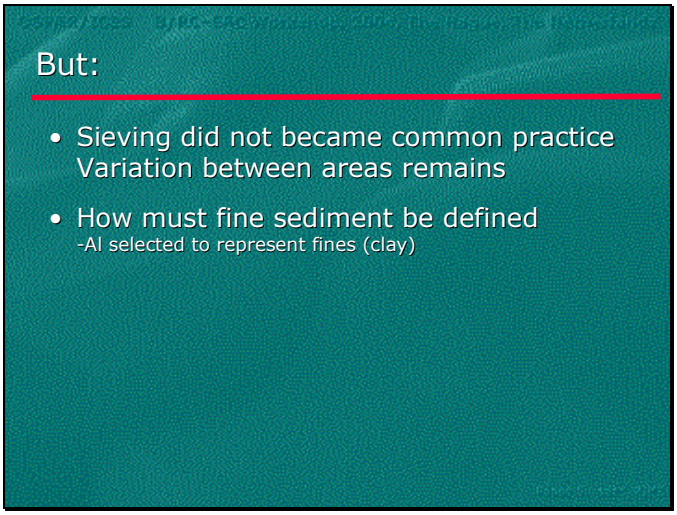

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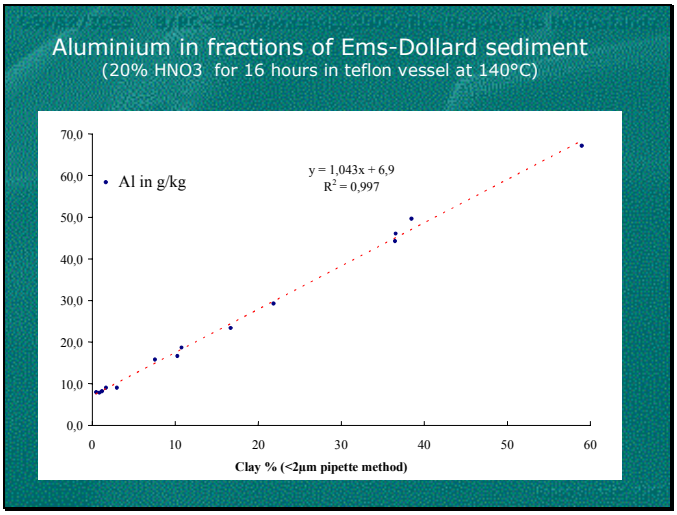

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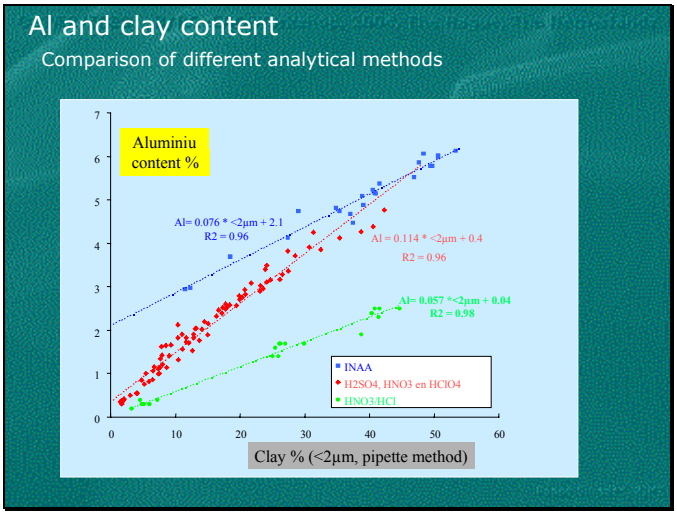

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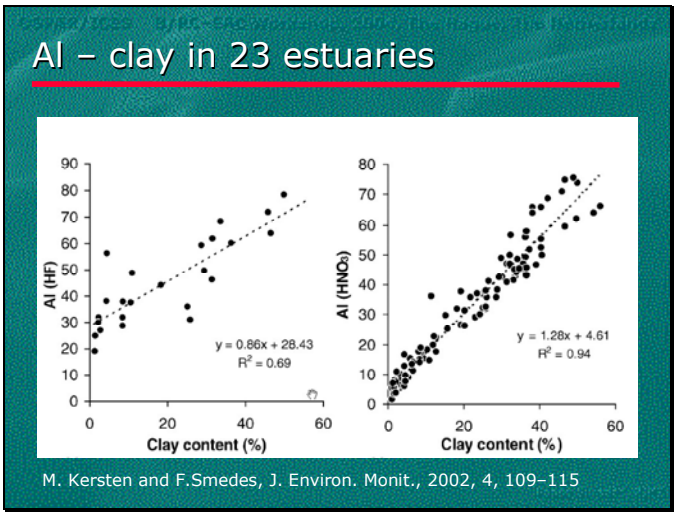

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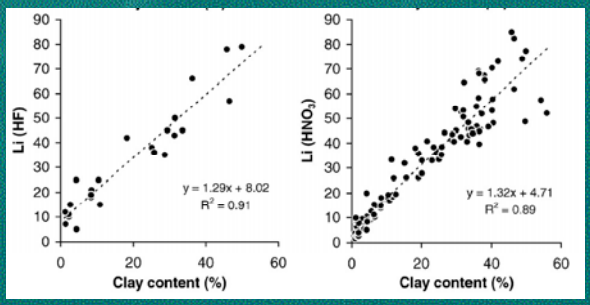
Li representing clay



M. Kersten and F.Smedes, J. Environ. Monit., 2002, 4, 109–115

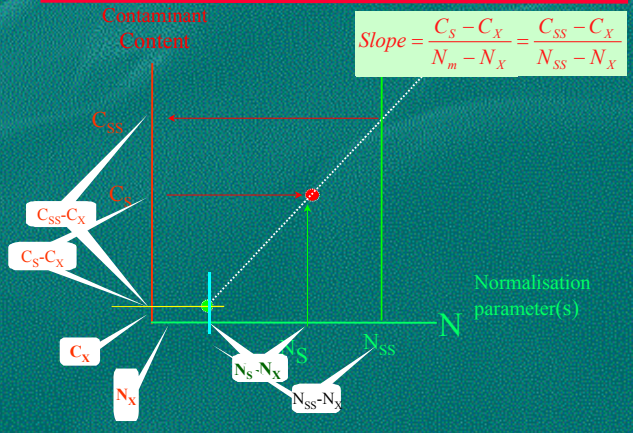
Slide 23

ICES/OSPAR

- Normalisation using intercepts (Pivot values)
- For total and for sieved sediments
- Recalculation to a defined "fine" sediment composition
- Error calculation

Slide 24

Model from OSPAR guidelines



Slide 25

Rewriting gives

$$C_{SS} = (C_S - C_X)\frac{N_{ss} - N_X}{N_m - N_X} + C_X$$

Normalisers can be:

- Clay — no N_X value
- Organic carbon — no N_X value
- Aluminium — N_X value, dependent on the analytical method
- Lithium — N_X value, yes
- You name it…?
- a combination of cofactors …?

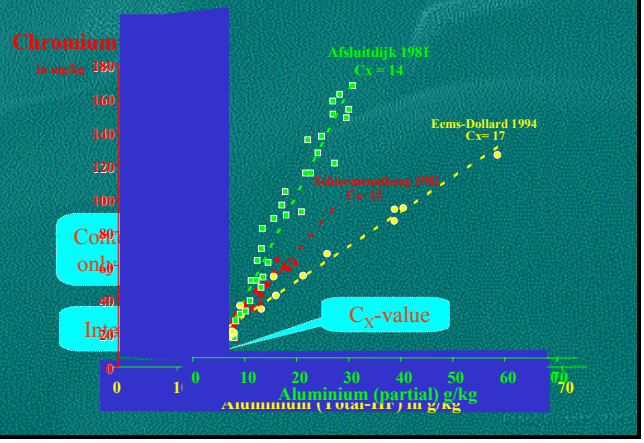
Slide 26

Pivot values can vary

- Area to area
- analytical method

Slide 27

Pivot point and values



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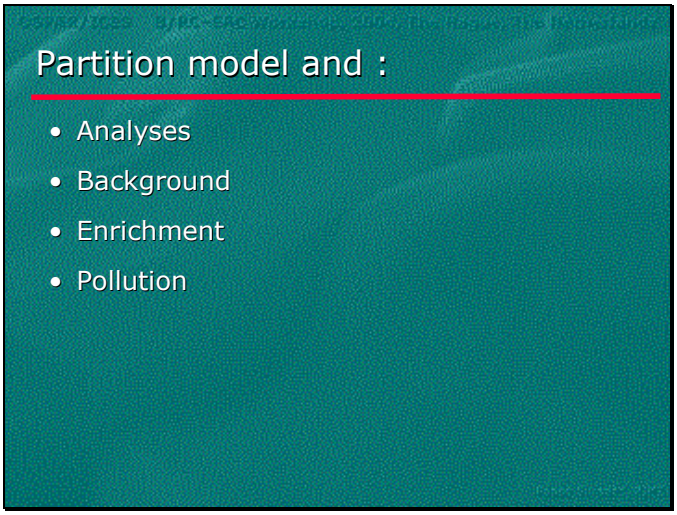

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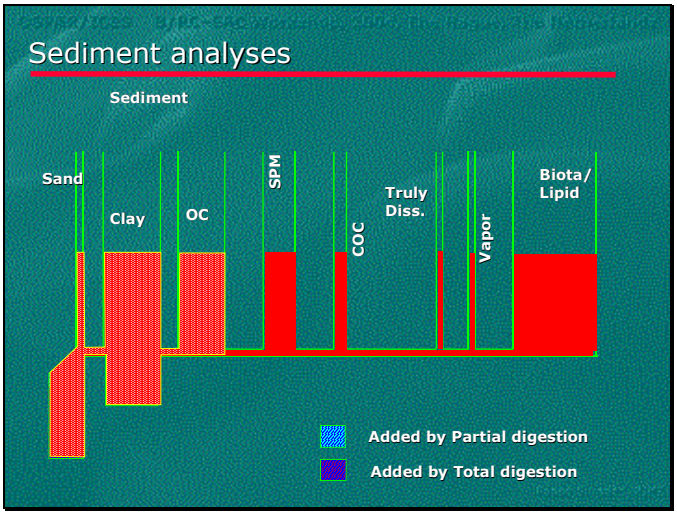

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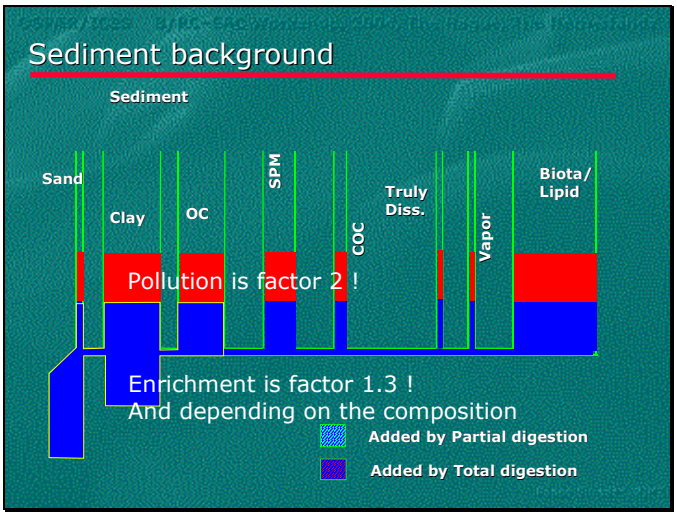

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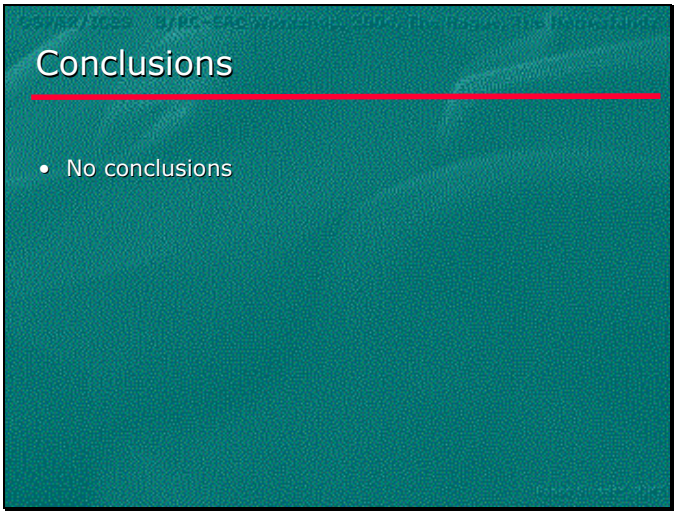

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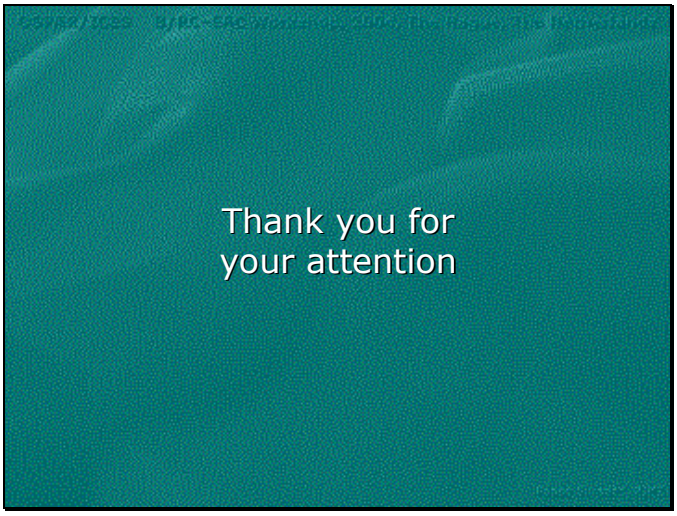
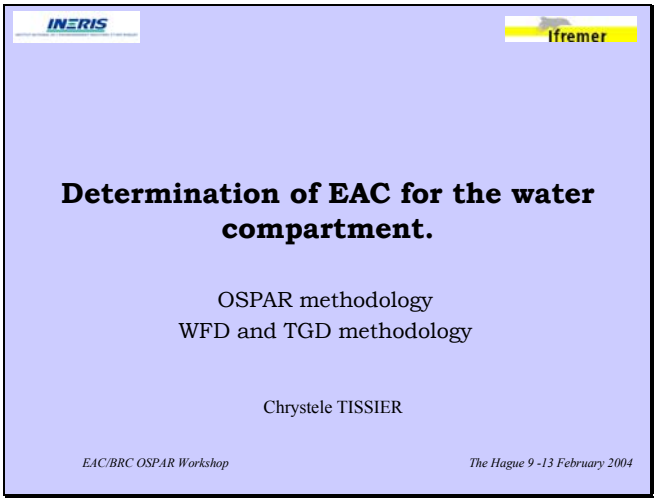


Appendix 8.5: Determination of EAC for the Water Compartment. OSPAR Methodology, WFD and TGD Methodology

Chrystèle Tissier

Slide 1



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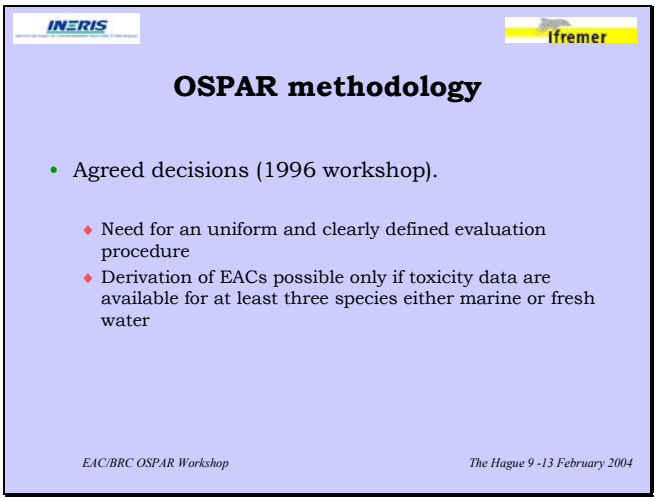

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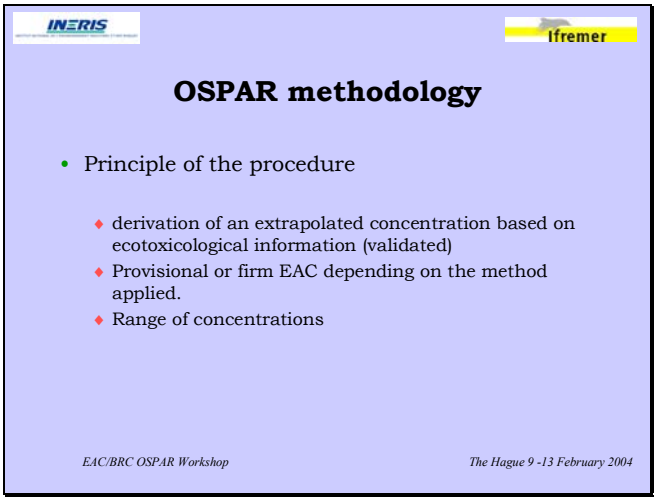

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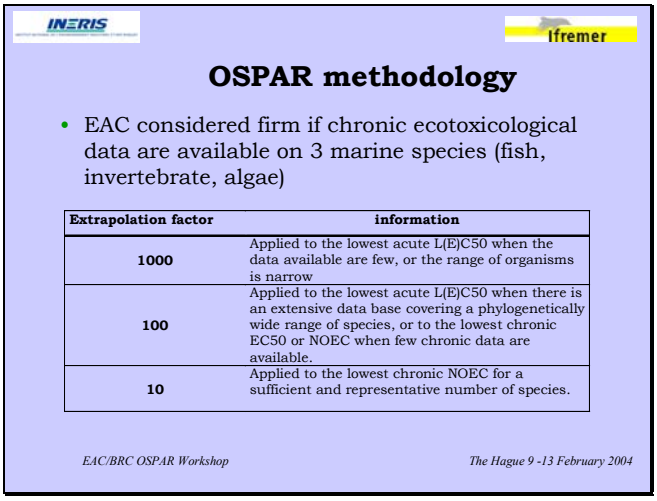

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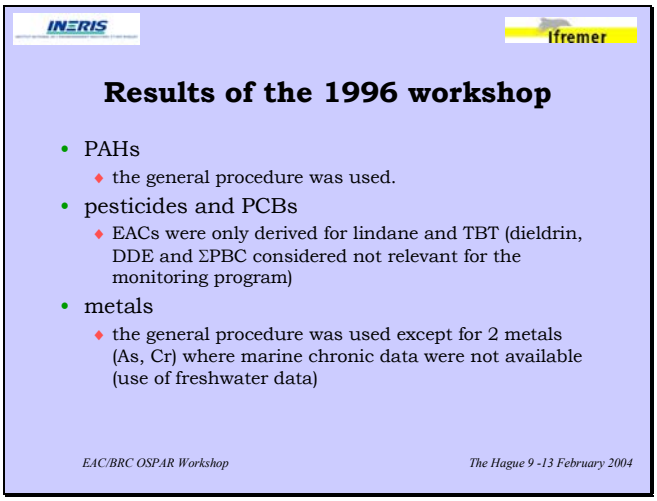

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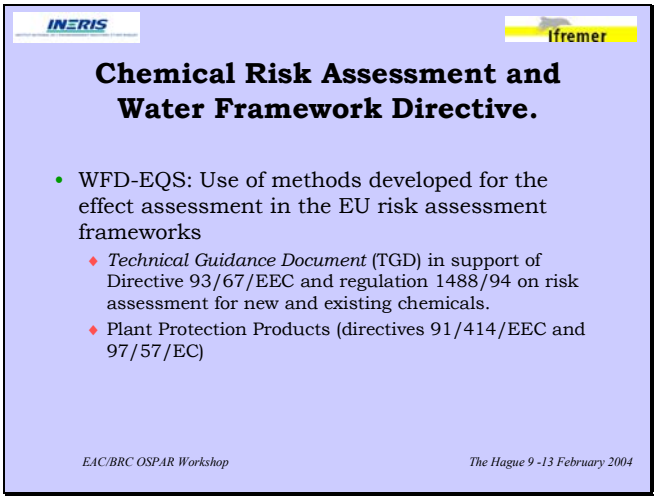

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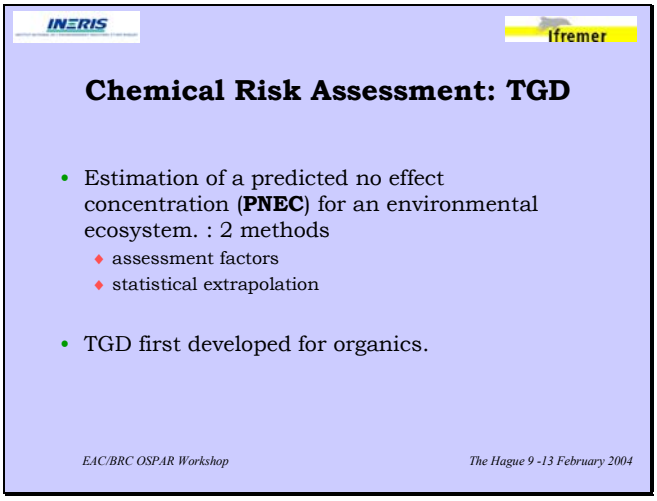

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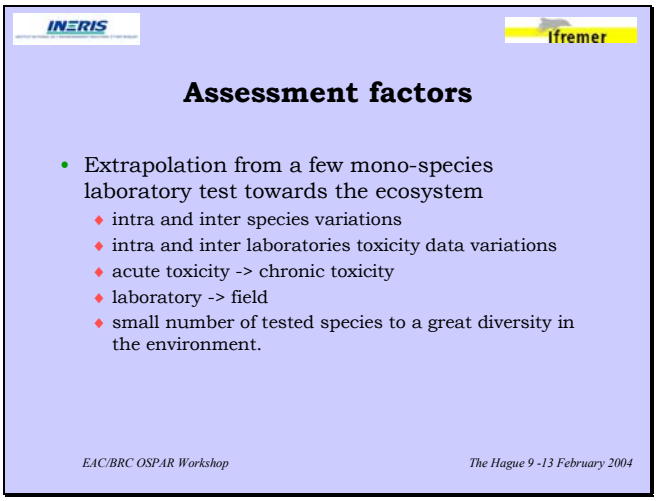

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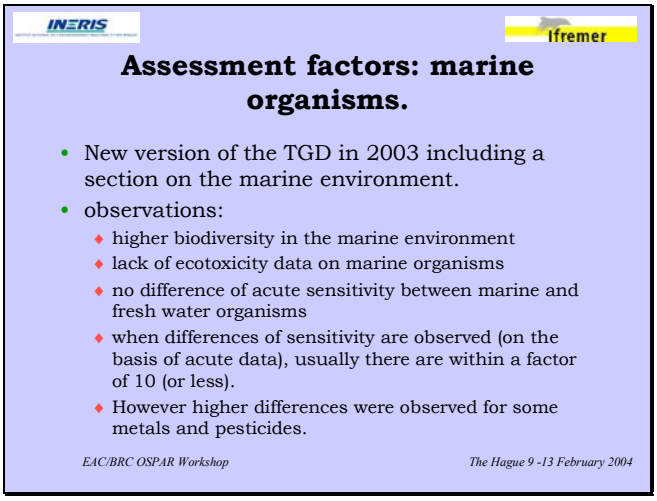

Slide 10

Assessment factors: marine organisms.

- Conclusions for the marine compartment
  - Use of a pool of marine and freshwater ecotoxicological data for the PNEC determination.
  - For precautionary reason (due to a lack of data on marine organisms) an extra assessment factor of 10 is applied on available ecotoxicological data

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Slide 11

Marine assessment factors

Table 25 Assessment factors proposed for deriving $PNEC_{water}$ for saltwater for different data sets

Data set	Assessment factor
Lowest short-term $L(E)C_{50}$ from freshwater or saltwater representatives of three taxonomic groups (algae, crustaceans and fish) of three trophic levels	10000(a)
Lowest short-term $L(E)C_{50}$ from freshwater or saltwater representatives of three taxonomic groups (algae, crustaceans and fish) of three trophic levels, + two additional marine taxonomic groups (e.g. echinoderms, molluscs)	1000(b)
One long-term NOEC (from freshwater or saltwater crustacean reproduction or fish growth studies)	1000(b)
Two long-term NOECs from freshwater or saltwater species representing two trophic levels (algae and/or crustaceans and/or fish)	500(c)
Lowest long-term NOECs from three freshwater or saltwater species (normally algae and/or crustaceans and/or fish) representing three trophic levels	100(d)
Two long-term NOECs from freshwater or saltwater species representing two trophic levels (algae and/or crustaceans and/or fish) + one long-term NOEC from an additional marine taxonomic group (e.g. echinoderms, molluscs)	50
Lowest long-term NOECs from three freshwater or saltwater species (normally algae and/or crustaceans and/or fish) representing three trophic levels + two long-term NOECs from additional marine taxonomic groups (e.g. echinoderms, molluscs)	10

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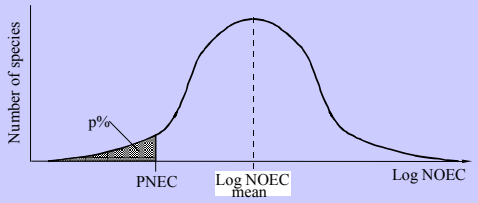
Slide 12

Statistical extrapolation

- Assumptions:
  - the distribution of species sensitivities follows a theoretical distribution function.
  - the group of species tested in the laboratory is a random sample of this distribution.



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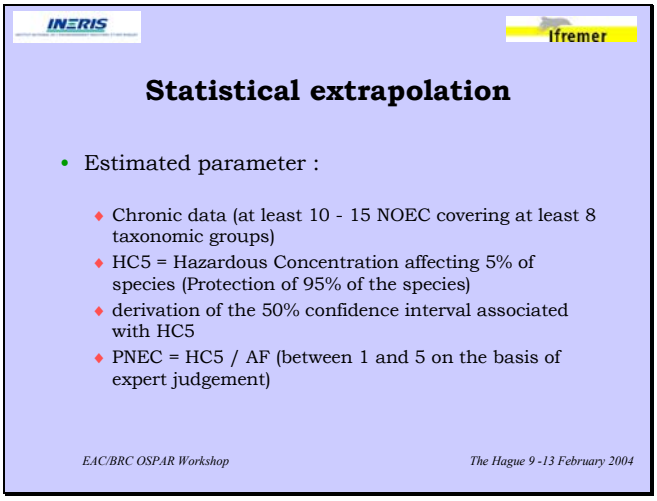

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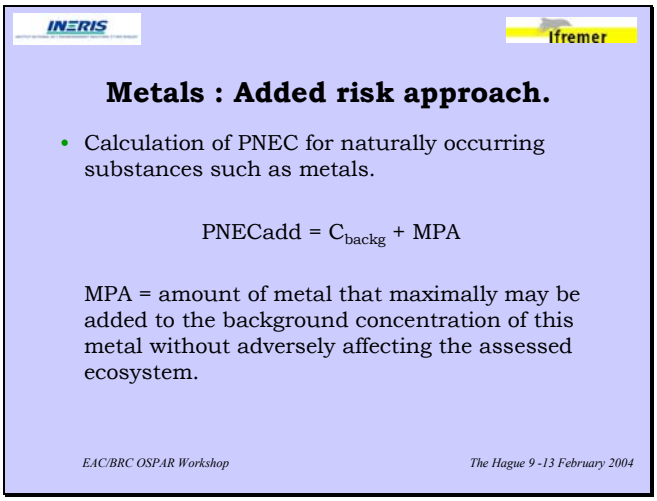

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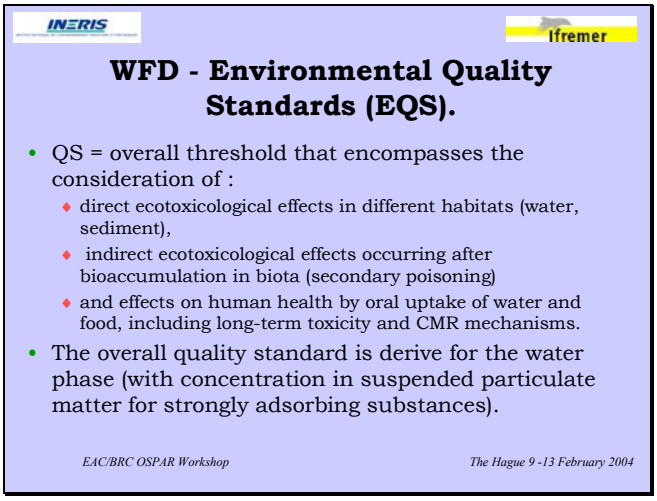

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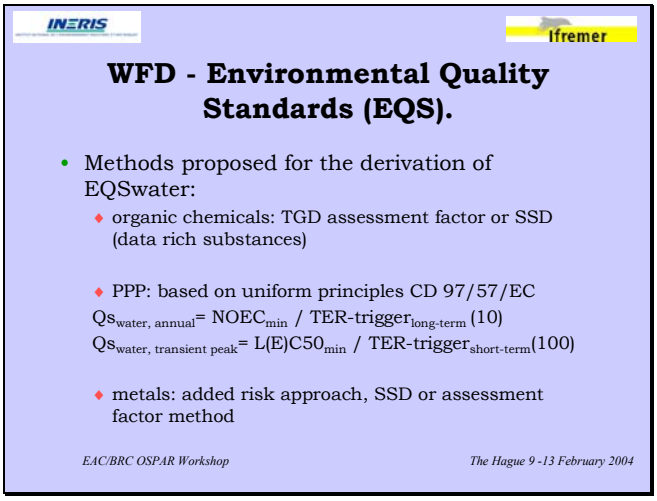
INERIS
Ifremer
WFD - Environmental Quality Standards (EQS).
• Methods proposed for the derivation of EQSwater:
♦ organic chemicals: TGD assessment factor or SSD (data rich substances)
♦ PPP: based on uniform principles CD 97/57/EC
Qs water, annual = NOEC min / TER-trigger long-term (10)
Qs water, transient peak = L(E)C50 min / TER-trigger short-term (100)
♦ metals: added risk approach, SSD or assessment factor method
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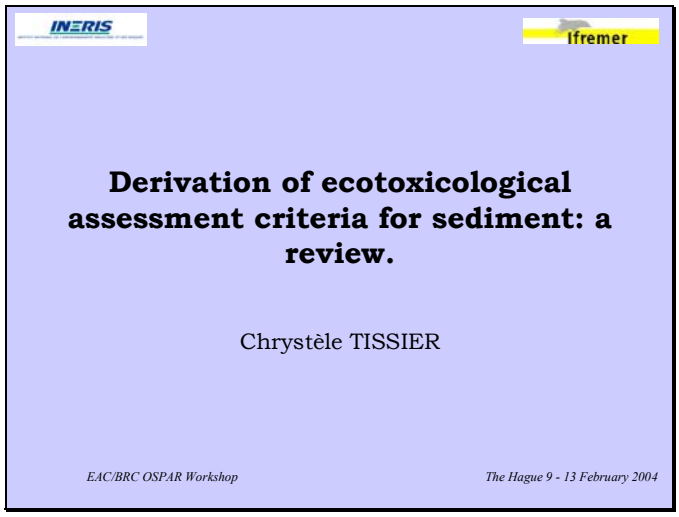
Appendix 8.6: Derivation of Ecotoxicological Assessment Criteria for Sediment: a Review

Chrystèle Tissier

Slide 1



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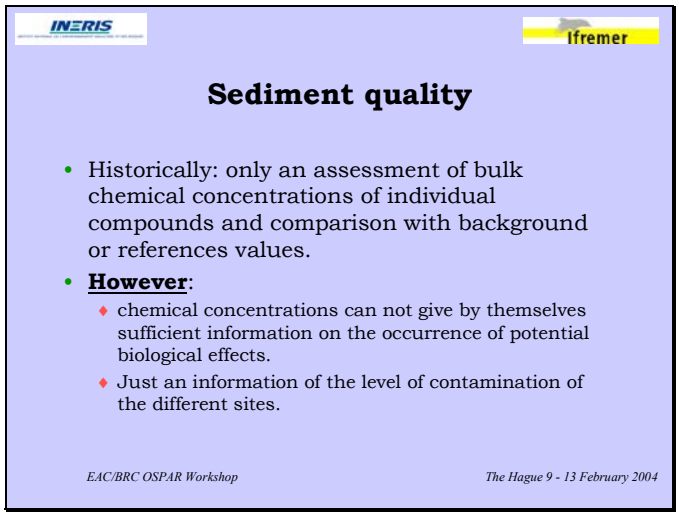

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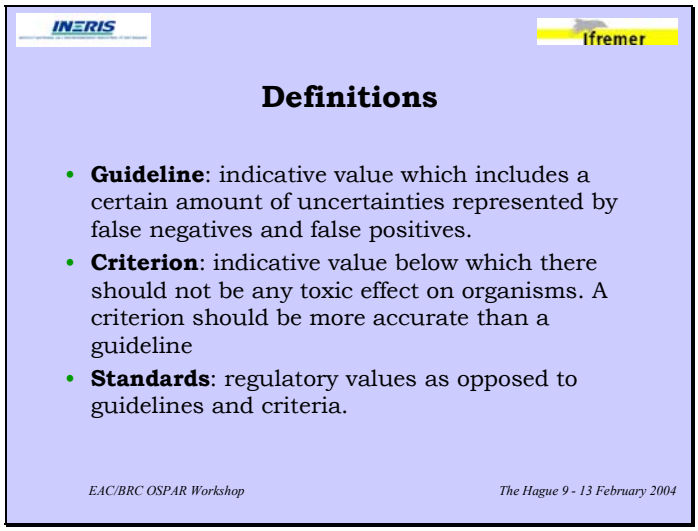

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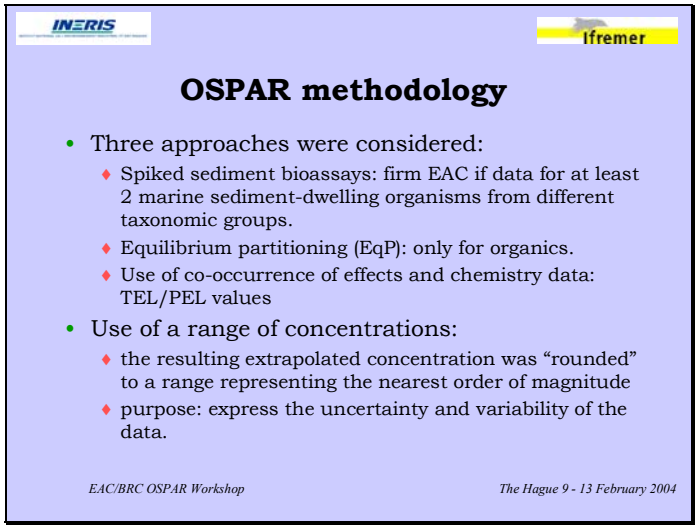

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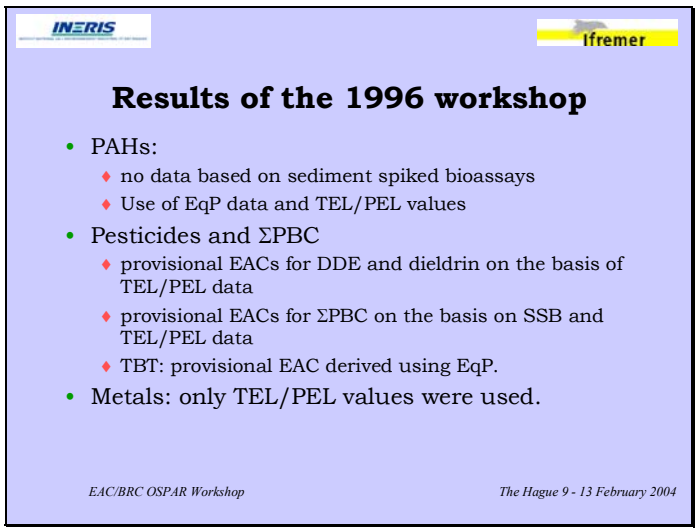

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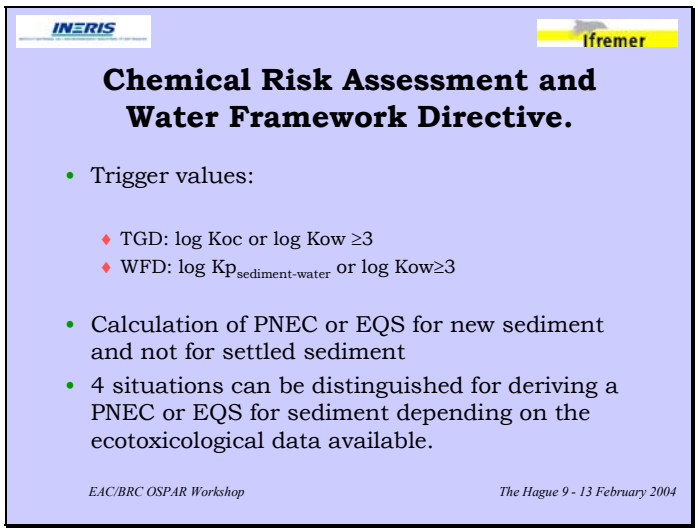

Slide 7

Chemical Risk Assessment and Water Framework Directive.

- Ecotoxicological data on benthic organisms are not available -> use of the EqP method as a screening approach.
- Only acute ecotoxicological data on benthic organisms are available -> assessment factors method + EqP
- Chronic ecotoxicological data on benthic organisms are available -> assessment factors method.

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Assessment factors used in the determination of the PNECsed.

Available test results	Assessment factor	$PNEC_{marine\ sediment}$
One acute freshwater or marine test	10000	Lowest of LC_{50} /10000 and equilibrium-partitioning method
Two acute tests including a minimum of one marine test with an organism of a sensitive taxa	1000	Lowest of LC_{50} /1000 and equilibrium-partitioning method

Available test results	Assessment factor
One long term freshwater sediment test	1000
Two long term freshwater sediment tests with species representing different living and feeding conditions	500
One long term freshwater and one saltwater sediment test representing different living and feeding conditions	100
Three long term sediment tests with species representing different living and feeding conditions	50
Three long term tests with species representing different living and feeding conditions including a minimum of two tests with marine species	10

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WFD On-going activities

- At this stage no EQS was set in sediment, partly due to the difficulty in determining the wider significance of sediment contamination given that:
  - data on toxic effect on benthic organisms are limited
  - differences in types of sediment matrices have implications for effects.
  - Different contaminant levels in sediment are of different importance at different locations.

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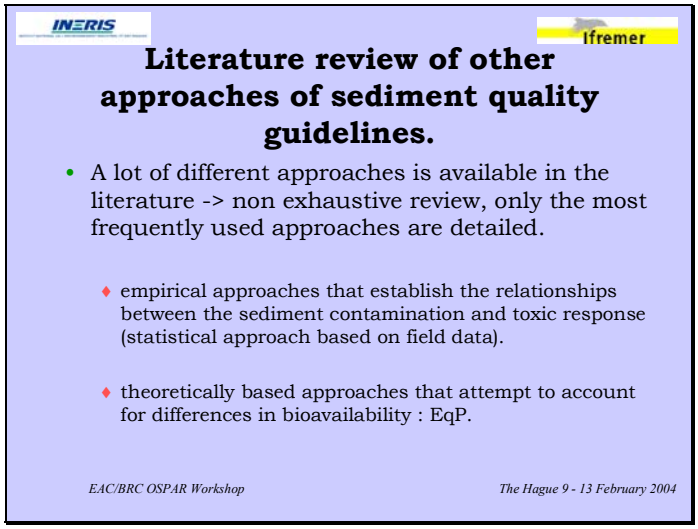

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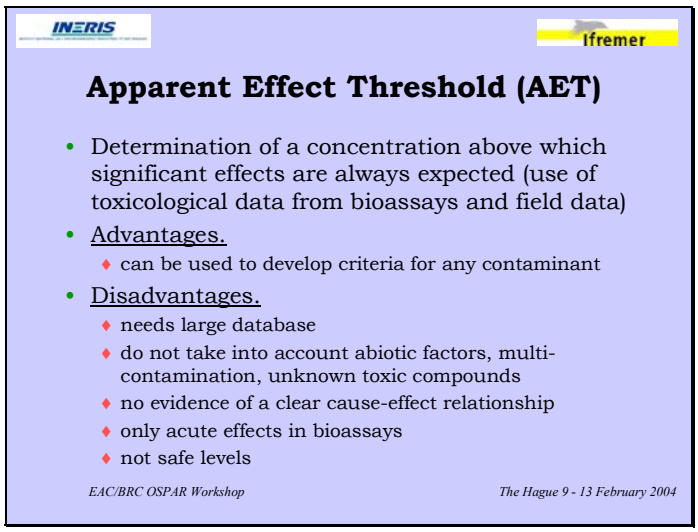

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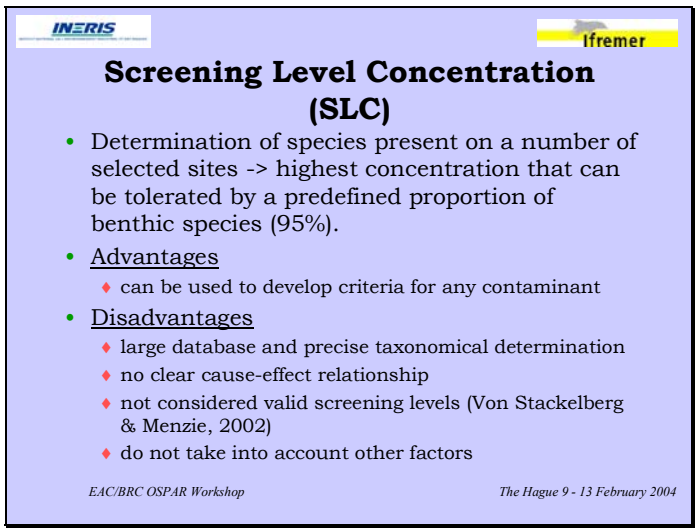

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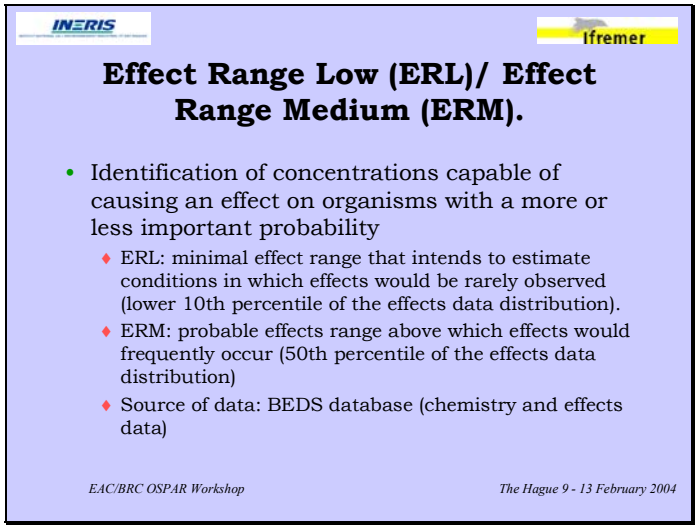

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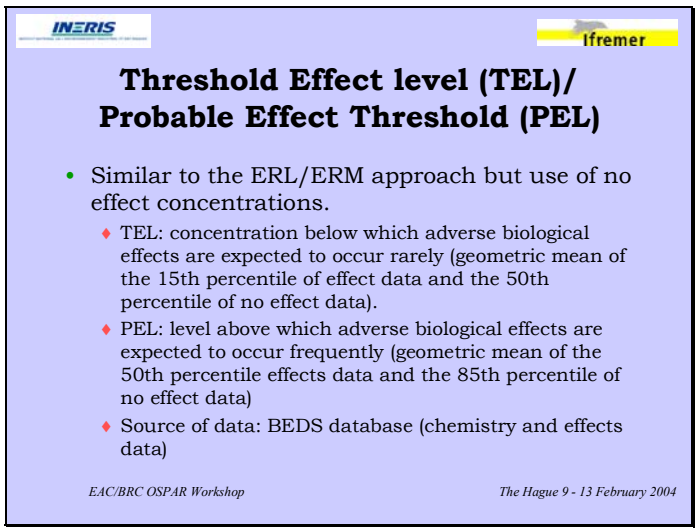

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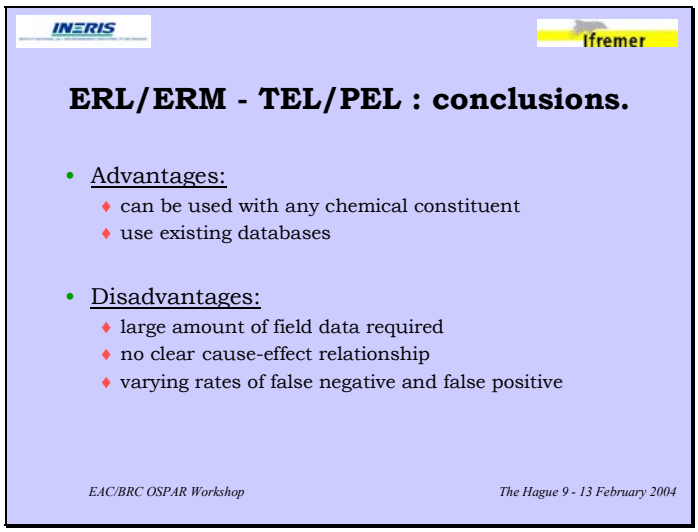

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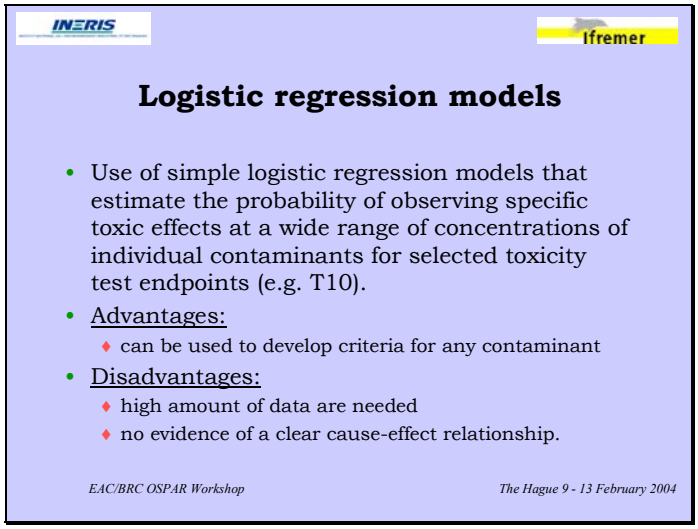

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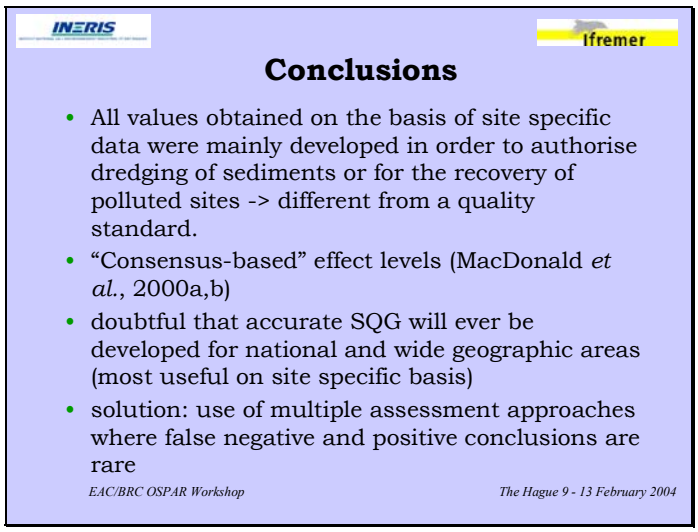

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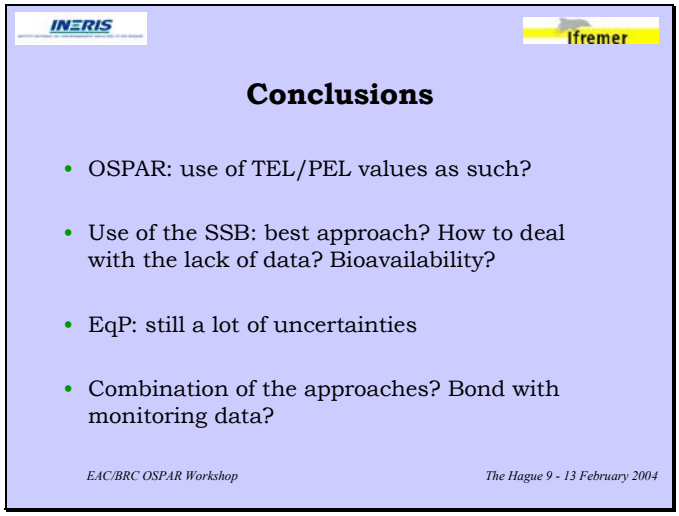

Appendix 8.7: Approaches for deriving EACs Biota

Janny Pijnenburg (Presented by Theo Traas)

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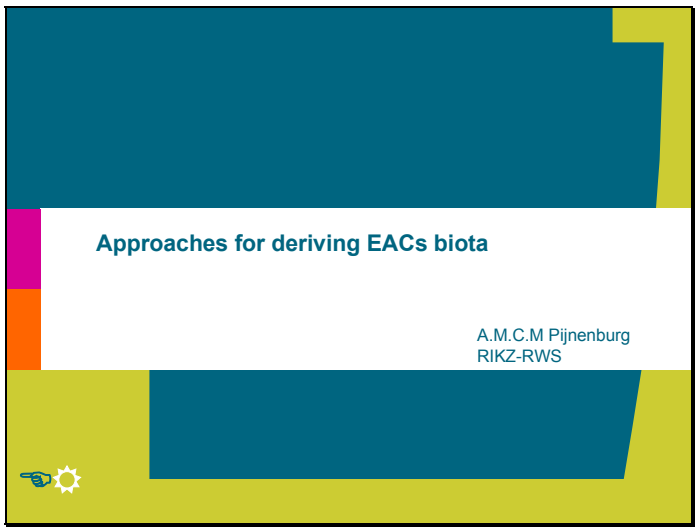

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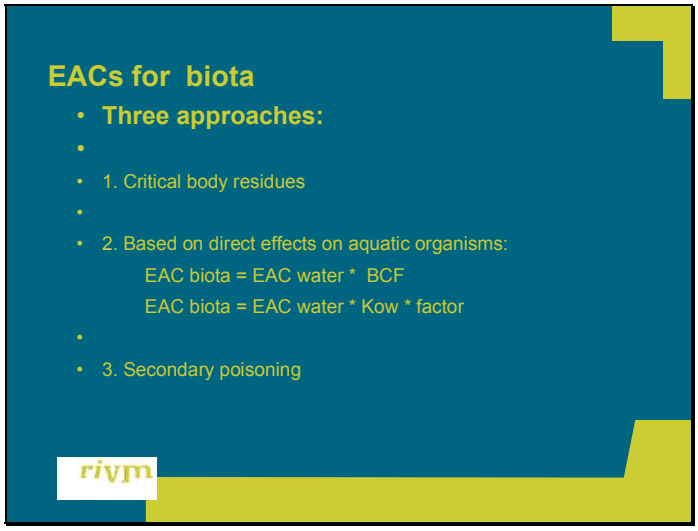

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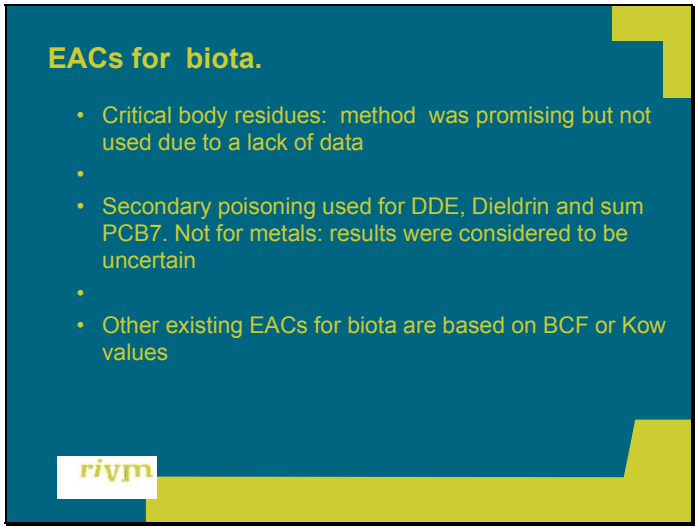

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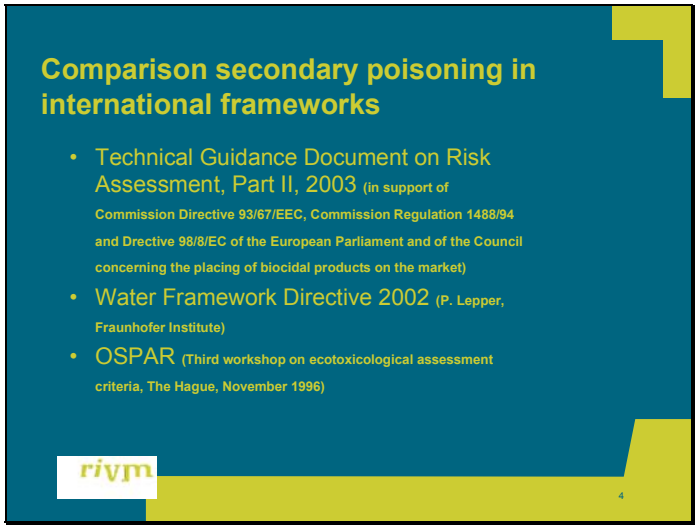

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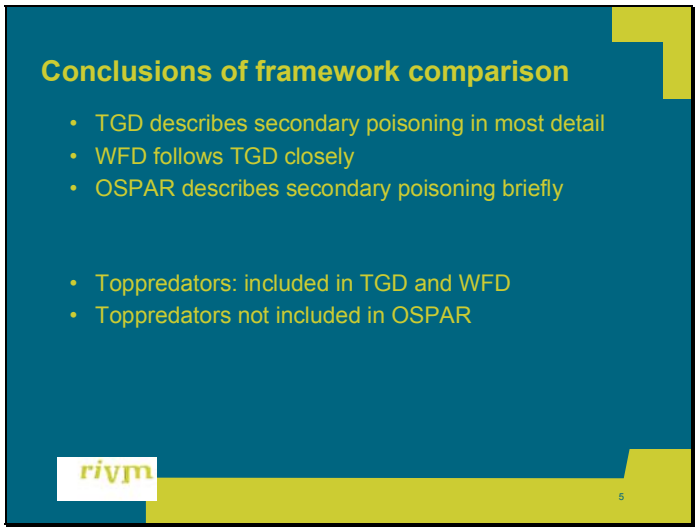

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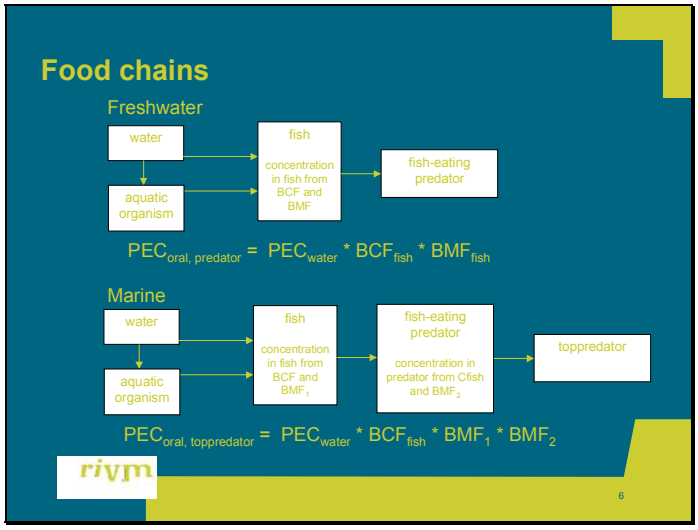

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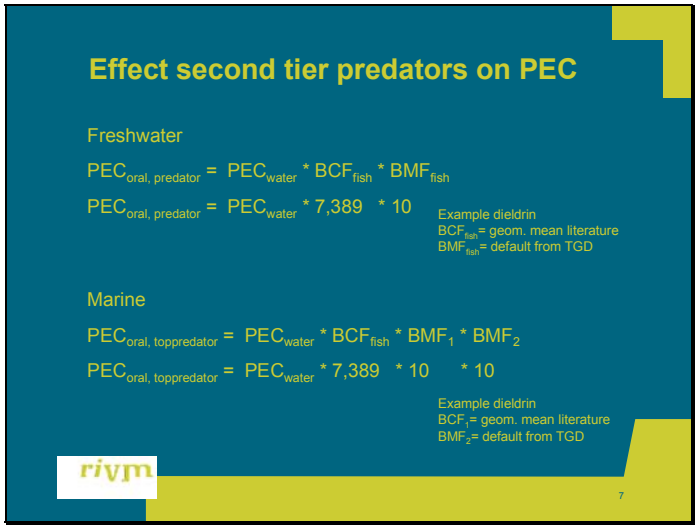

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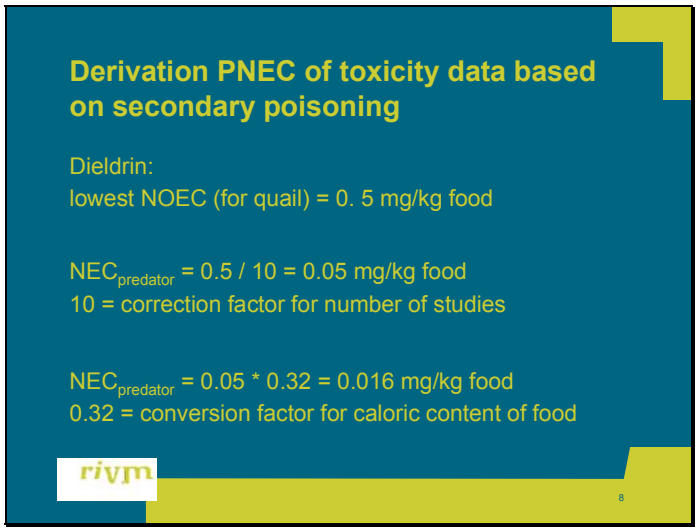

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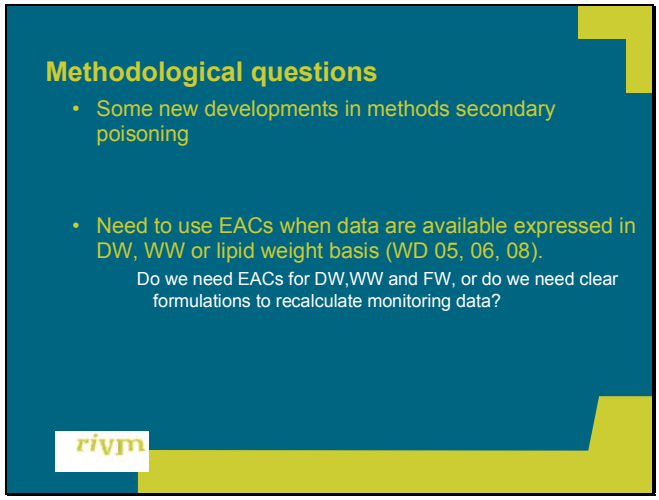

Appendix 8.8: Effective Environmental Standards

Rob Fryer

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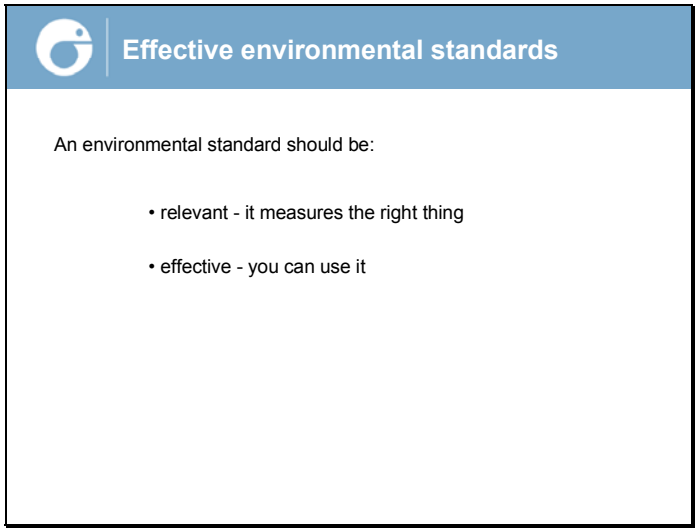

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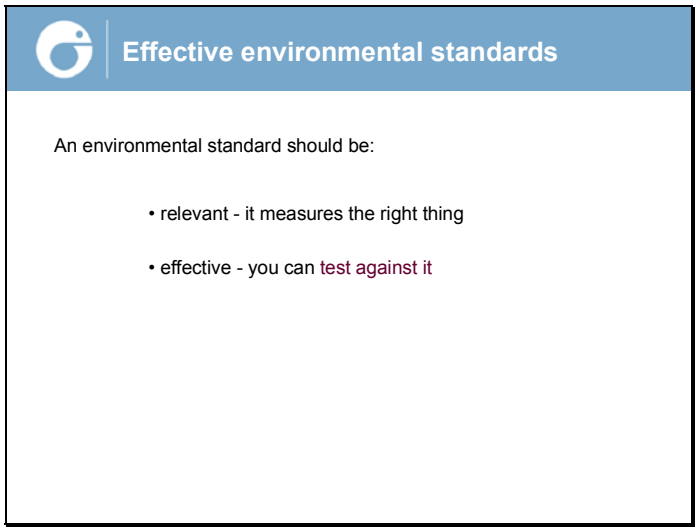

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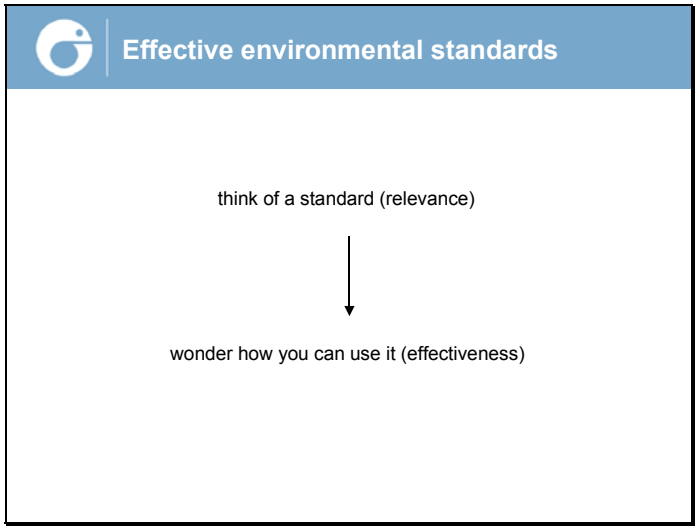

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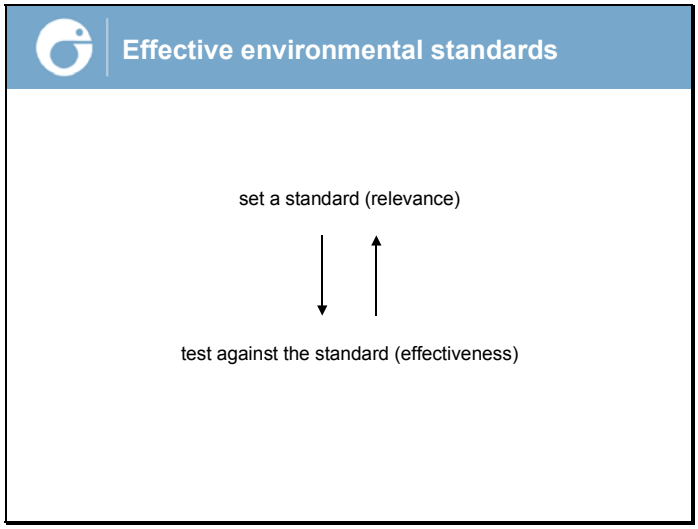

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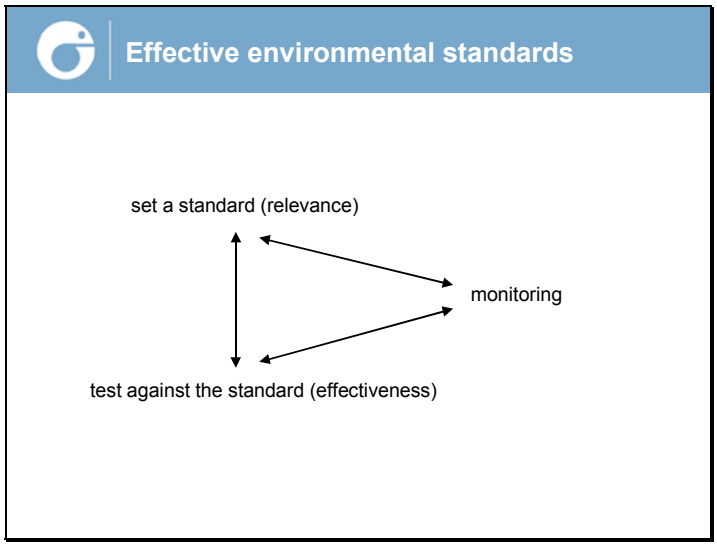

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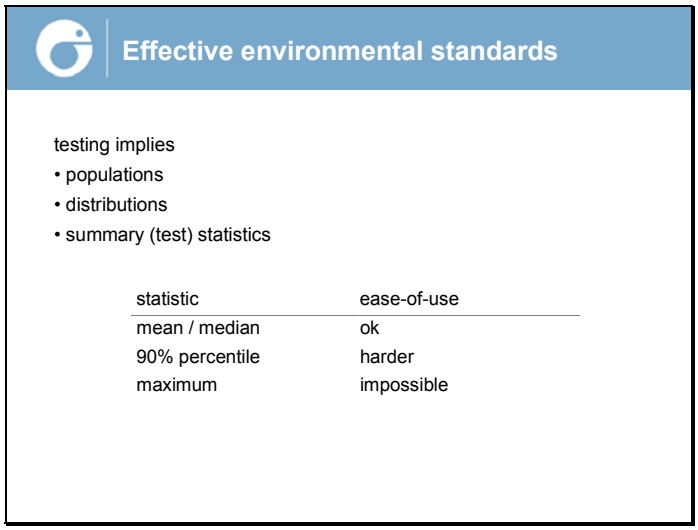

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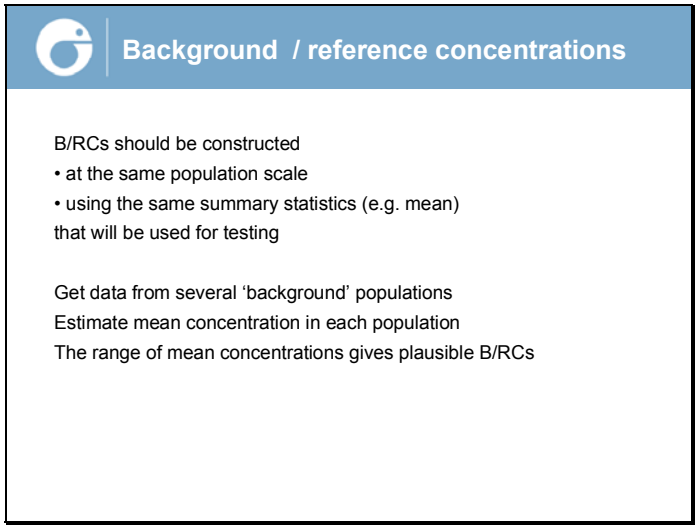

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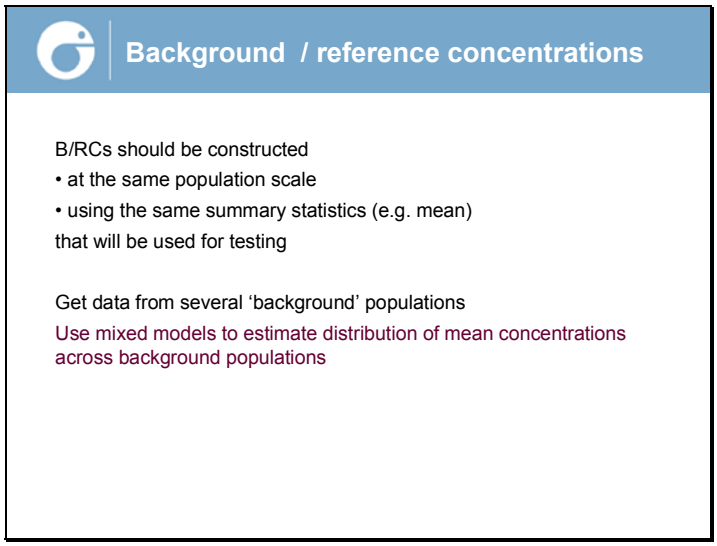

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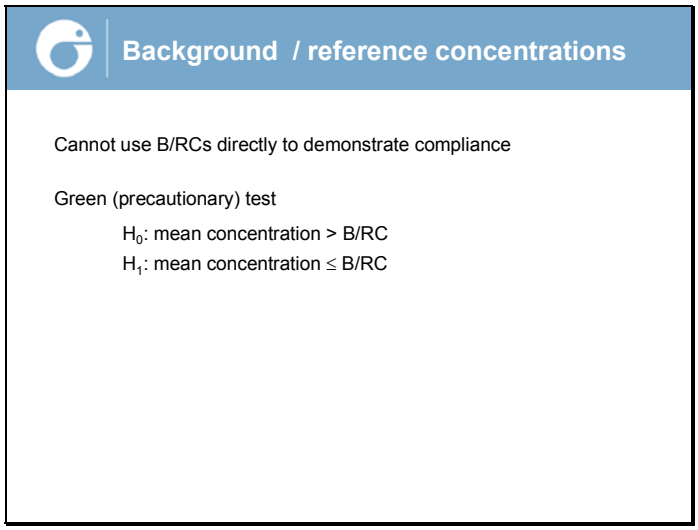
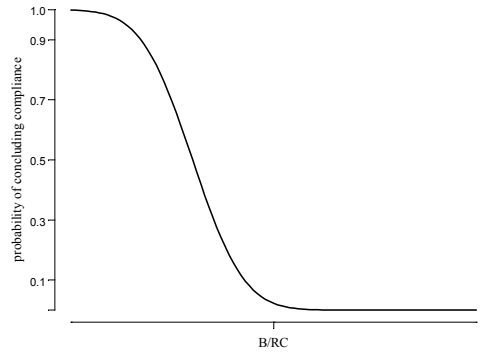


Slide 10

Background / reference concentrations



Slide 11

Background / reference concentrations

Construct a near-background concentration NB/RC

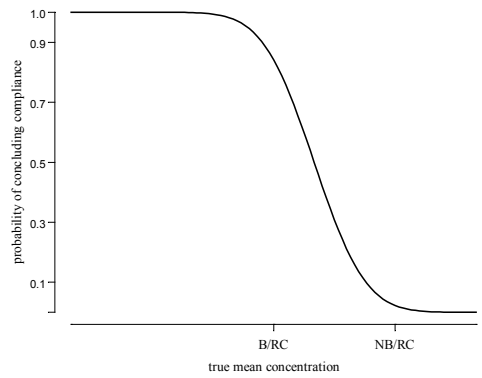
Modified green (precautionary) test

H_0: mean concentration > NB/RC

H_1: mean concentration ≤ NB/RC

Slide 12

Background / reference concentrations



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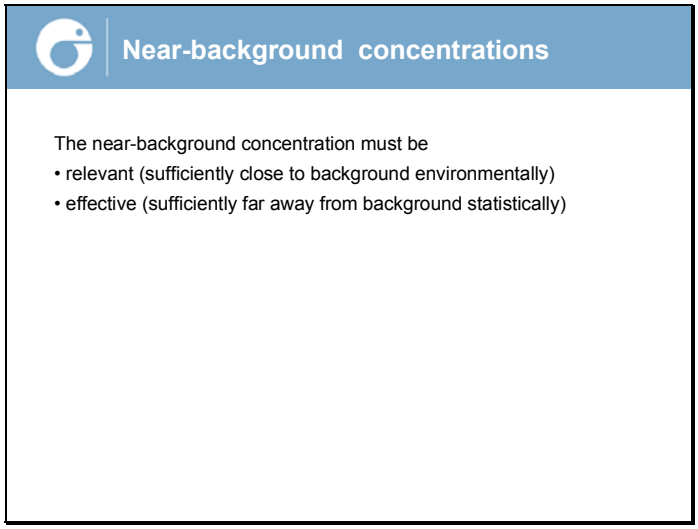
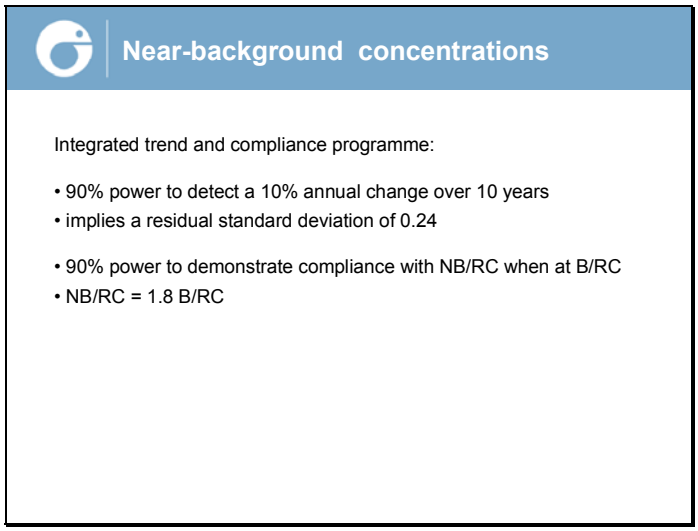
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