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REPORT OF THE

WORKING GROUP ON ENVIRONMENTAL ASSESSMENT AND MONITORING STRATEGIES

Nantes, France
17–21 March 1997

International Council for the Exploration of the Sea

Conseil International pour l'Exploration de la Mer

Palægade 2–4 DK–1261 Copenhagen K Denmark

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1 OPENING OF THE MEETING

The 1997 meeting of the Working Group on Environmental Assessment and Monitoring Strategies (WGEAMS) was opened by the Chairman, Dr Ian M. Davies at 10.00 hrs on 17 March 1997 at the IFREMER Laboratory, Nantes, France. Dr Henri Durant, Director of IFREMER Nantes, welcomed the Working Group on behalf of the Laboratory.

The terms of reference (ICES C.Res. 1996/2:15:4) for the meeting are given below:

The Working Group on Environmental Assessment and Monitoring Strategies (Chairman, Dr I.M. Davies, UK) will meet from 17–21 March 1997 in Nantes, France, to:

a) assess the implications of the results of the Baseline Study of Contaminants in Baltic Sea Sediments for future sediment monitoring strategies [HELCOM 1996/4];

b) assist in the development of monitoring guidelines for PAHs in sediments, with WGMS and MCWG, and biota with MCWG, including the number of replicate samples per area to characterise the sampling area [OSPAR 1997/1.1];

c) consider the current (revised) guidelines (to be elaborated at MON 1996) on chemical monitoring of fish and shellfish in relation to ICES advice on monitoring strategies;

d) prepare plans for a theme session/symposium/workshop on risk evaluation in environmental monitoring and assessment, jointly with WGSAEM;

e) to review the outcome of the Study Group on Monitoring Programmes for Contaminants in Sediments;

f) in collaboration with MCWG, review information gathered intersessionally on variance components in seabird egg analyses;

g) review progress with preparing a reply to the IWC enquiry concerning the effects of contaminants on the abundance and quality of cetacean prey.

The agenda is appended as Annex 1, and the list of participants as Annex 2. A list of the papers considered at the meeting is contained in Annex 3.

2 ADOPTION OF THE AGENDA

The draft agenda (WGEAMS97/2/1) was adopted, with the addition of discussions of the application of assessment criteria in the context of AMAP (Item 12.2), and the proposed OSPAR SIME approach to the problem of endocrine disruptors (Item 12.3).

3 ARRANGEMENTS FOR THE PREPARATION OF THE REPORT

The Chairman reminded WGEAMS that the ICES Secretariat required that the report of the meeting be drafted and approved by the end of the meeting, as is now usually the case. The deadline for receipt of the completed report at ICES Headquarters was 9 April 1997. Sections of the report were therefore drafted throughout the course of the meeting, and time was set aside on the final day for approval of the drafts, including the recommendations. The Chairman undertook any final detailed editing of the text prior to submitting it to ICES.

Photocopying and word processing facilities were kindly provided by IFREMER.

Only five members of the Working Group, from four countries, attended the meeting. There was some discussion of the possible reasons for this poor turn-out. It was noted that the meeting coincided with several other events, including an ICES Symposium on nutrients/eutrophication in Kiel, World Water Day, and World Meteorological Day, and that this had prevented some members from attending. It was also felt that, in some ICES Member Countries, funding for travel, etc., to ICES WG meetings was increasingly difficult to secure.

WGEAMS noted that its terms of reference were of rather different character to those of many other ICES Working Groups. They were not concerned with the completion of a task involving the manipulation of data (cf. stock assessment groups) nor did they deal with questions of a primarily technical nature (cf. MCWG, WGMS, WGBEC, etc.). Over the years, the main contributions of WGEAMS have been, appropriately, in strategic areas, such as the development of guidelines for environmental assessments, the redefinition of the ICES role in monitoring and ICES philosophy of monitoring, comments on the North Sea QSR, joint work with WGSAEM on statistical definitions of trend monitoring objectives, reconsideration of the future of the Cooperative ICES Monitoring Studies Programme, etc. Items on the present agenda which most closely fell into this area were Agenda Items 5 (implications of the Baltic Sediment Baseline Study), 8 (risk assessment in environmental monitoring) and 12 (assessment criteria and new monitoring targets). It was hoped that the current meeting would make useful contributions in these and other areas, and would be able to stimulate new areas of interest and activity for ACME.

WGEAMS noted that the official ICES list of members did not entirely match national lists (e.g., Dr Cynthia de Wit, Sweden, was missing from the ICES list), although it was recognized that the ICES list should represent the information as received from national delegates. It was noted that the organization of working group meetings could be simplified if either the list of members could be made available very soon after the Annual Science Conference (to catch initial circulars to Working Group members), or, if the list became available later in the ICES annual cycle, that it could be taken as referring to attendance at Working Group meetings in the subsequent yearly cycle, e.g., lists available in spring 1997 applied to meetings in the period October 1997–September 1998. WGEAMS recognized that this would require changes to Council procedures.

4 REPORTS OF ACTIVITIES IN OTHER FORA OF INTEREST TO THE MEETING

4.1 New Structure of ICES Committees and Working Groups

An extract from the Report of the Bureau Working Group on the Structure of ICES (ICES CM 1996/Gen:7) was made available to the Working Group. It was noted that in this proposal WGEAMS would continue to report to ACME, and the Working Group agreed that this would be appropriate, and probably have little impact on the work of WGEAMS.

It was also noted that in recent years there has been increasing emphasis on the need for interdisciplinary approaches to environmental problems. Within ICES, this has resulted in, among other things, joint meetings between WGMS and WGBEC, between WGSAEM and WGEAMS, and interdisciplinary meetings such as the one which developed statistical approaches to the definition of objectives for temporal trend monitoring programmes. It was noted that in the new proposal WGSAEM would be assigned to the Marine Habitat Committee, and that MCWG would be assigned to the Oceanography Committee. WGEAMS hopes that these changes will not reduce the potential for future interactions with these groups and the WGs parented by ACME, and that the new ICES Secretariat structure can retain the links and coordination between the environmental WGs and continue to ensure that, wherever possible, environmental WG meetings are scheduled appropriately (e.g., to avoid clashes with other meetings and to maximize possibilities for collaborative interactions).

It was not clear to WGEAMS why WGSAEM will be assigned to the Marine Habitat Committee, as members of WGEAMS were not aware that WGSAEM has (with any frequency) undertaken work related to any of the other WGs under that Committee. WGEAMS feels that WGSAEM would be more appropriately placed under ACME.

4.2 OSPAR SIME

M. Joanny reported on the 1997 meeting (3–7 February 1997) of the OSPAR Working Group on Concentrations, Trends and Effects of Substances in the Marine Environment (SIME) and its pre-meeting on monitoring (2 February 1997). The pre-meeting was organised to prepare maps of the locations of sampling stations of present or planned national monitoring programmes of OSPAR Contracting Parties, that will form the basis of the OSPAR Joint Assessment and Monitoring Programme (JAMP). It appeared to have been quite useful in starting to present a concrete picture of what is going on. The main additional items discussed at SIME were the following:

1) Endocrine disruptors. SIME proposed a 'line of action regarding endocrine disruptors', which is discussed further under Agenda Item 12.3

2) The DIFFCHEM (OSPAR Diffuse Chemical Sources) survey. A final report had been produced for this 'one-off' survey for PAHs, brominated flame retardants, chlorinated paraffins, alkylphenols and alkylphenol-ethoxylates. The programme had covered sediment samples from 23 locations in estuaries and coastal areas from eight countries. No interpretation of the results has yet been made. It was proposed that a similar survey be set up for pesticides.

3) Workshop reports. SIME discussed the reports of the OSPAR Third Ecotoxicological Assessment Criteria Workshop (25–29 November 1996) and the OSPAR/ICES Workshop on Background/Reference Concentrations (22–25 October 1996). These reports are discussed under Agenda Items 12.1 and 12.2.

4.3 Report from EEA ETC/MC (European Thematic Centre on Marine and Coastal Waters of the European Environment Agency)

M. Joanny reported on the activities in progress under the European Thematic Centre on Marine and Coastal Waters (ETC/MC) of the European Environment Agency. The ETC/MC is a consortium of the Ente per le Nuove Tecnologie, l'Energia e l'Ambiente (ENEA, Italy, Project leader), the Laboratorio Nacional de Engenharia Civil (LNEC, Portugal), the Institut Français de Recherche pour l'Exploitation de la Mer (IFREMER, France), the National Institute for Coastal and Marine Management (RIKZ, The Netherlands), and the Centre for Marine Research (CMR, Greece). One of the tasks of ETC/MC is to organize an annual Forum where the main organizations dealing with the protection of the marine environment (OSPAR, HELCOM, UNEP, ICES, etc.) can discuss ways to improve their activities in the European framework. ETC/MC is also responsible for the preparation of a report on the Mediterranean, the updating of the Dobris report, and other tasks of interest for the EEA.

5 ASSESSMENT OF THE IMPLICATIONS OF THE RESULTS OF THE BASELINE STUDY OF CONTAMINANTS IN BALTIC SEA SEDIMENTS FOR FUTURE SEDIMENT MONITORING STRATEGIES [HELCOM 1996/4]

WGEAMS discussed the draft report of the Results of the Baseline Study of Contaminants in Baltic Sea Sediments with a view to assessing the implications of these results for future sediment monitoring strategies. WGEAMS agreed that this Baseline Study was impressive in the way that it had been organised and conducted. It had proceeded in accordance with ICES guidelines: selection of sedimentation areas, on-site selection of sampling locations, core sampling, radiological dating of the core samples, quality assurance procedures, etc. As it stands, the Baseline Study constitutes a comprehensive project for the study of the contamination of Baltic Sea sediments and its participants are to be congratulated on their achievements.

On the other hand, it was noted that the report was still not complete, and that important data were missing, which reduced the ability to make a complete assessment. For instance, the chapter on organic contaminants includes only an introduction, and a comparative discussion of the dating methods seems to be necessary to explain some discrepancies between estimates of sedimentation rates. More importantly, the interpretation of the results from the cores is only made by class of parameter (metals, nutrients, organics, etc.). WGEAMS is of the opinion that a multiparameter discussion could significantly improve the interpretations that could be made of this important data set. It was mentioned, for example, that the difference in the behaviour of metals and organics could be useful in the interpretation of the anthropogenic contributions to the observed concentrations.

WGEAMS appreciated that the results have been used to prepare proposals as to which of the sampling stations should be included in a future monitoring exercise. Nevertheless, WGEAMS did not favour the recommendation that this programme should continue in the same way before a more satisfactory interpretation of the core profiles is available. It is quite surprising to note that, in conclusion, the report states that 'The main utility, however, of the sediments is to indicate areal variations rather than variations in time'. This statement has been made about a study dedicated to core sampling and which was supposed to be used as a time trend tool, and also as the basis for repeated (temporal trend?) studies. The main problems with the study are that the participants have largely been unable to interpret the core profiles with sufficient confidence so as to be able to identify the effects of changes in inputs of contaminants, changes in water column chemistry (e.g., stagnation, deoxygenation) and changes in the levels of primary productivity (eutrophication), and sediment diagenetic processes. The inability to quantify the effects of these processes on the observed sediment chemistry greatly limits the objectives that can be met by the present study and which might be addressed through the proposed repeat study, on a smaller scale. WGEAMS is of the opinion that if a study were to be conducted under a similar sampling scheme in five years (as is proposed), it is highly probable that the participants would still be unable to adequately interpret the observed core profiles, and that no new information would be obtained on the explanation of the time trends potentially preserved in the sediment as described in the present study.

WGEAMS therefore recommends that the future baseline study, in the framework of the HELCOM Baltic Monitoring Programme, should be designed in a manner that reflects the conclusions and uncertainties identified in the 1993 Baseline Study. Sampling should include a much reduced number of sediment cores, selected after full interpretation of the 1993 study, and a more extensive sampling of surficial sediments. The surface sediment sampling locations should be selected to investigate the effects of the various processes that are recognized as having influenced the profiles observed in the 1993 study, i.e., water column chemistry, sediment physico-chemical conditions, primary production, input rates of contaminants, etc. The new data should be combined with the results of other components of the HELCOM programme, such as hydrochemical monitoring, primary production monitoring, and pollution load monitoring. In this way, it may be possible to understand the influence of these processes on sediment chemistry and to move towards a fuller understanding of the meaning of the sediment analyses. The mechanism used to organise the 1993 Baseline Study, through a Steering Group responsible for all aspects of the planning, execution, analyses, and reporting of the study, should be retained, as it has proved to be efficient, although it is essential that the report of the 1993 Study is completed as soon as possible to properly inform the planning for any follow-up programme.

In the discussion, WGEAMS noted that this baseline study was purely a 'chemistry monitoring exercise'. It was suggested that, in keeping with ICES advice on monitoring strategies, strong consideration should be given to integrating sediment chemical measurements with appropriate biological effects measurements.

WGEAMS also recommended that the completed report should be made available to SGMPCS.

6 CONTRIBUTION TO THE DEVELOPMENT OF MONITORING GUIDELINES FOR PAHs IN SEDIMENTS, UNDERTAKEN JOINTLY WITH WGMS AND MCWG, AND BIOTA WITH MCWG, INCLUDING THE NUMBER OF REPLICATE SAMPLES PER AREA TO CHARACTERISE THE SAMPLING AREA [OSPAR 1997/1.1]

Both WGMS and MCWG held their 1997 meetings two weeks before WGEAMS. A representative from WGEAMS (Kari Stange) was present at MCWG and served as a link between the two groups. The subject of the development of guidelines for PAH monitoring was on the agenda for all three groups, and it had been established by correspondence among the Chairmen that WGEAMS would not be involved in detailed technical matters, but would review the draft papers in relation to the JAMP Monitoring Guidelines and ICES advice on monitoring strategies. The documents 'Determination of PAH in sediments: Analytical methods' prepared by WGMS at its 1997 meeting (WGEAMS97/6/4) and 'Guidelines for the determination of PAHs in sediments and biota' prepared by MCWG at its 1997 meeting (WGEAMS97/6/3) were available for consideration by WGEAMS.

WGEAMS recognized that the document from WGMS (WGEAMS97/6/4) was structured with a view to its direct inclusion as a Technical Annex in the JAMP Guidelines for monitoring of sediments. The document presented by MCWG (WGEAMS97/6/3) was not structured according to the JAMP Guidelines and, although this document reviewed useful information on many aspects of PAH analysis, it was felt that its format made it unsuitable for direct inclusion in the JAMP Guidelines.

WGEAMS recognized that specific guidelines on PAHs are needed for several aspects of monitoring within the JAMP (JAMP issue 1.10 – What are the concentrations in the maritime area? and JAMP issue 1.11 – Do PAHs affect fish and shellfish?). WGEAMS reviewed the document produced by the 1996 meeting of the OSPAR *Ad hoc* Working Group on Monitoring (MON96/9/1-E) to identify missing sections within the Guidelines, or sections which needed updating, in order to accommodate the monitoring for PAHs and related issues. The following list was prepared on the work that would be required to amend the relevant sections of the JAMP Guidelines, and suggestions were given as to the appropriate fora for preparing the updated sections.

1) The general section of the contaminant-specific guidelines for biota (MON96 report, Annex 5) needs to be updated to include PAHs. As this document has been adopted by MON96 and SIME97, the amendments are probably best undertaken by MON98.

2) A technical annex addressing issues specific for analyses of PAHs in biota should be attached to the Biota Guidelines or, alternatively, the technical annex on organic contaminants should be rewritten to include PAHs. The first alternative is preferable for the following reasons:

   a) The draft biota guidelines with technical annexes, as prepared by MON96, have already been adopted by SIME as the official JAMP Guidelines, with their current content and format.

   b) Monitoring of PAHs in biota will only concern one of the three matrices discussed in the existing technical annexes, namely the mussels.

   c) Analysis for PAHs differs significantly from the methods used for the other organic contaminants included in Technical Annex 1.

WGEAMS therefore suggests that Technical Annex 1 in the JAMP Biota Guidelines be renamed 'Halogenated organic compounds', and that ACME request MCWG to prepare a draft technical annex addressing the analysis of PAHs in mussels, following the format of existing Technical Annexes to the JAMP Biota Guidelines.

3) Guidelines on PAH analysis are also needed for contaminant-specific biological effects monitoring (MON96 report, Annex 12). Methods to be used in PAH-specific monitoring include the determinations of cytochrome P450A, DNA adducts, PAH metabolites in fish bile, and liver histopathology. Guidelines are already in place for some of these procedures, while others require additional work. WGEAMS suggests that ACME ask WGBEC and MCWG to collaborate on the finalization of the technical annexes regarding analyses for PAH-specific biological effects monitoring.

WGEAMS recommends that the Technical Annex for the determination of PAHs in sediments, as prepared by WGMS 1997, can be incorporated into the JAMP Guidelines in its current format, and therefore supports the recommendation made by WGMS that the document be approved for inclusion in the JAMP sediment monitoring guidelines.

7 CONSIDERATION OF THE CURRENT (REVISED) GUIDELINES (AS ELABORATED AT MON 1996) ON CHEMICAL MONITORING OF FISH AND SHELLFISH IN RELATION TO ICES ADVICE ON MONITORING STRATEGIES

The meeting had available a series of reports, including the full and summarized versions of the report of MON96, as presented to SIME97, and ICES statements on monitoring strategies and the ICES role in monitoring, as previously agreed by ACME. WGEAMS reviewed generalities in the MON96 report, in relation to such factors as structure and strategy, and did not address technical matters in detail.

The main purpose of MON96 had been to draft monitoring guidelines and technical annexes to be used under the new JAMP programme (and be available for adoption or advice elsewhere as other potential users felt appropriate). The documentation on chemical monitoring of fish and shellfish was structured to include a Guideline section, which was designed to be of general applicability and to be relatively long-lived, and Technical Annexes which would be subject to more frequent revision, as analytical techniques, etc., developed and became available for use in monitoring programmes. WGEAMS agreed that although this system led to considerable repetition (redundancy) of text, it ensured that the documents were simple to read and that the complete advice on a subject could be obtained by reference to a small number of documents that were not cluttered by alternative courses of action applicable to different matrices. It was noted that the sediment Guidelines also followed the same structure.

WGEAMS noted that to use the Guidelines in the design of coordinated monitoring activities, it would be necessary for a Steering Group to meet to agree detailed objectives of the programme, and then to select those sections and topics from the overall Guidelines and Technical Annexes that were directly applicable to any particular task. The Guidelines were therefore quite comprehensive, and the detailed description of particular monitoring exercises would include appropriate extracts from the Guidelines.

Some concern was expressed that the Guidelines on fish sampling might in practice prove difficult to follow exactly. It is a common experience that the required fish species may not be present in the necessary numbers, or covering the defined size/age range and at the time and location chosen for the sampling. Such problems can be reduced by appropriate interaction between programme designers and fisheries scientists. However, deviations from the sampling guidelines have given rise to difficulties in data assessment, where the exclusion of all data which did not meet all the Guidelines can greatly reduce the data available to the assessors, while inclusion of the data could lead to uncertainties in the degree to which comparisons might be valid. WGEAMS recognized that the Sampling Guidelines had been drawn up with the intention of, for example, allowing existing programmes to continue, or minimising the sampling variance, or investigating the spatial distribution of contaminants, and that in some cases indications had been given of the flexibility in the requirements. In some cases the requirements seemed rather demanding, and in others rather lax. WGEAMS felt that it would be very helpful to data assessors if some guidance could be given to them on the policy to be adopted towards data on samples that did not fully meet the Sampling Guidelines. As an initial approach to this question, WGEAMS recommended that ACME ask WGSAEM to consider whether it would be possible to include data on samples which did not fully meet the Sampling Guidelines in data assessments, and the effect that the inclusion of such data would have on the confidence the assessors could have in the overall assessment, or whether such data should be excluded.

WGEAMS reviewed the Purposes of the Biota Monitoring Guidelines, as given in paragraph 2 of Annex 5 of the MON96 report (WGEAMS97/7/2). WGEAMS noted that the Purposes appeared to have been derived partially from the Purposes of the old Joint Monitoring Programme (JMP), but had been significantly improved and clarified. Reference to monitoring to protect public health (food assurance, food quality) had been removed, and this subject was not included in the JAMP. WGEAMS endorsed the statements of Purpose a. (temporal trend monitoring) and Purpose b. (spatial distribution monitoring), and welcomed the clear statements of these Purposes. Purpose c. appeared more complicated, as it related to harm to living resources and marine life, and therefore covered the effects of chemicals on organisms. Purpose c.i. (to identify sites where contaminant-specific biological effects programmes should be applied) was very similar to Purpose b. (to assess the existing level of marine contamination ...), and was a slightly different application of rather similar data.

Purpose c.ii. (to investigate the chemical cause of observed biological effects) represented a clear link to the monitoring objectives based around biological effects measurements. ICES current advice is that biological effects and chemical monitoring should proceed in an integrated manner. WGEAMS agreed that detailed Guidelines and Technical Annexes should be completed for Biological Effects Monitoring, and that they should include such matters as sampling, sample preservation, sample pooling strategies, etc. It is likely that they will differ from those given for chemical monitoring in the Biota Guidelines. It is therefore necessary that integrated biological and chemical programmes are planned in detail, and that the requirements in such areas as sample mass, sample preservation, pooling procedures, and data interpretation are fully considered during the design of the programme to allow full advantage to be taken of the integrated approach.

WGEAMS noted that there might be scope to reduce the cost of monitoring data through multi-purpose cruises on research vessels, for example, taking advantage of sampling opportunities on surveys such as the annual International Young Fish Survey cruises, and that this could serve to encourage the integration of chemical and biological measurements.

WGEAMS agreed that the new JAMP Guidelines for chemical monitoring of fish and shellfish did not conflict with current ICES advice on monitoring strategies, but that procedures needed to be incorporated elsewhere in the JAMP Guidelines (perhaps in the Biological Effects Measurement Guidelines) that would ensure that, in programmes addressing Purpose c., the needs of both chemical and biological measurements would be met and the programme fully integrated.

8 PLANS FOR A THEME SESSION/SYMPOSIUM/WORKSHOP ON RISK EVALUATION IN ENVIRONMENTAL MONITORING AND ASSESSMENT, DEVELOPED JOINTLY WITH WGSAEM

A recommendation of the joint meeting of WGEAMS and WGSAEM (JEASA) in Stockholm in March 1996 was that a theme session, symposium or workshop should be organized on risk evaluation in environmental monitoring and assessment. WGEAMS supported this proposal, as reflected in the 1996 WGEAMS report, Section 15.

Risk assessments and evaluations are in use both for national and international purposes. However, the targets for such use are usually designed for specific topics. The CHARM model (Chemical Hazard Assessment and Risk Management) is an example of such a purpose. CHARM has been developed primarily for classifying chemicals used in the offshore oil and gas industries. Another example is the mandatory requirement for oil companies developing oil and gas fields on the Norwegian Shelf to produce an environmental risk assessment analysis when they apply for discharge permissions prior to drilling activities.

WGEAMS had available the draft 1997 WGSAEM report together with three 1997 WGSAEM working documents for its discussion on risk assessments and evaluations. WGEAMS did not review the documents in detail, but recognized that statistical tools existed and were under development that would be of importance in the development of concepts and guidelines in the field of risk evaluation and assessment in relation to monitoring and environmental assessments.

The understanding of the word 'risk' could include such various issues as, for example:

- the risk of damaging a certain part of a marine ecosystem due to a special event (an accidental release of a chemical or an oil blow-out);
- the risk of not detecting an undesirable or detrimental trend in an area, due to an inadequate monitoring scheme;
- the risk that a certain contaminant in marine food could interfere with aspects of human health;
- risk evaluations could be a valuable tool to assist in the development of appropriate and cost-effective monitoring programmes, for example, in relation to pre-established targets or objectives;
- assessing the risk for changes in a certain marine ecosystem due to an observed level of a specific contaminant in target biota.

WGEAMS discussed at length various aspects of risk evaluation and assessment and their use in monitoring. The discussion reinforced the conclusion from the 1996 WGEAMS discussion regarding the need to organise a broader discussion, including specialists in the various topics of risk evaluations and assessments. WGEAMS noted an *International Conference on Mapping Environmental Risks and Risk Comparison* to be held 21–24 October 1997 in Amsterdam. Although this conference is aimed mainly at terrestrial problems, the range of topics included in the scope of the conference and its scientific programme demonstrate the complexity and wide scientific field that can be included in the term risk evaluation and assessment.

It was suggested that the use of risk evaluation and assessment could be put in a more pragmatic context to answer questions such as:

- how often do you have to sample and at how many sites, to be able to recognize trends;
- how do you need to construct your monitoring if the purpose of the monitoring is to give warnings;
- what are the consequences or significance of a break (increase or decrease from a certain reference or target value) in a trend;
- is it possible to assess the consequences of not having monitored a certain contaminant or the distribution of a certain marine population, if an unexpected event happens.

WGEAMS acknowledged that within the ICES scientific field there are well-established monitoring programmes for a wide range of topics, including fish stocks, hydrography, fish disease, environmental contamination, etc. and that the techniques used to develop such programmes may well include risk assessments of the value of the monitoring. For further work in the field of risk evaluation and assessment, it would be appropriate to include such established operational aspects.

WGEAMS discussed how to proceed with this topic and came to the conclusion that a Workshop involving marine scientists and other specialists would be the best place to develop and draw up appropriate guidelines. A theme session or a mini-symposium at the Annual Science Conference certainly could draw the attention of scientists from a wide audience within the ICES circle, but was unlikely to attract the necessary external experts in risk evaluation.

WGEAMS felt it premature to arrange a workshop before it was able to address the topic more thoroughly. The conclusion of the discussion was that WGEAMS recommends that ICES should convene a Workshop on risk assessments and evaluations and that members of WGEAMS, together with members of WGSAEM, should work intersessionally to clarify specific topics for such a workshop.

9 REVIEW OF THE OUTCOME OF THE STUDY GROUP ON MONITORING PROGRAMMES FOR CONTAMINANTS IN SEDIMENTS (SGMPCS)

ICES had agreed with the recommendations from the 1996 meetings of WGSAEM and WGEAMS that a Study Group including members from several Working Groups (including WGSAEM, MCWG, WGEAMS and WGMS) should be formed to formulate advice on the design of monitoring programmes for contaminants in sediments. However, ICES had not been able to support the recommendation that the Study Group meet in 1996/1997, but required that the group work initially by correspondence under the Chairmanship of Dr S Rowlatt (UK).

WGEAMS was not aware that any significant progress had yet been made, although it was understood that Dr Rowlatt intended that the SGMPCS should work by e-mail, and report to ACME before its June 1997 meeting.

WGEAMS regretted that ICES had been unable to support a meeting of the Study Group during the current annual cycle, but noted that there was still time for SGMPCS to contribute effectively to the design of new international monitoring programmes. WGEAMS urged ACME to ensure that SGMPCS completes its task in time for the 1998 ACME meeting.

10 REVIEW OF INFORMATION GATHERED INTERSESSIONALLY, IN COLLABORATION WITH MCWG, ON VARIANCE COMPONENTS IN SEABIRD EGG ANALYSES

A representative from WGEAMS (Kari Stange) attended the 1997 meeting of MCWG and served as a link between the two groups. MCWG felt that they did not have the expertise present at their meeting to address the issue of variance components in seabird egg analysis. WGEAMS noted that MCWG had decided to approach the issue at their next meeting and to invite Anders Bignert (Stockholm Museum of Natural History) to give a plenary presentation on the use of guillemot eggs in the Swedish national monitoring programme. WGEAMS recommends that this presentation include statistical aspects of the work, allowing the quantification of variance components.

Information on variance components of contaminants in seabird eggs monitored in the German national monitoring programme had been made available to the MCWG (and subsequently to WGEAMS) by Prof. P. Becker (WGEAMS97/10/1, 4–6). In addition to this documentation, recent publications with relevant information on contaminants in eggs from several species of seabirds from northern Norway (WGEAMS97/10/2), in guillemots (*Uria aalga*) in the Baltic Sea (WGEAMS97/10/7), and on organochlorines in different tissues of herring gull (*Larus argentatus*) (WGEAMS97/10/3) were available to WGEAMS. A report (WGEAMS97/10/8) on congener patterns of PCBs in kittiwakes (*Rissa tridatyla*) in relation to mobilization of body lipids associated with reproduction was also available and may provide useful information on the tissue distribution of contaminants within marine birds. Although kittiwake is not on the list of species in the JAMP Guidelines, the processes discussed in the paper need to be borne in mind during the interpretation of monitoring data.

One of the advantages associated with the use of seabird eggs as a matrix for monitoring contaminants is that some of the variance factors inherent in other matrices are comparatively small in eggs. Only one sex, females, produce eggs, and the egg-laying season is fixed within a narrow time window. Eggs provide a well-defined biological matrix as compared to specific tissues within an organism requiring dissection and sub-sampling. However, when designing or reviewing programmes which use seabird eggs as a matrix for monitoring spatial and temporal trends of contaminants, knowledge of several variance components is required, for example:

- variability between eggs within the same clutch;
- variability between clutches within the same site;
- variability between sites within the same year;
- variability between years at the same site;

- analytical variance within a laboratory, within a year;
- analytical variance within a laboratory, between years;
- analytical variance between laboratories.

In the documentation provided, information could be found on between-area variations of concentrations of mercury and organochlorine contaminants in eggs of the common tern (*Sterna hirundo*) and oyster catcher (*Haematopus ostralegus*) on the German coast of the North Sea. In addition, estimates of the variance between clutches within the same area and variation between eggs within the same clutch were available for these species from the German coast of the North Sea.

Information on between-site and within-site variances of mercury and organochlorine concentrations was available for eggs from several species of seabirds from the northern Norway/Barents Sea area.

Data on DDT, PCBs, and eggshell parameters in guillemots (*Uria aalga*) monitored in the national Swedish monitoring programme have recently been published. Differences in contaminant content and eggshell parameters between the first egg and replacement eggs were investigated and several relevant variance components presented.

Little information is available on the analytical variance factors for seabird egg analysis. Seabird eggs have not, to our knowledge, been included in international interlaboratory testing schemes, nor are there any Certified Reference Materials available for contaminants in this matrix. The analytical variability is therefore difficult to assess. To improve this situation, the inclusion of seabird eggs as a matrix should be considered by the administrators of initiatives such as QUASIMEME.

In reviewing the various documents addressing the issues of contaminants in seabird eggs, WGEAMS felt that the support of statisticians was needed to evaluate the completeness and usefulness of the information provided. The documents are therefore included as Annex 4 to this report (for the attention of ACME) with the recommendation that analysis of the data is included in the terms of reference for the 1998 meeting of WGSAEM.

11 REVIEW OF PROGRESS IN THE PREPARATION OF A REPLY TO THE IWC ENQUIRY CONCERNING THE EFFECTS OF CONTAMINANTS ON THE ABUNDANCE AND QUALITY OF CETACEAN PREY

At its meeting in 1996, WGEAMS had discussed different ways to respond to a question received from the International Whaling Commission (IWC) concerning areas where chemical contamination was adversely affecting the quantity and quality of prey for cetaceans. Following the 1996 meetings of WGEAMS and ACME, in order to assist in the formulation of a reply, the IWC had been asked to provide information on the diet and feeding locations of cetaceans in the ICES area. Up until the date of the present meeting of WGEAMS, the IWC had not provided the requested information.

The current meeting of WGEAMS considered this subject again, but in the absence of the information requested from IWC, was only able to make general comments on one aspect of the question, namely the effects of contaminants on the quality of cetacean prey, as indicated by the presence of persistent organic contaminants in prey species. It is known that there is potential for persistent organic contaminants (e.g., CBs, dioxins, dieldrin, DDT compounds) to adversely affect a wide range of marine predators, for example, through the inhibition of reproduction in seals or the thinning of egg shells in some bird species.

The primary uptake route for these compounds is through the diet. The resultant concentrations and patterns of compounds in the predators, including cetaceans, are therefore a function of intake (species composition of diet, concentrations of contaminants in dietary species, variations of diet and its contaminant burden in space and time, age, etc.) and loss mechanisms (e.g., condition of the animal, reproductive status, excretion rate, metabolic abilities and activity). For example, the loss of lipophilic contaminants during lactation has been shown to lead to considerable differences in contaminant concentrations between mature males and females of some species. Different species show different abilities to metabolise or degrade organic contaminants.

Consequently, there are often very large differences (e.g., factors of 1000) in the concentrations of organic contaminants among individuals of the same species (e.g., differences between old mature males and newly born young). The patterns of CB congeners found in marine mammals show greater consistency than the absolute concentrations and species-specific patterns can be recognized which have resulted from factors indicated above, for example, differences in diet and metabolic capability.

Data are presented in WGEAMS97/11/1 (*Effect of diet on organochlorine patterns in marine mammals from northern European waters*, D.E. Wells, C. McKenzie, and H.M. Ross; included as Annex 5 to this report) demonstrating species-specific patterns of CBs in marine mammals from northern European waters. Marine mammals feeding on similar food in localised areas show similar congener patterns, but species feeding at different trophic levels (i.e., on different prey species) are likely to have distinctly different CB patterns, reflecting different uptake and metabolic processes. Broad divisions can be drawn between fish feeders, mixed feeders, and cephalopod feeders.

CB congener patterns in prey species, e.g., fish, also show geographical differences, which appear to be linked to proximity to coasts and to mode of transport of the contaminants (e.g., atmospheric versus aquatic mechanisms). Wells *et al.* (WGEAMS97/11/1) demonstrated differences in CB patterns between fish from the northern and western coasts of Scotland.

While the pattern of congeners in the prey species clearly influences the pattern in the predator species, the 'quality' of the prey is also dependent on the absolute concentrations of contaminants in the prey and their potential to induce adverse effects in the predators. These concentrations vary geographically; for example, concentrations of CB congeners in cod liver are a factor of ten higher in the Southern Bight of the North Sea than in the northern North Sea (North Sea Task Force, 1993) and differences have been reported between various areas of the Scottish coast (Kelly and Campbell, 1994). There is very little information available on the acceptable concentrations of organic contaminants in cetacean prey. However, criteria have been set by several agencies for concentrations of selected organic contaminants in fish tissue to protect wildlife, with particular reference to the Great Lakes. These are summarized in the following table.

Table 11.1. Guidelines for the concentrations (wet weight) of selected organic contaminants in fish species.

Contaminant	**(a) IJC** (Fish tissue)	**(b) EQG** (Fish tissue)	**(c) USEPA** (Fish tissue)	**(d) Dietary NOAEC values**
2,3,7,8-TCDD		1.1 pg g^{-1}	0.5 pg g^{-1}	2 pg g^{-1} food
DDT	1.0 µg g^{-1}	0.0063 µg g^{-1}	0.039 µg g^{-1}	100 µg g^{-1}
Total PCBs	0.1 µg g^{-1}	0.06 µg g^{-1}	0.16 µg g^{-1}	0.072 µg g^{-1}
Mirex				
Toxaphene				(e) (4 µg g^{-1})
Aldrin/Dieldrin	0.3 µg g^{-1}			5 µg g^{-1}

(a) International Joint Commission (IJC) Annex 1, objectives for protection of aquatic life and wildlife (concentrations in whole fish).

(b) Draft Canadian Environmental Quality Guidelines (EQG) for protection of animals that consume aquatic biota (Environment Canada, 1996).

(c) USEPA guideline values for assessment of hazards to fish-eating wildlife (USEPA, 1995).

(d) Dietary No Adverse Effect Concentrations (NOAEC) for reproductive effects on mink (Giesy *et al.*, 1994).

(e) NOAEC for thyroid effects in rats and dogs (Chu *et al.*, 1986).

It may be noted that there can be considerable differences between the values given by different agencies for the same contaminant group, particularly for ΣDDT. There are no values available for mirex or toxaphene. The values for mink (and other terrestrial mammals) are given because they are well supported by experimental data and mink have been shown to be relatively sensitive to these contaminants in their diet. The values may, therefore, give some limited guidance on levels which may have no effect on other mammals, such as cetaceans.

In the absence of detailed advice on the diets and feeding locations within the ICES area of the cetacean species of concern, only very general comparisons can be made between the values in the table above and the concentrations of contaminants found in fish liver in the ICES area. Data for North Sea fish species are available for eleven Sub-Regions as a map in the North Sea QSR (North Sea Task Force, 1993, Figure 3.7). Data for Swedish coastal waters were provided at the WGEAMS meeting. The ranges of concentrations may be summarized as follows:

Table 11.2. Summary of the concentration ranges (wet weight) of selected organic contaminants in fish tissue in the North Sea and Swedish coastal waters. [Note: HM = herring muscle.]

Contaminant	Fish liver North Sea $\mu g\ g^{-1}$	Cod liver West Sweden $\mu g\ g^{-1}$	Cod liver Baltic Sea $\mu g\ g^{-1}$
Sum 7 CBs	0.2–6	0.18–0.23 0.004–0.009 (HM)	0.4–0.6 0.004–0.014 (HM)
Dieldrin	0.01–0.16		
Sum DDT	0.1–1.2	0.06–0.08 0.002–0.006 (HM)	0.6–0.8 0.002–0.014 (HM)

It would appear from these data that the concentrations of CBs and total DDTs in the ICES area can exceed the environmental guidelines given in Table 11.1. This suggests that there is a potential for the chemical quality of potential prey species (fish) to be adversely affected by current (1990–1996) organic contaminant concentrations in these fish in the North Sea and the Baltic Sea. However, such comparisons must be made with considerable caution, as some of the environmental guidelines clearly refer to whole fish, whereas the chemical analyses are of defined organs/tissues. Cetaceans will consume entire prey, or at least are unlikely to effectively separate and selectively consume particular organs. As these contaminants are lipophilic, it is likely that the data for fish liver will be an overestimate of the concentrations in whole fish, whereas the data for herring muscle may be an underestimate of the concentrations in whole herring. No information has been made available concerning the feeding locations or preferred prey species of the cetaceans. If a more complete analysis, taking these factors into account, tends to confirm that there may be some potential for effects, it would be necessary to undertake programmes of appropriate observations on the target organisms (the cetaceans) themselves in an integrated biological and chemical programme.

Recent compilations of data under the AMAP programme have emphasized the occurrence of high mercury and cadmium concentrations in the kidney and liver of a range of Arctic marine mammals and birds. High concentrations have also been found in redfish (*Sebastes marinus* and *Sebastes mentella*) in the Iceland/Greenland area (Stange *et al.*, 1996), and there are suggestions that some other species of deep-water fish may accumulate high concentrations of these elements. There may be some potential for these or other deep-water species to act as prey species for cetaceans. The significance of these metals to the fish species (and to their predators) is not yet understood.

References

Chu, I., Villeneuve, D.C., Sun, C.-W., Secours, V., Procter, B., Arnold, E.P., Clegg, D.J., Reynolds, L., and Valli, V.E. 1986. Toxicity of toxaphene in the rat and Beagle dog. Fundamentals of Applied Toxicology, 7: 406–418.

Environment Canada. 1996. Draft environmental quality guidelines for PCBs, DDT, PCDD/Fs and cadmium. Environmental Conservation Service, Evaluation and Interpretation Branch, Ottawa K1A OH3.

Giesy, J.P., Verbrugge, D.A., Othout, R.A., Bowerman, W.W., Mora, M.A., Jones, P.D., Newsted, J.L., Vandervoort, C., Heaton, S.N., Aulerich, R.J., Bursian, S.J., Ludwig, J.P., Dawson, G.A., Kubiak, T.J., Best, D.A., and Tillitt. D.E. 1994. Contaminants in fish from Great Lakes-influenced sections and above dams of three Michigan rivers. II: Implications for health of mink. Archives of Environmental Contamination and Toxicology, 27: 213–223.

Kelly, A.G., and Campbell, L.A. 1994. Organochlorine contaminants in liver of cod (*Gadus morhua*) and muscle of herring (*Clupea harengus*) from Scottish waters. Marine Pollution Bulletin, 28: 103–108.

NSTF. 1993. North Sea Quality Status Report 1993, p. 47. Oslo and Paris Commissions, London.

Stange, K., Maye, A., and Klungsøyr, J. 1996. Contaminants in fish and sediments in the North Atlantic Ocean. Tema: Nord, 522. 79 pp.

USEPA. 1995. Great Lakes Water Quality Initiative Criteria documents for the protection of wildlife. EPA-820-B-95-008. U.S. Environmental Protection Agency, Office of Science and Technology, Washington, D.C.

WGEAMS recommends that ACME convey the above text to the IWC, together with Annex 5, as a partial response to their enquiry.

12 ANY OTHER BUSINESS

12.1 Comments on the Report of the OSPAR/ICES Workshop on the Overall Evaluation and Update of Background/Reference Concentrations for Nutrients and for Contaminants in Sea Water, Biota, and Sediment

WGEAMS was asked to review and comment on the Report of the OSPAR/ICES Workshop on the Overall Evaluation and Update of Background/Reference Concentrations for Nutrients and for Contaminants in Sea Water, Biota and Sediment (22–25 October 1996). WGEAMS felt that the participants did the best they could with the material available at the workshop. Every type of background/reference concentration (BC) is defined with cautious 'scientific settings', including application tests on monitoring data. MCWG and WGMS also made comments on this report. It appears that, although the workshop improved the 1992 document, there are still very considerable scientific reservations concerning technical questions and philosophical matters (e.g., terminology, pristine area approach). It is recommended that the remarks made by MCWG and WGMS (and possibly other WGs) should be forwarded to OSPAR.

Nevertheless, WGEAMS recognized that this document is likely to be used by OSPAR MON98 in a first step to gain experience in the usefulness of Background Concentrations as assessment criteria in the framework of assessment of data from OSPAR monitoring programmes. In recognition of this, WGEAMS discussed how these values might be used, and the appropriate responses to field data that fell above, below, or within the Background Concentration ranges.

One of the main problems in issuing such an assessment tool is the potential for misuse of the Background/Reference Concentrations. The term 'background' has different meanings in radiology, epidemiology, geochemistry, etc. It is often the case that a contamination problem is brought to the public as a level of 'ten to a hundred times the background concentration'. Such statements cannot readily be translated into hazard or risk, either to the environment or to man. The Background Concentrations developed by the Workshop, as pointed out in the report, have been derived from data representing different time frames, and on different geographical bases (e.g., areas relevant to the QSR 2000, or 'pristine' areas). Such factors are the origin of many of the technical and conceptual criticisms that have been directed at this report.

With regard to using the Background Concentrations in an assessment of the acceptability of the environmental quality as revealed by monitoring data, it is worth noting that the Background Concentrations do not necessarily represent an ecologically desirable condition. For example, pristine areas in the Arctic can be contaminated by certain organic contaminants (owing to atmospheric deposition) to the extent that concern can be expressed for the health of top predators in these areas. It is recent experience in Sweden that otters are returning to populate certain lakes, but that they tend to be found in lakes suffering from eutrophication rather than in pristine oligotrophic lakes. It has been suggested that this may arise through a reduction in the availability of toxic organic contaminants through their incorporation into the enriched plant growth in the lakes.

As indicated in the Workshop report, Background Concentrations defined in it should not be used as targets. In order to contribute to a proper use of the report, WGEAMS discussed the different conclusions that might be drawn when assessing data by comparison with the Background Concentration (BC) values. Such an attempt contains large elements of uncertainty; for example, it is not clear what levels of uncertainty apply to the specified boundaries of the BC ranges, how analytical and other variances are to be handled, and whether comparisons should be made using means, medians, upper quartiles, or some other summary statistics of the field data. However, putting these problems aside (temporarily), the main possibilities are that the observed values will be stated to fall below, within, or above the defined BC ranges. Some of the possible conclusions and actions that might result from such observations are outlined below:

Range of concentrations found	Conclusions
Between 0 and bottom of the BC range	• This probably represents positive conditions, but where have the contaminants gone? • Should the BC range be revised? • Is it an unusual occurrence, a response to an unusual event? • Is there a new process operating, or have inputs of contaminants fallen? • Check analytical QA and look for any procedural errors!
Within the BC range	• Probably no cause for concern? • No action required? • Conclusions on acceptability will depend on whether it is considered that the BC range represents a desirable condition, or an acceptable degree of contamination.
Above the BC range	• Select other tools to refine the assessment (such as food quality standards or undertake biological effects measurements). • Investigate the reasons for the observed concentrations. Attempt to identify probable causes (e.g., discharges, geochemical factors, natural processes). • Undertake investigations to determine whether the concentrations are harmful (biological effects measurements). • If any effects have been observed, assess their biological significance.

Clearly, the above represents preliminary considerations of the possible conclusions and subsequent actions. Even within this limited discussion, it appears that interpretation of the field observations will not be straightforward, nor will the conclusions be unambiguous.

12.2 Use of Assessment Criteria in the Preparation of the Ecotoxicological Section of the AMAP Report

In its 1996 report, WGEAMS considered the marine component of the Arctic Monitoring and Assessment Programme (AMAP). The entire Arctic Assessment Report (AAR) is now being finalized and will be available in printed form in the summer of 1997. WGEAMS 1996 recognized that the major threats from contaminants in the Arctic were most likely to appear at higher trophic levels. C. de Wit presented the strategy that AMAP had used to assess the potential for biological effects from current organochlorine concentrations in Arctic biota. The objective of this approach was to identify species potentially at risk, as it is difficult and expensive to carry out screening studies for biological effects in the Arctic, and resources for field programmes are usually very limited. Thus, it was important to try to determine which species may be at risk, for which types of effects, and from which contaminants, in order to target future biological effects studies and monitoring programmes effectively.

In a first step, the range of chemical contaminant levels in each Arctic species for which data were available was compared to known threshold levels (no effect levels (NOELs); low effect levels (LOELs); EC50s; other biological endpoints) for similar species taken from the literature. These were available primarily for the effects of DDTs, PCBs, PCDDs/PCDFs and some pesticides in mammals and birds, and toxaphene in fish. For mammals, the comparisons were made on a lipid weight basis in order to normalize the data for the different tissue types analysed. For birds, most data were available for eggs on a wet weight basis, both as concentration levels and as thresholds and, where possible, comparisons were performed on this basis.

As a second step, the risks from dietary intake were assessed using information on different species' food preferences and the range of chemical concentrations in their diet. The contaminant concentrations in food items for predators were compared to dietary no effects concentrations/low effects concentrations (NOEC/LOEC) taken from the literature.

In a third step, the concentrations in food items for predatory species were compared to environmental quality guidelines for protecting aquatic wildlife derived by the U.S. Environmental Protection Agency, Environment Canada, and the International Joint Commission (Great Lakes).

Using this combination of comparisons, it was possible to identify species potentially at risk for biological effects based on the concentrations of contaminants in their bodies and/or on the dietary intake (e.g., for predatory birds, polar bears, Arctic fox, some pinnipeds and cetaceans), in which effects might be suspected to occur (e.g., reproductive, immunosuppressive, neurobehavioural effects) and instances where contaminants might be the cause of these (e.g., DDTs, PCBs, PCDDs/PCDFs, chlordane). In a few cases, biological effects studies had been carried out on species in the Arctic region. Where comparisons were possible, a few species suspected to be at risk also had subtle but measurable biological effects that were correlated to organochlorine concentrations (e.g., in peregrine falcons, polar bears).

Based on this assessment for persistent organic pollutants (POPs), the authors of the AAR chapter on POPs recommended that levels of POPs in the abiotic environment and in biota continue to be monitored and that chemical contaminant monitoring be combined with biological effects monitoring in the species assessed as being at risk for potential biological effects. This will require the refinement and development of sensitive assays at the biochemical or physiological level for use in Arctic biota. Research on immunology and immunosuppression and on reproduction in the species identified as most at risk was also recommended, particularly with reference to the possible sensitivity of species with delayed implantation, including mustelids, seals, and polar bear.

The assessment method used by AMAP was discussed by WGEAMS in the context of the current development of environmental assessment criteria by OSPAR (WGEAMS97/12/4-6). The OSPAR Ecotoxicological Assessment Criteria (EAC) approach is rather different from the assessment methods used in the AMAP process, although both approaches have some similar goals, i.e., "to identify possible areas of concern and to diagnose which substances could be considered a priority" and to "implement an integrated chemical and biological effects monitoring programme" (recommendations of the Third OSPAR Workshop on Ecotoxicological Assessment Criteria). WGEAMS noted that the AMAP procedures relied heavily on direct relationships between contaminant concentrations in organisms and the biological effects observed in the same organisms. In some cases, use had been made of experimental data relating dietary contaminant burdens to biological effects in predators. The AMAP assessors were able to concentrate on a relatively small number of top predators as being at risk through dietary intake of contaminants. This may be contrasted with the OSPAR EAC document, which mainly seeks to derive concentrations in inorganic media (water, sediment) which are 'safe' in that they show insignificant potential for biological effects in species at a range of trophic levels, exposed through different routes. The more direct approach adopted by AMAP is more closely identifiable with current ICES advice on monitoring strategies in that it seeks to combine chemical and biological effects measurements in sensitive species.

12.3 Review of SIME Approach to the Problem of Endocrine Disruptors

The document 'SIME line of action regarding endocrine disruptors' (WGEAMS97/12/3) was discussed by WGEAMS. It was noted that although the two alternative definitions of endocrine disruptors given in the above document are general, the rest of the text deals implicitly with only one specific group of endocrine disruptors, namely, environmental oestrogens. It was also noted that, in defining potential endocrine disruptors, the structural resemblance of the **contaminant as well as its metabolites** should be considered, as in some cases it is the metabolites that are biologically active as endocrine disruptors. The research and development activities proposed in the SIME document relate to methods to determine oestrogenic effects in fish and invertebrates. The screening that is proposed once these methods are in place has clear roles concerning oestrogenic activity, but has limited use for studying endocrine disruption in general.

ACME presented a discussion on hormonal/endocrine disruptors in its 1996 report, defining them as falling into five classes: oestrogens, anti-oestrogens, androgens, anti-androgens, or substances which affect the hormonal system indirectly, i.e., do not act directly via specific receptors (ICES, 1996). Even this limits the scope of the definition of endocrine or hormone disruptors, because living organisms have numerous endocrine systems regulated by hormones and many of these are disrupted by exposure to contaminants. These disruptions include adverse effects on the adrenal gland (hyperplasia, necrosis, changes in circulating adrenocortical hormones), the thyroid gland (hyperplasia, reduced plasma thyroid hormone levels), the immune system (various types of immunosuppression), and vitamin A homeostasis.

Many of the organochlorine endocrine disruptors listed in the SIME document are known to cause multiple effects on endocrine systems. For example, o,p′-DDT is oestrogenic (Kupfer and Bulger, 1980; Mason and Schulte, 1980), but p,p′-DDE is anti-androgenic (Kelce *et al.*, 1995). Methylsulfone metabolites of DDE bind covalently to the adrenal gland causing damage (Lund *et al.*, 1988; Brandt *et al.*, 1992; Jönsson *et al.*, 1991, 1992). DDT also causes immunosuppression and induces liver enzymes (Banerjee *et al.*, 1986; Banerjee, 1987; Nebert and Gonzalez, 1987; Wong *et al.*, 1992). PCBs and PCDDs/PCDFs disrupt the immune system, affect the adrenal and thyroid glands, induce liver enzymes and disrupt vitamin A homeostasis (Ahlborg *et al.*, 1988, 1992; WHO, 1989; Safe, 1990, 1994). Beta-

HCH is oestrogenic (Wester *et al.*, 1985; Van Velsen *et al.*, 1986; Wester, 1991), whereas lindane can show both oestrogenic and anti-oestrogenic properties (Chadwick *et al.*, 1988; WHO, 1992).

The current dramatic increase of interest in endocrine disruptors has partly arisen because of observations of effects in biota in field studies, as discussed in the ACME report in relation to environmental oestrogens (ICES, 1996). Part of the discussion has also arisen because the toxic mechanisms of action of many known contaminants are now being understood in the context of biological effects at the molecular level instead of at the organism or population level. Because of this new information, it is now recognized that many organochlorine compounds that have been studied for many years exert their toxicity by disrupting endocrine systems (Colborn *et al.*, 1993). Several interact with receptors such as the dioxin receptor (which behaves like a hormone receptor) to elicit responses having multiple effects on endocrine systems (Ahlborg *et al.*, 1988, 1992; WHO, 1989; Safe, 1990, 1994). Hydroxylated PCB metabolites and pentachlorophenol have been shown to bind to the thyroxin binding site on transthyretin, the plasma transport protein for thyroid hormones and vitamin A (Brouwer and van den Berg, 1986; Brouwer *et al.*, 1988, 1990; van den Berg, 1990; Bergman *et al.*, 1994).

Liver enzyme (P450) induction can cause indirect effects on endocrine systems by changing the rate of metabolism of endogenous hormones, upsetting the fine balance of these hormones in the organism and leading to disruptive effects (Kupfer and Bulger, 1976). Most of the organochlorines on both lists in the SIME document (WGEAMS97/12/3) are known to induce liver P450 enzymes. Many of the substances listed as 'provisional' should be moved to the other list if the lists are to cover endocrine disruptors in a wide sense, and not simply be restricted to environmental oestrogens, as many of these have other endocrine effects. For example, toxaphene has been shown to be oestrogenic (Soto *et al.*, 1994). Toxaphene, hexachlorobenzene (HCB), dieldrin, endosulfan, and chlordane all affect the immune system (Loose *et al.*, 1981; Loose, 1982; Spyker-Cranmer *et al.*, 1982; Allen *et al.*, 1983; Vos, 1986; Barnett *et al.*, 1987; Vos and Luster, 1989; Van Loveren *et al.*, 1990; Wong *et al.*, 1992; Naqvi and Vaishnavi, 1993) and induce liver enzymes (den Tonkelaar and van Esch, 1974; Zavon and Stemmer, 1975; Peakall, 1976; Campbell *et al.*, 1983; Rush *et al.*, 1983; WHO, 1984; Naqvi and Vaishnavi, 1993; Goksøyr, 1995). Toxaphene and HCB affect the thyroid gland (Hurst *et al.*, 1974; Chu *et al.*, 1986; Den Besten *et al.*, 1993). Pentachlorophenol is missing from the lists, but has been shown to bind to transthyretin as previously stated. Mirex is also missing from the lists but is known to affect the immune system and to induce liver enzymes (Iverson, 1976; Fabacher and Hodgson, 1976; Villeneuve *et al.*, 1977, 1979; Kaminsky *et al.*, 1978; Warren *et al.*, 1978; Chambers and Trevathan, 1983; Wong *et al.*, 1992).

It may be noted that both the SIME document and the ACME report largely disregard effects on birds and marine mammals, although in most cases it is now recognized that the biological effects now known as endocrine disruption were first seen in these animals (e.g., eggshell thinning in birds, reproductive failure in seals). Monitoring of seabird eggs is now included in the OSPAR JAMP guidelines, and biological effects monitoring could include methods to determine endocrine effects. There are a number of non-destructive methods available, such as the determination of circulating hormone levels in plasma (oestrogens, androgens, thyroid hormones, adrenocorticosteroids, etc.) as well as a number of tests of the immune system that can be carried out on blood samples. Some of these may be worth further investigation with a view to their use in a biological effects monitoring programme for endocrine effects in fish and seabirds. Pathological/histological studies may also be appropriate in some cases.

WGEAMS supports the spirit of the SIME and ACME documents, but recommends that a review document be prepared by the appropriate experts addressing the entire scope of endocrine disruption as it pertains to the marine environment and the interests of OSPAR, HELCOM and ICES. The document should also address methods that may be available or that could easily be developed to measure other types of endocrine disruption than oestrogenic effects.

References

Ahlborg, U.G., Håkansson, H., Wærn, F., and Hanberg, A. 1988. Nordisk dioxinriskbedömning. NORD 1988:7. Nordic Council of Ministers, Copenhagen, Denmark.

Ahlborg, U.G., Hanberg, A., and Kenne, K. 1992. Risk assessment of polychlorinated biphenyls (PCBs). NORD 1992:26, Nordic Council of Ministers, Copenhagen, Denmark.

Allen, A.L., Koller, L.D., and Pollock, G.A. 1983. Effect of toxaphene exposure on immune responses in mice. Journal of Toxicology and Environmental Health, 11: 61–69.

Banerjee, B.D. 1987. Effects of sub-chronic DDT exposure on humoral and cell-mediated immune responses in albino rats. Bulletin of Environmental Contamination and Toxicology, 39: 827–834.

Banerjee, B.D., Ramachandran, M., and Hussain, Q. 1986. Subchronic effect of DDT on humoral immune response in mice. Bulletin of Enviromental Contamination and Toxicology, 37: 433–440.

Barnett, J.B., Barfield, L., Walls, R., Joyner, R., Owens, R., and Soderberg, L.S.F. 1987. The effect of *in utero* exposure to hexachlorobenzene on the developing immune response of BALB/c mice. Toxicology Letters, 39: 263–274.

Bergman, Å., Klasson Wehler, E., and Kuroki, H. 1994. Selective retention of hydroxylated metabolites in blood. Environmental Health Perspectives, 102: 464–469.

Brandt, I., Jönsson, C.-J., and Lund, B.-O. 1992. Comparative studies on adrenocorticolytic DDT-metabolites. Ambio, 21: 602–605.

Brouwer, A., and van den Berg, K.J. 1986. Binding of a metabolite of 3,4,3′,4′-tetrachlorobiphenyl to transthyretin reduces serum vitamin A transport by inhibiting the formation of the protein complex carrying both retinol and thyroxin. Toxicology and Applied Pharmacology, 85: 301–312.

Brouwer, A., Blaner, W.S., Kukler, A., and van den Berg, K.J. 1988. Study on the mechanism of interference of 3,4,3′,4′-tetrachlorobiphenyl with the plasma retinol-binding proteins in rodents. Chemico-biological Interactions, 68: 203–217.

Brouwer, A., Klasson-Wehler, E., Bokdam, M., Morse, D.C., and Traag, W.A. 1990. Competitive inhibition of thyroxin binding to transthyretin by monohydroxy metabolites of 3,4,3′,4′-tetrachlorobiphenyl. Chemosphere, 20: 1257–1262.

Campbell, M.A., Gyorkos, J., Lelci, B., Homonko, K., and Safe, S. 1983. The effects of twenty-two organochlorine pesticides as inducers of the hepatic drug-metabolizing enzymes. General Pharmacology, 14: 445–454.

Chadwick, R.W., Cooper, R.L., Chang, J., Rehnberg, G.L., and McElroy, W.K. 1988. Possible anti-oestrogenic activity of lindane in female rats. Journal of Biochemistry and Toxicology, 3: 147–158.

Chambers, J.E., and Trevathan, C.A. 1983. Effect of mirex, dechlorinated mirex derivatives and chlordecone on microsomal mixed-function oxidase activity and other hepatic parameters. Toxicology Letters, 16: 109–115.

Chu, I., Villeneuve, D.C., Sun, C.W., Secours, V., Procter, B., Arnold, E.P., Clegg, D.J., Reynolds, L., and Valli, V.E. 1986. Toxicity of toxaphene in the rat and Beagle dog. Fundamentals of Applied Toxicology, 7: 406–418.

Colborn, T., vom Saal, F.S., and Soto, A.M. 1993. Developmental effects of endocrine-disrupting chemicals in wildlife and humans. Environmental Health Perspectives, 101: 378–384.

Den Besten, C., Bennik, M.H.J., Bruggeman, I., Schielen, P., Kuper, F., Brouwer, A., Koeman, J.H., Vos, J.G., and van Bladeren, P.J. 1993. The role of oxidative metabolism in hexachlorobenzene-induced porphyria and thyroid hormone homeostasis: a comparison with pentachlorobenzene in a 13-week feeding study. Toxicology and Applied Pharmacology, 119: 181–194.

den Tonkelaar, E.M., and van Esch, J.G. 1974. No-effect-levels of organochlorine pesticides based on induction of microsomal liver enzymes in short-term toxicity experiments. Toxicology, 2: 371–380.

Fabacher, D.L., and Hodgson, E. 1976. Induction of hepatic mixed-function oxygenase enzymes in adult and neonatal mice by kepone and mirex. Toxicology and Applied Pharmacology, 38: 71–77.

Goksøyr, A. 1995. Use of cytochrome P450 1A (CYP1A) in fish as a biomarker of aquatic pollution. Archives of Toxicology Supplements, 17: 80–95.

Hurst, J.G., Newcomer, W.S., and Morrison, J.A. 1974. Some effects of DDT, toxaphene and polychlorinated biphenyl on thyroid function in bobwhite quail. Poultry Science, 53: 125–133.

ICES. 1996. Report of the Advisory Committee on the Marine Environment, 1996, pp. 91–95. ICES Cooperative Research Report No. 217.

Iverson, F. 1976. Induction of paraoxon dealkylation by hexachlorobenzene (HCB) and mirex. Journal of Agriculture and Food Chemistry, 24: 1238–1241.

Jönsson, C.-J., Rodriguez-Martinez, H., Lund, B.O., Bergman, Å., and Brandt, I. 1991. Adrenocortical toxicity of 3-methylsulfonyl-DDE in mice. II. Mitochondrial changes following ecologically relevant doses. Fundamentals of Applied Toxicology, 16: 365–374.

Jönsson, C.-J., Lund, B.O., Bergman, Å., and Brandt, I. 1992. Adrenocortical toxicity of 3-methylsulfonyl-DDE in mice; 3: Studies in fetal and suckling mice. Reproductive Toxicology, 6: 233–240.

Kaminsky, L.S., Piper, L.J., McMartin, D.M., and Fasco, M.J. 1978. Induction of hepatic microsomal cytochrome P-450 by mirex and kepone. Toxicology and Applied Pharmacology, 43: 327–338.

Kelce, W.R., Stone, C.R. Laws, S.C. Gray, L. Kemppainen, J., and Wilson, E. 1995. Persistent DDT metabolite p,p′-DDE is a potent androgen receptor antagonist. Nature, 375: 581–585.

Kupfer, D., and Bulger, W.H. 1976. Interactions of chlorinated hydrocarbons with steroid hormones. Federation Proceedings, 35: 2603–2608.

Kupfer, D., and. Bulger, W.H. 1980. Oestrogenic properties of DDT and its analogs. *In* Oestrogens in the Environment, pp. 239–262. Ed. by J.A. McLachlan. Elsevier North Holland, New York, New York.

Loose, L.D. 1982. Marcrophage induction of T-suppressor cells in pesticide-exposed and protozoan-infected mice. Environmental Health Perspectives, 43: 89–97.

Loose, L.D., Silkworth, J.B. Charbonneau, T., and Blumenstock, F. 1981. Environmental chemical-induced macrophage dysfunction. Environmental Health Perspectives, 39: 79–91.

Lund, B.O., Bergman, Å., and Brandt, I. 1988. Metabolic activation and toxicity of a DDT-metabolite, 3-methylsulphonyl-DDE, in the adrenal zona fasciculata in mice. Chemico-biological Interactions, 65: 25–40.

Mason, R.R., and Schulte, G.J. 1980. Oestrogen-like effects of o,p′-DDT on the progesterone receptor of rat uterine cytosol. Research Communications in Chemical Pathology and Pharmacology, 29: 281–290.

Naqvi, S.M., and Vaishnavi, C. 1993. Bioaccumulative potential and toxicity of endosulfan insecticide to nontarget animals. Comparative Biochemistry and Physiology, 105C: 347–361.

Nebert, D.W., and Gonzalez, F.J. 1987. P450 genes: Structure, evolution, and regulation. Annual Review of Biochemistry, 56: 945–993.

Peakall, D.B. 1976. Effects of toxaphene on hepatic enzyme induction and circulating steroid levels. Environmental Health Perspectives, 13: 117–120.

Rush, G.F., Smith, J.H., Maita, K., Bleavins, M., Aulerich, R.J., Ringer, R.K., and Hook, J.B. 1983. Perinatal hexachlorobenzene toxicity in the mink. Environmental Research, 31: 116–124.

Safe, S. 1990. Polychlorinated biphenyls (PCBs), dibenzo-*p*-dioxins (PCDDs), dibenzofurans (PCDFs), and related compounds: environmental and mechanistic considerations which support the development of toxic equivalency factors (TEFs). Critical Review of Toxicology, 21: 51–88.

Safe, S.H. 1994. Polychlorinated biphenyls (PCBs): Environmental impact, biochemical and toxic responses, and implications for risk assessment. Critical Review of Toxicology, 24: 87–149.

Soto, A.M., Chung, K.L., and Sonnenschein, C. 1994. The pesticides endosulfan, toxaphene and dieldrin have oestrogenic effects on human oestrogen-sensitive cells. Environmental Health Perspectives, 102: 380–383.

Spyker-Cranmer, J.M., Barrett, J.B., Avery, D.L., and Cranmer, M.F. 1982. Immunoteratology of chlordane: Cell-mediated and humoral immune responses in adult mice expressed in utero. Toxicology and Applied Pharmacology, 62: 402–408.

van den Berg, K.J. 1990. Interaction of chlorinated phenols with thyroxine binding sites of human transthyretin, albumin and thyroid binding globulin. Chemico-biological Interactions, 76: 63–75.

Van Loveren, H., Krajnc, E.I. Rombout, P.H.A., Blommaert, F.A., and Vos, J.G. 1990. Effect of ozone, hexachlorobenzene and bis(tri-*n*-butyltin)oxide on natural killer activity in the rat lung. Toxicology and Applied Pharmacology, 102: 21–33.

Van Velsen, F.L., Danse, L.H.J.C., Van Leeuwen, F.X.R., Dormans, J.A.M.A., and Van Logten, M.J. 1986. The subchronic oral toxicity of the beta-isomer of hexachlorocyclohexane in rats. Fundamentals of Applied Toxicology, 6: 697–712.

Villeneuve, D.C., Yagminas, A.P., Marino, I.A., Chu, I., and Reynolds. L.M. 1977. Effects of food deprivation in rats previously exposed to mirex, PESTAB/78/0118. Bulletin of Environmental Contamination and Toxicology, 18: 278–284.

Villeneuve, D.C., Ritter, L., Felsky, G., Norstrom, R., Marino, I.A., Valli, B.E., Chu, I., and Becking. G.C. 1979. Short-term toxicity of photomirex in the rat. Toxicology of Applied Pharmacology, 47: 105–114.

Vos, J.G. 1986. Immunotoxicity of hexachlorobenzene. *In* Hexachlorobenzene: Proceedings of an International Symposium, pp. 347–356. Ed. by C.R. Morris and J.R.P. Cabral. IARC Scientific Publications No. 77, Lyon.

Vos, J.G., and Luster, M.I. 1989. Immune alterations. *In* Halogenated biphenyls, terphenyls, naphthalenes, dibenzodioxins and related products, pp. 295–322. Ed. by R.D. Kimbrough and S. Jensen. Elsevier Science Publishers.

Warren, R.J., Kirkpatrick, R.L., and Young, R.W. 1978. Barbiturate-induced sleeping times, liver weights, and reproduction of cottontail rabbits after mirex ingestion. Bulletin of Environmental Contamination and Toxicology, 19: 223–228.

Wester, P.W. 1991. Histopathological effects of environmental pollutants β-HCH and methyl mercury on reproductive organs in freshwater fish. Comparative Biochemistry and Physiology, 100C: 237–239.

Wester, P.W., Canton, J.H., and Bischop, A. 1985. Histopathological study of *Poecilia reticulata* (guppy) after long-term β (beta)-hexachlorocyclohexane exposure. Aquatic Toxicology, 6: 271–296.

WHO. 1984. Environmental Health Criteria 34: chlordane. World Health Organization, Geneva.

WHO. 1989. Environmental Health Criteria 88: polychlorinated dibenzo-*para*-dioxins and dibenzofurans. World Health Organization, Geneva.

WHO. 1992. Environmental Health Criteria 124: lindane. World Health Organization, Geneva.

Wong, S., Fournier, M., Coderre, D., Banska, W., and Krzystyniak, K. 1992. Environmental immunotoxicology. *In* Animal biomarkers as pollution indicators, pp. 8–189. Ed. by D.B. Peakall. Chapman and Hall, London.

Zavon, M.R., and Stemmer, K.L 1975. The effect of dieldrin ingestion on rhesus monkeys. A six-year study. Kettering Laboratory, Cincinnati, Ohio.

13 CONSIDERATION AND APPROVAL OF RECOMMENDATIONS

WGEAMS agreed the action list, attached as Annex 6, and the recommendations for ACME and the ICES Council as indicated in Annex 7 to this report.

14 PROPOSALS FOR A FURTHER MEETING

Following invitations from the ICES Secretariat and from Lars Føyn, WGEAMS recommended that it meet for a period of five days in March 1998 either at ICES Headquarters or at the Institute of Marine Research (Bergen, Norway) to consider, *inter alia,* the matters listed in the relevant Recommendation 14.1 in Annex 7. WGEAMS considered that the items proposed for the terms of reference included subjects which could give rise to new perspectives in environmental assessment in the ICES area.

15 CONSIDERATION AND APPROVAL OF THE MEETING REPORT

WGEAMS considered and approved the report of the meeting, subject to completion of necessary editorial work to be carried out by the Chairman prior to the submission of the report to the ICES Secretariat.

16 CLOSURE OF THE MEETING

On behalf of WGEAMS, the Chairman thanked both current and retired IFREMER staff for their hospitality, and closed the meeting at 13.00 hrs on Friday 21 March 1997.

ACRONYMS

JEASA	Joint Meeting of the Working Group on Environmental Assessment and Monitoring Strategies and the Working Group on Statistical Aspects of Environmental Monitoring
MCWG	Marine Chemistry Working Group
SGMPCS	Study Group on Monitoring Programmes for Contaminants in Sediments
WGBEC	Working Group on Biological Effects of Contaminants
WGMS	Working Group on Marine Sediments in Relation to Pollution
WGSAEM	Working Group on Statistical Aspects of Environmental Monitoring

ANNEX 1

AGENDA

1) Opening of the meeting.

2) Adoption of the agenda.

3) Arrangements for the preparation of the report.

4) Reports of activities in other fora of interest to the meeting.

5) Assess the implications of the results of the Baseline Study of Contaminants in Baltic Sea Sediments for future sediment monitoring strategies [HELCOM 1996/4].

6) Assist in the development of monitoring guidelines for PAHs in sediments, with WGMS and MCWG, and biota with MCWG, including the number of replicate samples per area to characterise the sampling area [OSPAR 1997/1.1].

7) Consider the current (revised) guidelines (to be elaborated at MON 1996) on chemical monitoring of fish and shellfish in relation to ICES advice on monitoring strategies.

8) Prepare plans for a theme session/symposium/workshop on risk evaluation in environmental monitoring and assessment, jointly with WGSAEM.

9) Review the outcome of the Study Group on Monitoring Programmes for Contaminants in Sediments.

10) In collaboration with MCWG, review information gathered intersessionally on variance components in seabird egg analyses.

11) Review progress in responding to the IWC enquiry concerning the effects of contaminants on the abundance and quality of cetacean prey.

12) Any other business.

    12.1) Prepare comments on the report of the OSPAR/ICES Workshop on the Overall Evaluation and Update of Background/Reference Concentrations for Nutrients and for Contaminants in Sea Water, Biota, and Sediment.

    12.2) Consider the application of assessment criteria in the context of AMAP.

    12.3) Consider the proposed OSPAR SIME approach to endocrine disruptors.

13) Consideration and approval of recommendations.

14) Proposals for a further meeting.

15) Consideration and approval of the meeting report.

16) Closure of the meeting.

ANNEX 2

LIST OF PARTICIPANTS

Name	Address	Telephone No.	Fax No.	E-mail address
Ian Davies (Chairman)	SOAEFD Marine Laboratory P O Box 101 Victoria Road Aberdeen AB9 8DB UK	+44 1224 876544	+44 1224 295511	daviesim@marlab.ac.uk
Lars Føyn	Institute of Marine Research P O Box 1870 5024 Bergen-Nordnes Norway	+47 55 23 85 00	+47 55 23 85 84	lars@imr.no
Michel Joanny	IFREMER/Centre de Brest DEL/QM BP 70 29280 Plouzané France	+33 98 22 43 58	+33 98 22 45 48	mjoanny@ifremer.fr
Kari Stange	Institute of Marine Research P O Box 1870 5024 Bergen-Nordnes Norway	+47 55 23 85 00 +47 55 23 84 82	+47 55 23 85 84	kari.stange@imr.no
Cynthia de Wit	Institute of Applied Environmental Research Stockholm University S-10691 Stockholm Sweden	+46 8 674 7180	+46 8 287829	cynthia.de.wit@itm.su.se

ANNEX 3

LIST OF MEETING PAPERS

Document number	Title/source
WGEAMS97/1/1	Report of the ICES Working Group on Environmental Assessment and Monitoring Strategies, 1994. CM 1994/Env:4
WGEAMS97/1/2	Report of the ICES Working Group on Environmental Assessment and Monitoring Strategies, 1995. CM 1995/Env:5
WGEAMS97/1/3	Report of the ICES Working Group on Environmental Assessment and Monitoring Strategies, 1996. CM 1996/Env:7
WGEAMS97/1/4	Report of the Joint Meeting of the ICES Working Groups on Environmental Assessment and Monitoring Strategies, and on Statistical Aspects of Environmental Monitoring, 1996. CM 1996/Env:6
WGEAMS97/1/5	Report of the ICES Working Group on Marine Sediments in Relation to Pollution, 1996. CM 1996/Env:4
WGEAMS97/1/6	Letter from Chairman of ACME (Stig Carlberg), 12/3/97.
WGEAMS97/2/1	Draft agenda for meeting of the ICES Working Group on Environmental Assessment and Monitoring Strategies, 1997. (Annex 1 of this report)
WGEAMS97/2/2	Resolutions adopted at the ICES 1996 Annual Science Conference, 84th Statutory Meeting.
WGEAMS97/4/1	Draft Summary Record of OSPAR Working Group on Concentrations, Trends, and Effects of Substances in the Marine Environment (SIME), Ostend, February 1997.
WGEAMS97/4/2	Extracts from the 1996 ICES ACME report.
WGEAMS97/4/3	Extract from the Report of the Bureau Working Group on the Structure of ICES. ICES CM 1996/Gen:7.
WGEAMS97/5/1	Draft final report (dated 25.02.97) of the results of the 1993 ICES/HELCOM Baseline Study of Contaminants in Baltic Sea Sediments.
WGEAMS97/5/2	Report of the ICES Steering Group for the Coordination of the Baseline Study of Contaminants in Baltic Sea Sediments, 1996. CM 1996/E:5
WGEAMS97/6/1	Extract of the draft report of the ICES Working Group on Marine Sediments in Relation to Pollution, 1997. PAH Guidelines.
WGEAMS97/6/2	Draft report of the ICES Working Group on Marine Sediments in Relation to Pollution, 1997. Main text and Annex 7.
WGEAMS97/6/3	Guidelines for the determination of polycyclic aromatic hydrocarbons (PAH) in sediments and biota. Jarle Klungsøyr and Robin Law, MCWG 1997/8.2.8.
WGEAMS97/6/4	Determination of polycyclic aromatic hydrocarbons (PAH) in sediments. Birgit Schubert, following WGMS 1997.
WGEAMS97/7/1	Report on the outcome of MON 1996. SIME 97/4/1
WGEAMS97/7/2	Summary record of the OSPAR Ad Hoc Working Group on Monitoring (MON) 1996. MON 96/9/1
WGEAMS97/7/3	Report of the ICES/OSPAR Workshop on Biological Effects Monitoring Techniques, Aberdeen, 1995.
WGEAMS97/7/4	ICES Role in Environmental Monitoring. C M 1995/Gen:7
WGEAMS97/7/5	Strategy for incorporating biological effects in an integrated monitoring programme. Extract from report of ICES ACME, 1995.

Document number	Title/source
WGEAMS97/8/1	Draft report of the ICES Working Group on Statistical Aspects of Environmental Monitoring, 1997.
WGEAMS97/8/2	Dynamic sampling strategies for several independent monitoring sites. Rob Fryer and Mike Nicholson, presented to ICES WGSAEM 1997.
WGEAMS97/8/3	Cumulative sum techniques for assessing temporal trends of marine pollutants. William G. Warren, presented to ICES WGSAEM 1997.
WGEAMS97/8/4	The SMOOTH-SUM. A modified CUSUM for long-term monitoring of contaminants. Rob Fryer and Mike Nicholson, presented to ICES WGSAEM 1997.
WGEAMS97/8/5	ICES 1997 ASC Theme Session V, background information.
WGEAMS97/10/1	E-mail from P. Becker to B. Pedersen, 25 February 1997.
WGEAMS97/10/2	Recent changes in levels of persistent organochlorines and mercury in eggs of seabirds from the Barents Sea. R.T. Barrett, J.U. Skarre, and G.W. Gabrielsen, 1996. Environmental Pollution, 92: 13–18.
WGEAMS97/10/3	Chloroganische Verbindungen und Schwermetalle in weiblichen Silbermowen (*Larus argentatus*) und ihren Eiern mit bekannter Legefolge. P.H. Becker, B. Conrad, and H. Sperveslage, 1989. Die Vogelwarte, 35: 1–10.
WGEAMS97/10/4	Seabirds as monitor organisms of contaminants along the German North Sea coast. P.H. Becker, 1989. Helgolander Meeresuntersuchungen, 43: 395–403.
WGEAMS97/10/5	Schadstoffmonitoring mit Seevogeln. P.H. Becker, C.Koepff, W.A. Heidmann, and A. Buthe, 1991. Part 1.
WGEAMS97/10/6	Schadstoffmonitoring mit Seevogeln. P.H. Becker, C. Koepff, W.A. Heidmann, and A. Buthe, 1991. Part 2.
WGEAMS97/10/7	Time-related factors influence the concentrations of ΣDDT, PCBs, and shell parameters in eggs of Baltic guillemot (*Uria aalge*), 1861–1989. A. Bignert, K. Litzen, T. Odsjö, M. Olsson, W. Persson, and L. Reutergardh, 1995. Environmental Pollution, 89: 27–36.
WGEAMS97/10/8	Levels and congener pattern of PCBs in kittiwakes, *Rissa tridactyla*, in relation to mobilization of body-lipids associated with reproduction. E. O. Henriksen, 1995. Cand. Sci. thesis, University of Tromsø.
WGEAMS97/11/1	The effect of diet on organochlorine patterns in marine mammals from Northern European waters. D.E. Wells, C. McKenzie, and H.M. Ross.
WGEAMS97/12/1	Report of the OSPAR/ICES Workshop on the Overall Evaluation and Update of Background/Reference Concentrations for Nutrients and for Contaminants in Sea Water, Biota and Sediment. October 1996.
WGEAMS97/12/2	E-mail from ICES Secretariat to WGEAMS, 17 March 1997.
WGEAMS97/12/3	Extract from OSPAR SIME 1996 draft Summary Record, concerned with an approach to endocrine disruptors.
WGEAMS97/12/4	Report of the third OSPAR Workshop on Ecotoxicological Assessment Criteria. SIME 97/7/1-Add.1.
WGEAMS97/12/5	Report of the third OSPAR Workshop on Ecotoxicological Assessment Criteria. SIME 97/7/1- presentation overheads.
WGEAMS97/12/6	Report of the third OSPAR Workshop on Ecotoxicological Assessment Criteria. SIME 97/7/1.

ANNEX 4

VARIANCE COMPONENTS IN SEABIRD EGG ANALYSES

As indicated in the main text of this report, several documents on seabird egg analysis were available to WGEAMS through MCWG. WGEAMS reviewed these documents and extracted those elements which contain information relevant to the investigation of variance components, omitting data from Sweden which is proposed to be covered by a special presentation at MCWG in 1998.

Information received from Dr P.H. Becker (Institut für Vogelforschung in Wilhelmshaven) indicated that, for most contaminants, there were no data on replicate analyses of the same material, i.e., direct measurements of analytical variance. However, the intraclutch variablity was low, indicating that analytical variability (which would be a component of intraclutch variability) was also low. Only very limited estimates of inter-laboratory variance were available, and for mercury only.

The following documents were considered by WGEAMS at the meeting.

WGEAMS97/10/2	Recent changes in levels of persistent organochlorines and mercury in eggs of seabirds from the Barents Sea. R.T. Barrett, J.U. Skarre, and G.W. Gabrielsen, 1996. Environmental Pollution, 92: 13–18.
WGEAMS97/10/3	Chloroganische Verbindungen und Schwermetalle in weiblichen Silbermowen (*Larus argentatus*) und ihren Eiern mit bekannter Legefolge. P.H. Becker, B. Conrad, and H. Sperveslage, 1989. Die Vogelwarte, 35: 1–10.
WGEAMS97/10/5	Schadstoffmonitoring mit Seevogeln. P.H. Becker, C.Koepff, W.A. Heidmann, and A. Buthe, 1991. Part 1.
WGEAMS97/10/6	Schadstoffmonitoring mit Seevogeln. P.H. Becker, C. Koepff, W.A. Heidmann, and A. Buthe, 1991. Part 2.

ANNEX 5

EFFECT OF DIET ON ORGANOCHLORINE PATTERNS IN MARINE MAMMALS FROM NORTHERN EUROPEAN WATERS

D.E. Wells, C. McKenzie and H.M. Ross*
SOAEFD Marine Laboratory, PO Box 101
Victoria Road, Aberdeen, AB39 8DB
*Scottish Agricultural College, Veterinary Investigation Centre
Stratherrick Road, Inverness, IV2 4JZ

SUMMARY

Marine mammals are regularly stranded along the Scottish coast and, since 1990, these animals have been sampled as part of the UK national survey. Chlorobiphenyl (CB) and organochlorine pesticide (OCP) residues have been measured in blubber to determine the concentration of toxic contaminants.

A multivariant generalised linear hypothesis (discriminant analysis) has been applied to data from a small number (approximately 2–25) of 12 different marine mammals species to discriminate between the species on the basis of the CB patterns in blubber. The raw data are normalised to a single congener, CB153, and the discriminant factors are plotted to display the differences between species in relation to the intake and the metabolism of chlorobiphenyls.

INTRODUCTION

Elevated CB concentrations have been linked to mass mortalities of marine mammals worldwide and, at high concentrations, CBs in cetaceans and pinnipeds have been reported to cause reproductive and immunological disorders, such as sterility, implantation failure and reproductive disorders and disorders associated with the suppression of the immune system (Delong *et al*, 1973; Reijnders, 1988, 1994).

In the marine environment, CB patterns change from those found in industrial products as a result of weathering through the metabolic action of organisms which ingest the contaminants from the food chain or directly from the water column and marine sediments. The CB patterns in marine mammals can differ markedly from those in their prey. In striped dolphin, for example, the differences between the CB profiles in the marine mammal blubber and its food web give an indication of the way in which cetaceans bioaccumulate and modify these compounds (Tanabe *et al.*, 1988). Muir *et al.* (1988) showed that large differences in CB patterns were apparent through the food chain of Arctic animals resulting from the ability of each animal in the chain (cod → ringed seal → polar bear) to metabolise individual CB congeners to differing extents.

Studies involving a group of common seals in captivity with carefully controlled diets have further illustrated the differences in CB pattern between the fish in their diet and the seals (Boon *et al.*, 1989, 1992). The location of the prey eaten by marine mammals may also cause differences in CB patterns. Fish of the same species from different locations have been found to have different CB patterns (Elskus *et al.*, 1994; Storr-Hansen *et al.*, 1995).

In this paper, differences in CB patterns between 12 species of marine mammals, including cetaceans and pinnipeds, are described using DA. PCA was used with data from individual species as a method to investigate within-species pattern variances. The CB congeners which contribute to the maximum differences between the species are identified. The ability of each species to metabolise any given CB congener can be used as a possible indication of the relative vulnerability of that animal to the toxic effects of these compounds both as parent compounds and metabolites.

MATERIALS AND METHODS

Samples of marine mammal blubber were obtained by the Veterinary Investigation Centre (VIC) based at the Scottish Agricultural College, Inverness. The samples were collected from animals which had stranded around the coast of Scotland between 1989 and 1992. The blubber samples were taken, wrapped in hexane-washed aluminium foil and stored at –20 °C prior to analysis (Wells *et al.*, 1994). Dutch sperm whale strandings were obtained from Dr J.P. Boon, Netherlands Institute for Sea Research (NIOZ), Texel and the Belgian samples from P. Roose, (Rijksstation voor Zeevisserij, Oostende) sampling and storage procedures were identical.

Quality assurance, analytical and statistical methodology have been discussed in detail elsewhere (Wells *et al.*, 1996)

DISCUSSION

Following the phocine distemper virus epizootic in the North Sea in 1988 and 1989, the UK began a national survey to monitor stranded marine mammals to establish the causes of death and any contributory factors. A small number of each species of marine mammals was collected through opportunistic sampling from this survey. The within- and between-species variability of contaminant concentrations results from the history of the individual animals sampled. The main co-factors which account for this variability are: a) age; b) sex; c) condition of the animal; d) reproductive status; e) habitat; f) food source; and g) the biological differences between species (Tanabe *et al.*, 1987; Wells *et al.*, 1994).

The data were transformed by normalising each congener to CB153. Normalising all congeners to CB153 significantly reduces the within-species variance associated with life history and so allows a more critical evaluation of the differences between the species.

The range of the absolute concentration of contaminants in different animals of the same species can be as high as factors of 1000–10000, depending upon the age range within the size data set.

a) Differences within species

i) Harbour Porpoise

To assess whether there was a difference in CB patterns related to differences in habitat and possibly the quality of prey species available. The normalised harbour porpoise data was analysed using PCA.

A biplot of the first and second principal components is given in Figure A5.1 and includes the vector loadings for the individual CBs. The biplot shows a cluster of vectors for CBs 28, 44, 70, 105 and 118, where the variance is explained by the first principal component. A second cluster of vectors occurs for CBs 156, 170, 180 and 194.

There are two (possibly three) groups of animals in the plane of the first two principal components. The following observations were made for these three groups of animals:

i) animals in Group A have significantly (f test) higher absolute CB concentrations than Group B;

ii) the relative concentrations of the CBs which have the structural requirements for metabolism are lower in Group A than in Group B.

The two harbour porpoise in Group C (PP2 and PP9) are the only samples originating from the west coast of Scotland (south). Both animals have high absolute CB burdens and, on the basis of the relative concentrations of metabolisable CB congeners would be placed in Group B. However, the two animals have higher relative concentrations of the persistent congeners, CBs 170, 180, 194 and the theoretically metabolisable CB156. The apparent cause for a difference in the ratio of persistent CBs is a different diet. Differences in contaminant patterns in fish from the southwest coast of Scotland and the northeast coast of Scotland and have been observed. Storr-Hansen *et al.* (1995) have observed differences in the patterns of CBs between fish from the Wadden Sea and fish from the Atlantic. The cause of a possible difference could be differences in the contaminant patterns in the diet of these two animals although conclusions must be treated cautiously when dealing with so few animals.

ii) Killer Whales

Observable differences in contaminant patterns were also noted in two killer whales (*Orcinus orca*). The two animals showed different p,p′-DDE/sDDT ratios, with the male, stranded in the Shetland Isles, having a ratio of 0.87, higher than observed in other cetaceans, but similar to the ratios observed in male and female common seals and male grey seals (mean ratios of 0.79, 0.78 and 0.91, respectively). The female killer whale stranded on the north coast of Scotland had a ratio similar to other cetacean species analysed (0.55). The levels can tentatively be explained by differences in diet, with the male feeding on pinnipeds and the female feeding on fish, although contaminant levels in the female were higher. The comparison is further complicated by the fact that the female was lactating prior to stranding.

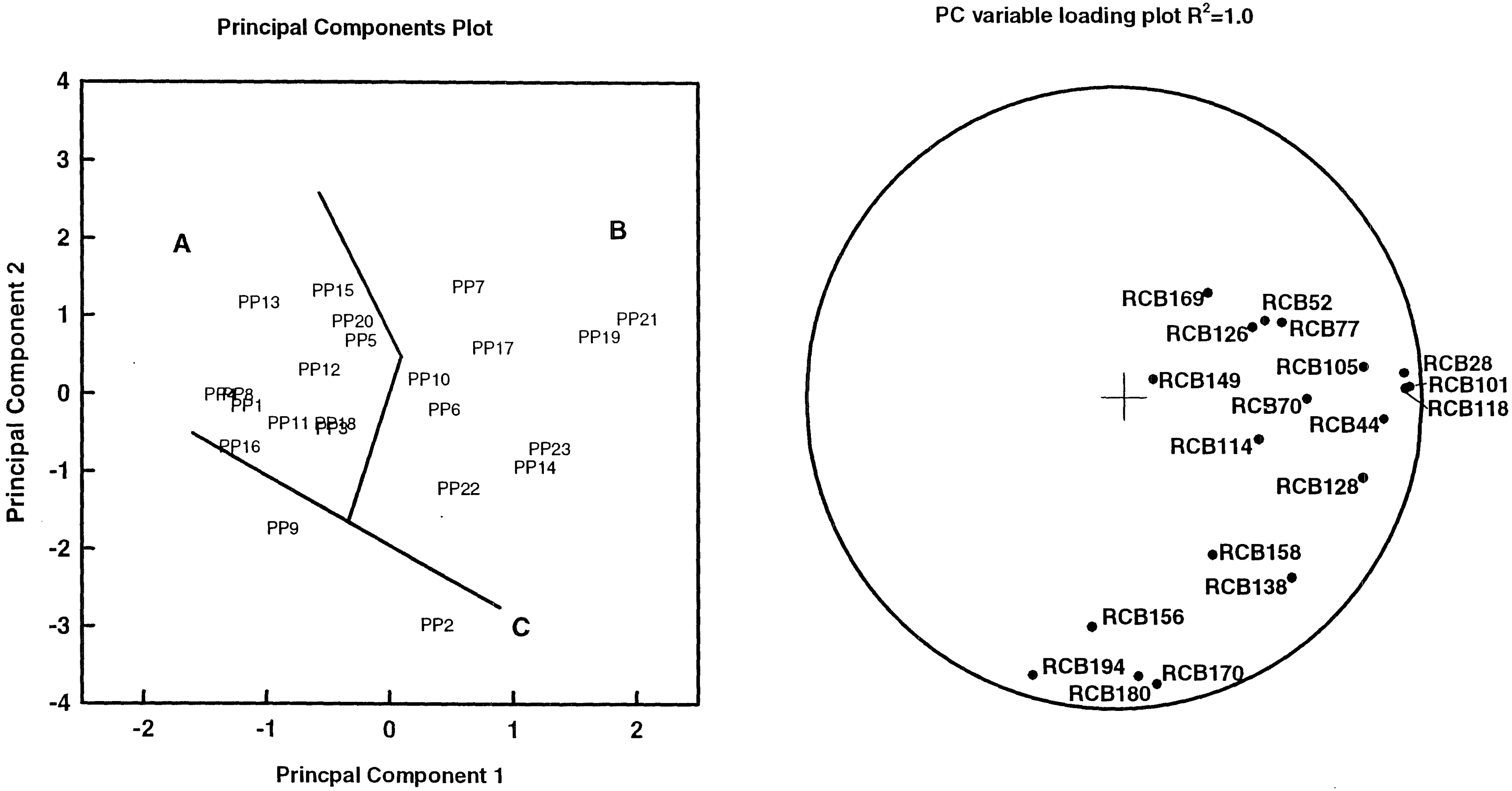

Figure A5.1. Biplot of the first and second principal components of the normalized CB harbour porpoise data set. A denotes animals with high contaminant burdens; B denotes animals with low contaminant burdens; C denotes animals from the southwestern coast of Scotland.

b) Differences between species

Higher contaminant burdens are generally found in species inhabiting coastal regions due to the close proximity of the animals to possible sources of input (Schwartz and Stalling, 1991; Blomkvist *et al.*, 1992; Storr-Hansen and Spliid, 1993). Any differences in relative congener patterns as a result of different input sources, i.e., different commercial mixtures, will be effectively integrated by the food web and by the mobility of marine mammals. The differences in locations of the animals described in this study may not be large enough to show differences in contaminant patterns. The principal route of entry of CBs into a marine mammal is via its food, unlike plankton and fish where a high proportion of the CB burden comes primarily from the water in addition to its prey. The metabolic action of the food organism changes the congener pattern from that in a commercial mixture (Clophen, Aroclor, etc.) to the fingerprint in the fish. The CB pattern in fish is dependent on location, seasonal changes in lipid mobilisation and the degree of migration of the species. Fish species are more likely to show geographical differences in organochlorine pollution as a result of their mode of input. Storr-Hansen *et al.* (1995), for example, found pattern differences between plaice from the Wadden Sea and mackerel from the Atlantic Ocean.

The majority of the marine mammal species studied are migratory or semi-migratory. From the data acquired there appears to be little segregation of the CB patterns within a species as a result of differences in location of the order represented by the sampling programme. This is shown by the similarity of the CB patterns found in Atlantic whitesided dolphins from the east and west coasts of Scotland to those found in the same species stranded on the northwest coast of Ireland (McKenzie *et al.*, in prep). An exception to the common CB pattern in the same species was observed in two harbour porpoises from the southwest coast of Scotland (PP2 and PP9) when compared with the harbour porpoise from the Moray Firth, which may be related to differences in prey quality.

Marine mammals feeding on similar food in localised areas (bottlenosed dolphins, white beaked dolphin) have similar congener patterns, but species feeding at different trophic levels from one another (sperm whales feeding on cephalopods, bottlenose dolphins feeding mainly on fish) in the same locality are likely to have distinctly different CB patterns as a result of the different uptake and metabolic processes in different prey species (Figure A5.2). Keul *et al.*, previously noted that common dolphins feeding on cephalopods had relatively higher levels of p,p'-DDE than common dolphins feeding only on mackeral (Keul *et al.*, 1991).

The fish feeders, the mixed feeders and the cephalopod feeders essentially form the three types of feeding behaviour in this set of mammals. The relationship between an animal and its food source can be described in multivariate space. Animals are grouped in the DA plots as a result of food source (Figure A5.2). All cephalopod feeders have a positive DA factor 1. This group of species consists of Risso's dolphin, Sowerby's beaked whales and sperm whales, all of which possess a CYP1A enzyme, but lack the CYP2B enzyme system, and are grouped to the right of other cetaceans in the DA plots although they appear not to lie in the same region as the striped dolphin.

The generic information on feeding behaviour is supported by the specific information on the stomach contents of marine mammals stranded around the coast of Scotland (Santos *et al.*, 1994). A number of the animals in this study also had their stomach contents identified. It is important to note that the stomach contents of a stranded animal may be different from that of another population of the same species, as a result of the influence of any illness which may result in stranding (Sekiguchi *et al.*, 1992).

In the absence of the sperm whales and pinnipeds from the discriminant biplot (Figure A5.3), the striped dolphins (as well as the Risso's dolphins and Sowerby's beaked whale) have a positive score for df1. These striped dolphins were feeding on cephalopods prior to stranding.

With the exception of the striped dolphin, the CB burdens of these cephalopod feeders are relatively low due to their relatively uncontaminated diet. The metabolisable congeners for these species therefore appear to be relatively higher than in the other samples. Another difference is the higher levels of the persistent CBs 170, 180 and 194 (the CBs with highest scores on df in Figure A5.3).

In theory, there should only be a low level of discrimination between species based on persistent congeners, as they remain unmetabolised in all the species studied. If the inputs of certain congeners into the samples which have high positive scores on DA factor 1 are higher than the other species studied they will be unable to metabolise those compounds, so resulting in higher relative concentrations. Keul *et al.* (1991) have previously noted that common

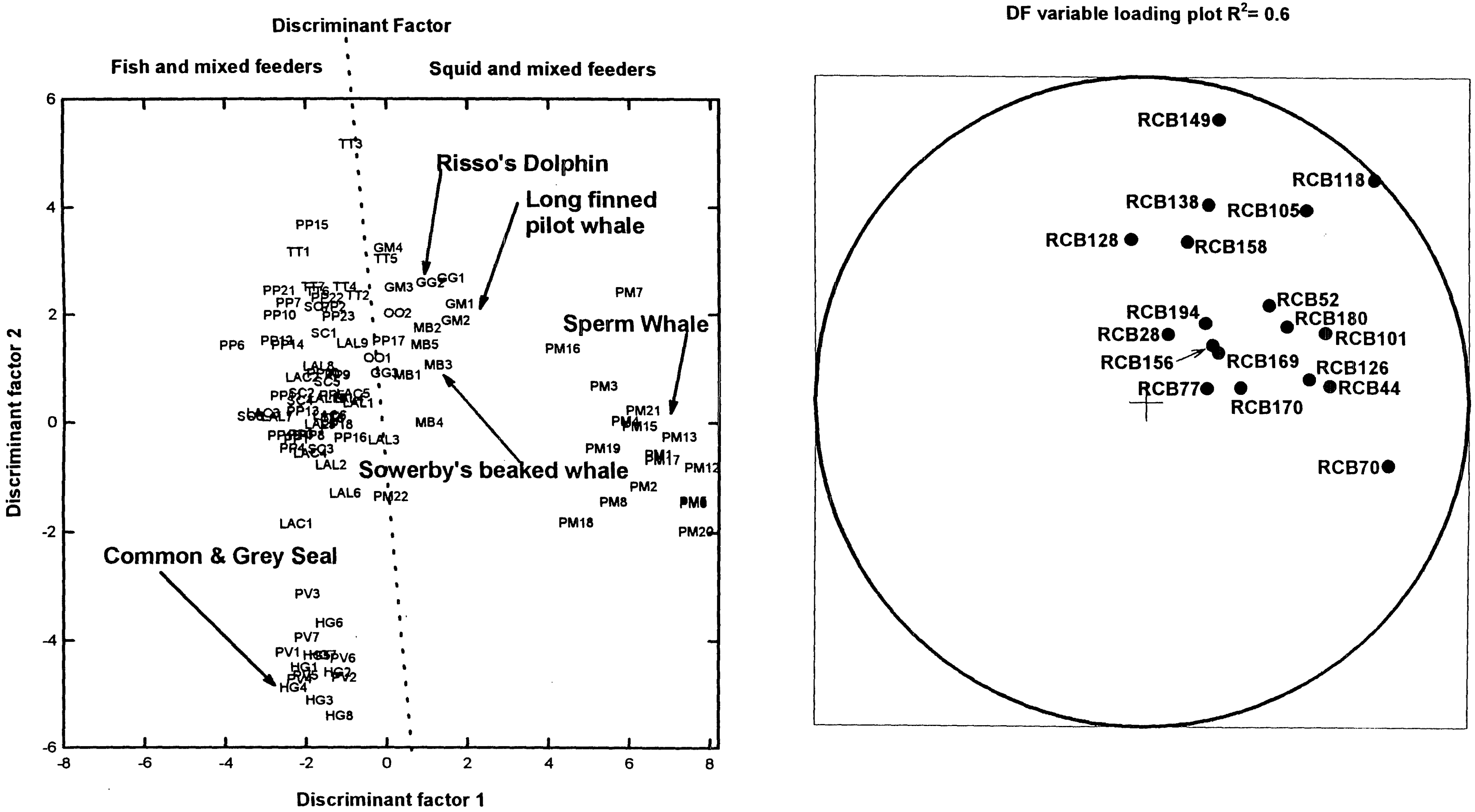

Figure A5.2. Biplot of the first two discriminant functions for all species. All species separated.

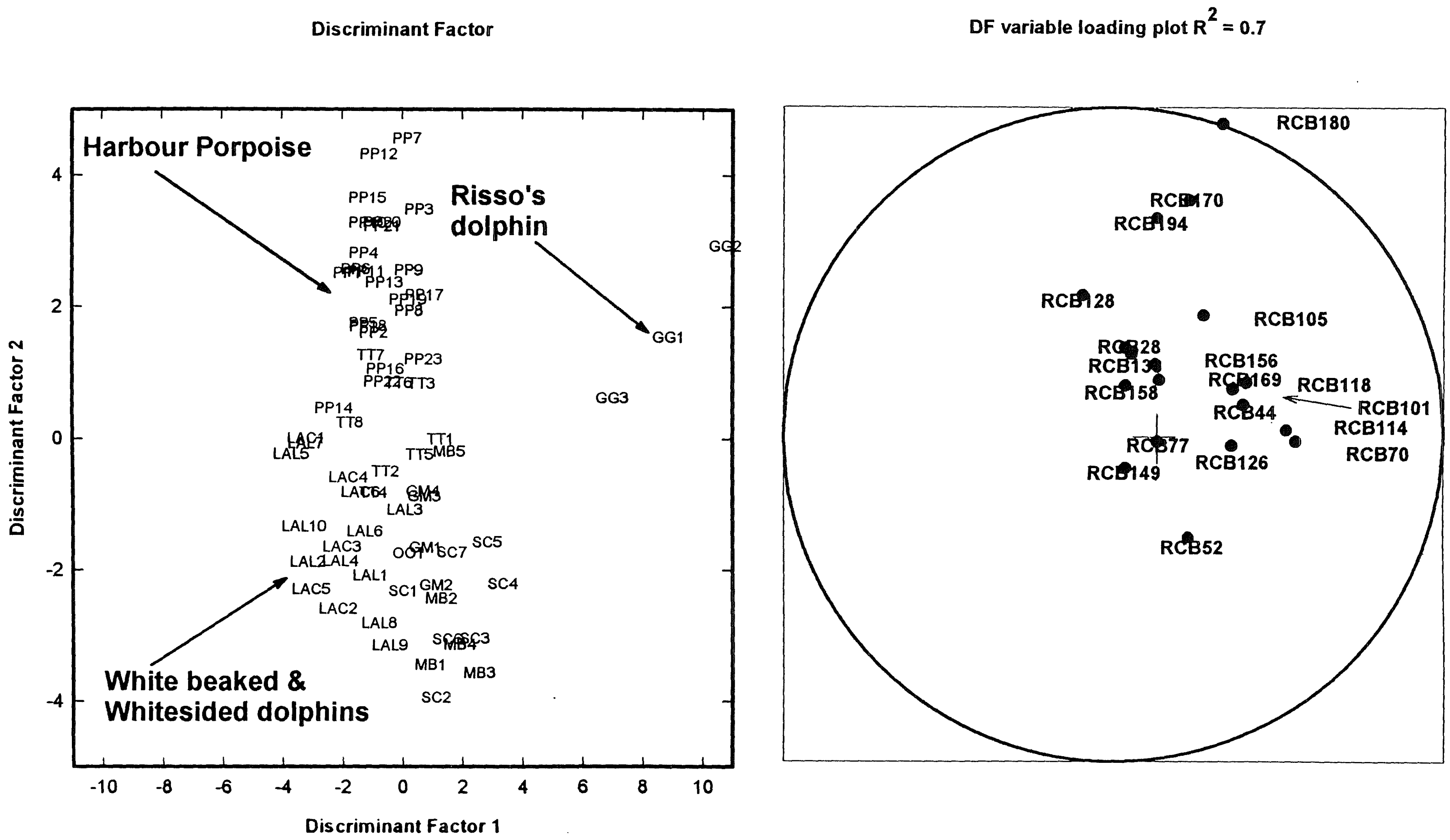

Figure A5.3. Biplot of the first two discriminant functions after removal of common seals, grey seals. and sperm whales.

dolphins feeding on cephalopods had relatively higher levels of the organochlorine pesticide p,p′-DDE than another group of the same species feeding upon mackerel. This indicates that the differences in contaminant patterns, in the case of the p,p′-DDE found by Keul and the elevated levels of the CB congeners 170, 180 and 194 found in this study, may be as a direct result of the type of prey species taken. Species which eat predominantly fish have positive or low negative DA factor 1 values, for example, harbour porpoise will eat a large variety of fish both pelagic and demersal (Rae, 1965). The harbour porpoise always appears to lie at the opposite end of the feeding axis from the squid eaters, although this may be enhanced as a result of the different enzyme capability of this species.

Grey and common seals are also fish feeders, but in fact have a very mixed diet which may vary seasonally (Pierce *et al.*, 1989). Their different position in the discriminant analysis biplot (Figure A5.2) is primarily due to the influence of the distinct differences in the metabolic patterns known between pinnipeds and cetaceans (Watanabe *et al.*, 1989; Gøksøyr *et al.*, 1992).

c) Geographical variation in CB patterns in potential prey species

Preliminary data have been collected on the concentrations and patterns of CBs in fish species around the Scottish coast. PCA of these data (Figure A5.4) suggest that fish from the Shetland area (north coast) show higher loadings on PCA factor 1, and lower loadings on factor 2, than fish from the Clyde Sea area (west coast). The main difference between the factors arises from a greater loading of the CBs 170, 180, and 187 in factor two than factor 1, i.e., fish from the Clyde are relatively enriched in these congeners. It is not yet clear whether these differences are reflected in the CB patterns in the marine mammals from these areas, or in other compartments of the ecosystem, such as the sediments.

CONCLUSIONS

These studies have shown the value of using discriminant analysis to distinguish between different marine mammal species, and PCA to detect which factors contribute to the within-species variability of CB patterns in marine mammals.

Patterns of CB congeners in marine mammals are influenced, at least partially, by the food source.

Preliminary data suggest that the patterns of CB congeners in potential prey for cetaceans can differ over relatively short distances.

REFERENCES

Blomkvist, G., Roos, A., Jensen, S., Bignert, A. and Olsson, M. 1992. Concentrations of sDDT and PCB in seals from Swedish and Scottish waters. Ambio, 21: 539–545.

Boon, J.P., Eijgenraam, F., Everaarts, J.M., and Duinker, J.C. 1989. A structure-activity relationship (SAR) approach towards metabolism of PCBs in marine animals from different trophic levels. Marine Environmental Research, 27: 159–176.

Boon, J.P., Arnhem, E. van, Jansen, S., Kannan, N., Petrick, G., Schulz, D., Duinker, J.C., and Reijnders, P.J.H. 1992. The toxicokinetics of PCBs in marine mammals with special reference to possible interactions of individual congeners with the cytochrome P450-dependent mono-oxygenase system—an overview—Publication No. 29 of the applied science project of the Netherlands Institute for Sea Research. [Note: Appeared in 'Persistent pollutants in marine ecosystems'. Ed. by C.H. Walker and D.L. Livingstone. Pergamon Press, Oxford, New York, Seoul, Tokyo.]

Delong, R.L., Gilmartin, W.G., and Simpson, J.G. 1973. Premature births in Californian sea lions: association with high organochlorine pollutant levels. Science, 181: 1168–1170.

Elskus, A.A., Stegeman, J.J., Gooch, J.W., Black, D.E., and Pruell, R.J. 1994. Polychlorinated biphenyl congener distributions in winter flounder as related to gender, spawning site and congener metabolism. Environmental Science Technology, 28: 401–407.

Gøksøyr, A.T., Beyer, J., Larsen, H.E., and Forlin, L. 1992. Cytochrome P450 in seals: monooxygenase activities, immunochemical cross reactions and response to phenobarbital treatment. Marine Environmental Research, 34: 113.

Keul, D.W., Haebler, R., and Potter, C. 1991. Chemical residues in dolphins from the US Atlantic coast including Atlantic bottlenose obtained during the 1987/88 mass mortality. Chemosphere, 22(11): 1071–1084.

McKenzie, C., Rogan, E., and Wells, D.E. In prep. Patterns and concentrations of organic contaminants in Atlantic white-sided dolphins from Irish and Scottish coastal waters.

Muir, D.C.G., Norstrom, R.J., and Simon, M. 1988. Organochlorine contaminants in arctic food chains. Accumulation of specific polychlorinated biphenyls and chlordane related compounds. Environmental Science Technology, 22: 1071–1079.

Pierce, G.J., Boyle, P.R., and Thompson, P.M. 1989. Diet selection by seals. Diets of common seals and grey seals in Scottish waters. Report on research conducted for the Department of Agriculture and Fisheries for Scotland.

Rae, B.B. 1965. The food of the common porpoise (*Phocoena phocoena*). Journal of Zoology, 146: 114–122.

Reijnders, P.J.H. 1988. Environmental impact of PCBs in marine environment. *In* Environmental protection of the North Sea, pp. 85–98. Ed. by P.J. Newman, and A.R. Agg. Heinemann, Oxford.

Reijnders, P.J.H. 1994. Toxokinetics of chlorobiphenyls and associated physiological responses in marine mammals with particular reference to their potential for ecotoxicological risk assessment. Science of the Total Environment, 154: 229–236.

Santos, M.B., Pierce, G.J., Ross, H.M., Reid, R.J., and Wilson, B. 1994. Diets of small cetaceans from the Scottish coast. ICES CM 1994/N:11.

Schwartz, T.R., and Stalling, D.L. 1991. Chemometric comparison of polychlorinated biphenyl residues and toxicological active polychlorinated biphenyl congeners in the eggs of Forster's Terns (*Sterna fosteri*). Archives of Environmental Contamination Toxicology, 20: 183–199.

Segikuchi, K. Klages, N.T.W., and Best, P.B. 1992. Comparative analysis of the diets of smaller adontocete cetaceans along the coast of Southern Africa. *In* Benguela trophic functioning. Ed. by A. IL. Payne *et al.* South African Journal of Marine Science, 12: 843–861.

Storr-Hanson, E., and Spliid, H. 1993. Coplanar polychlorinated biphenyl congener levels and patterns and the identification of different populations of harbour seals in Denmark. Archives of Environmental Contamination and Toxicology, 24: 44–58.

Storr-Hanson, E., Spliid, H., and Boon, J.P. 1995. Patterns of chlorinated biphenyl congeners in harbour seals (*Phoca vitulina*) and their food. Statistical Analysis. Archives of Environmental Contamination and Toxicology, 28: 48–54.

Tanabe, S., Loganathian, B.G., Subraimian, A., and Tatsukawa, R. 1987. Organochlorine residues in short-finned pilot whale. Possible use as tracers of biological parameters. Marine Pollution Bulletin, Vol.: 1561–563.

Tanabe, S., Watanabe, S., Kan, H., and Tatsukawa, R. 1988. Capacity and mode of PCB metabolism in small cetaceans. Marine Mammal Science, 4(2): 103–124.

Watanabe, S., Shimada, T., Nakamura, S., Nishiyama, N., Yamashita, N., Tanabe, S., and Tatsukawa, R. 1989. Specific profile of liver microsomal cytochrome P450 in dolphins and whales.

Wells, D.E., Campbell, L.A., Ross, H.M., Thompson, P.M., and Lockyer, C.H. 1994. Organochlorine residues in harbour porpoise and bottlenosed dolphins stranded on the coast of Scotland 1988–1991. Science of the Total Environment, 151: 77–99.

Wells, D.E., McKenzie, C., and Reid, R. 1996. Organochlorine residues in marine mammals stranded on the coast of Scotland 1990–1994. SOAEFD Scottish Fisheries Working Paper, Marine Laboratory, Aberdeen, UK.

ANNEX 6

ACTION LIST

Action number	Action required	Responsible person(s)
1	To develop firm proposals for a Workshop on Risk Evaluation intersessionally with a view to defining the scope and terms of reference for the Workshop and presenting these proposals to the next meeting of WGEAMS.	I. Davies
2	To write to QUASIMEME concerning the inclusion of seabird egg analyses in the JAMP Guidelines and the need for Reference Materials and information on the within- and between-laboratory variances in the determination of organochlorine compounds and mercury in this matrix.	I. Davies
3	To send copies of the section of the WGEAMS report on seabird eggs, and the annexed documents relating to variance components to the Chairman of WGSAEM.	I. Davies
4	To send the final version of Section 11 of the WGEAMS report to the Chairman of WGBEC for comment.	I. Davies
5	To prepare a review of endocrine disruptors, other than environmental oestrogens.	K. Stange/C. de Wit
6	To ask the Chairman of WGBEC whether there are any actions in WGBEC on endocrine disruptors.	I. Davies
7	To collate information intersessionally on methods for the identification of priority contaminants in the contexts, among others, of	
	a) Esbjerg Declaration	I. Davies/K. Stange
	b) Arctic processes	K. Stange
	c) Long-range transport atmospheric processes (LRTAP)	K. Stange
	d) OSPAR/SIME	M. Joanny
	e) OSPAR/DIFF	I. Davies/C. de Wit
8	To circulate the report from the WGEAMS meeting in Halifax to participants at WGEAMS97	I. Davies
9	To prepare a discussion document on national and international approaches to monitoring the effects of produced water from oil and gas installations, incorporating information from:	L. Føyn
	Scotland	I. Davies
	England/Wales	A. Franklin
	Norway	L. Føyn
	E+P Forum	L. Føyn
	The Netherlands	WG member
	USA	WG member
	Canada	J. Piuze
	Denmark	WG member
	JAMP/SIME	R. Stagg
	Approaches to persons named above but not present at WGEAMS97	I. Davies

Action number	Action required	Responsible person(s)
10	Compile information on procedures available to assess the combined effects of exposure to groups of chemically similar, or dissimilar, contaminants.	All
11	Approach the ICES Secretariat for a document outlining the current ICES links with EEA and ETC/CW.	I. Davies
12	Compile information on the activities of ETC/CW.	M. Joanny
13	Compile information on the marine activities of EEA.	I. Davies
14	Approach the ICES Secretariat with a view to inviting a representative of EEA to the next WGEAMS meeting to present an account of the EEA activities in the marine environment.	I. Davies
15	Compile information on useful Websites. Act as a postbox for the above information.	All I. Davies
16	Enquire of the ICES Secretariat whether it is anticipated that WGEAMS will be involved in review of the QSR 2000 and, if so, when.	I. Davies

ANNEX 7

RECOMMENDATIONS

The recommendations are ordered by agenda item number.

3.1 WGEAMS recommends that ACME recommend procedures to ICES Council that would ensure that current lists of members of Working Groups were available to Working Group chairmen immediately after the Annual Science Conference (i.e., at the same time as the Council Resolutions concerning Working Group meetings). This could be achieved if lists of Working Group members were provided by National Delegates during one annual cycle, for use during the following annual cycle.

4.1 WGEAMS recommends that ACME take action to ensure that if a new ICES Committee and Working Group structure similar to that described in ICES CM 1996/Gen:7 is adopted, this will not reduce the potential for interactions between the various environmental working groups, including MCWG and WGSAEM, and that the ICES Secretariat structure would be able to retain the links and coordination among the environmental WGs, and continue to ensure that, wherever possible, environmental WG meetings were scheduled appropriately (e.g., to avoid clashes and permit interactions).

4.2 WGEAMS recommends that WGSAEM be transferred to the new ACME, and not the Marine Habitats Committee, as members of WGEAMS were not aware that the WGSAEM had with any frequency undertaken work related to any of the other WGs proposed for the Marine Habitats Committee, but worked regularly with WGs under ACME.

5.1 WGEAMS recommends that ACME encourage the Participants in the Baltic Sediment Baseline Study to complete the report of the Study as soon as possible.

5.2 WGEAMS recommends that ACME advise HELCOM that the proposed repeat of the Baltic Sediment Baseline Study (using a reduced sampling grid) is unlikely to result in additional understanding of the significance of the observed concentrations of contaminants in the sediment, or of the processes leading to the observed profiles. Any follow-up study should include a larger number of surface sediment sampling locations, selected to investigate the effects of the various processes that are recognized as having influenced the profiles observed in the 1993 Baseline Study, i.e., water column chemistry, sediment physico-chemical conditions, primary production, input rates of contaminants, etc. The new data should be combined with the results of other components of the HELCOM programme, such as the hydrochemical monitoring, production monitoring, and pollution load monitoring. In this way, it may be possible to understand the influence of these processes on sediment chemistry, and move forward towards a fuller understanding of the meaning of the sediment analyses. The mechanism used to organise the 1993 Baseline Study, through a Steering Group responsible for all aspects of the planning, execution, analyses, and reporting of the study should be retained, as it has proved to be effective, although it is essential that the report of the 1993 Baseline Study is completed as soon as possible to properly inform the planning for any follow-up programme.

5.3 WGEAMS noted that the Baltic Sediment Baseline Study was purely a 'chemistry monitoring exercise'. It was suggested that, in keeping with ICES advice on monitoring strategies, ACME recommend to HELCOM that strong consideration should be given to integrating sediment chemical measurements with appropriate biological effects measurements in any follow-up study.

5.3 WGEAMS recommends that the ICES Secretariat should make the completed report on the Baltic Sediment Baseline Study available to SGMPCS.

6.1 WGEAMS recommends that the text prepared by WGMS on the determination of PAHs in sediment be conveyed to OSPAR with a recommendation that it be included as a technical annex to the JAMP guidelines for the monitoring of sediments.

6.2 WGEAMS recommends that ACME recommend that the JAMP Biota Guidelines be amended (probably by MON98) to incorporate measurements of PAHs.

6.3 WGEAMS recommends that the document prepared by MCWG on the determination of PAHs in marine sediments and biota be amended by MCWG, removing the references to sediment analysis, and providing detailed technical advice on the analysis of biota, primarily mussel tissue, with a view to the revised document being incorporated as a technical annex to the JAMP Biota Guidelines.

6.4 WGEAMS recommends that ACME request WGBEC and MCWG to complete guidelines on biological effects monitoring to cover the necessary analytical methods, including the determinations of cytochrome P450A (WGBEC), DNA adducts (WGBEC), PAH metabolites in fish bile (WGBEC and MCWG), and liver histopathology (WGBEC), with the view that they be conveyed to OSPAR for inclusion as Technical Annexes in the JAMP Guidelines.

7.1 WGEAMS recommends that ACME ask WGSAEM to consider whether it would be possible to include, in data assessments, chemical analytical data on samples which did not fully meet the JAMP Biota Sampling Guidelines (e.g., insufficient numbers of fish were available, or the available fish were of a different size range to those sampled previously) and the effect that the inclusion of such data would have on the confidence the assessors could have in the overall assessment, or whether such data should be excluded.

7.2 ACME is invited to note that WGEAMS agreed that the new JAMP Guidelines for chemical monitoring of fish and shellfish did not conflict with current ICES advice on monitoring strategies, but that procedures needed to be incorporated elsewhere in the JAMP Guidelines (perhaps in the Biological Effects measurement Guidelines) that would ensure that the needs of both chemical and biological measurements would be met and the overall programme fully integrated, particularly in programmes addressing monitoring Purpose c. (as defined in the JAMP Biota Guidelines, MON96) i.e.,

"to assess harm to living resources and marine life. The role of chemical measurements in integrated chemical and biological effects monitoring programmes is:

i) to identify sites where contaminant-specific biological effects programmes should be applied; and

ii) to investigate the chemical cause of observed biological effects."

8.1 WGEAMS recommends that ACME recommend that an ICES Workshop be convened on risk assessment and evaluation, and that members of WGEAMS and WGSAEM should work intersessionally to develop an adequate set of topics and questions to be considered at the Workshop, and appropriate experts to provide key presentations.

9.1 WGEAMS recommends that ACME take appropriate action to ensure that the Study Group on Monitoring Programmes for Contaminants in Sediments (SGMPCS) completes its task in time for the 1998 ACME meeting, and that a meeting of SGMPCS should be held, at Council expense, for this purpose. The work carried out through this mechanism by a previous Study Group dedicated to the definition of quantified objectives for temporal trend monitoring of contaminants in biota has proved to be a significant advance in monitoring procedures, and has been influential in a range of national and international programmes. There is a need for a similar dedicated meeting concerning the use of sediments in monitoring programmes. The current revisions of international monitoring programmes make this a particularly opportune time to hold such a meeting.

10.1 WGEAMS recommends that the documents included as Annex 4 to this report are forwarded by the ICES Secretariat to the Chairman of WGSAEM, and that ACME request WGSAEM 1998 to prepare a report quantifying and summarizing the variance components influencing the data.

11.1 WGEAMS recommends that ACME convey to the International Whaling Commission the information and discussion given in the meeting report text under Agenda Item 11, together with Annex 5, in partial answer to the question raised in 1996 by the IWC concerning areas where contaminants were affecting the quantity and quality of cetacean prey.

12.1.1 ACME is invited to note that a range of conceptual and technical difficulties have been raised (e.g., in the MCWG and WGMS reports) concerning the report of the OSPAR/ICES Workshop on the Evaluation and Update of Background/Reference Concentrations. ACME is invited to take note of the comments in Section 12.1, above, on the difficulties of interpretation of field monitoring data in relation to Background Concentrations, as defined in the abovementioned Workshop report.

12.2.2 ACME is invited to note the assessment mechanisms used in the ecotoxicological component of the AMAP assessment, and their compatibility with current ICES advice on monitoring strategies.

14.1 WGEAMS recommends that it meet for a period of five days in March 1998 at either ICES Headquarters, Copenhagen, or the Institute of Marine Research, Bergen, under the Chairmanship of Dr I.M. Davies, UK, to undertake, *inter alia*, the following tasks:

a) To update the review prepared at the WGEAMS meeting in Halifax, Nova Scotia (1991) on methods for the identification of priority contaminants with particular reference to the Esbjerg Declaration regarding contaminants which are toxic, persistent, and liable to bioaccumulate.

Justification: The need to identify priority contaminants has been identified in the context of the Esbjerg Declaration. WGEAMS reported on available methods some years ago, and the objective is to update ICES advice in this area, with a view to providing reliable information to ICES, and hence also to OSPAR and HELCOM.

b) To review information collated intersessionally on current national and international monitoring strategies which address the hazards presented by the discharge of produced water by the offshore oil and gas industries.

Justification: There is increasing concern over the environmental impacts of the marine oil and gas industries. Considerable attention has been paid to near-field effects in the immediate vicinity of structures. However, there is now evidence of more widespread detectable effects. Produced water is thought to be a contributory factor.

c) To review the role of ICES in marine environmental monitoring and assessment in relation to the activities of the European Environment Agency and the European Thematic Centre on Marine and Coastal Water, and to invite representatives of EEA and UNEP to attend the meeting.

Justification: The establishment of the European Environment Agency and its associated bodies is a relatively new phenomenon in marine environmental science. WGEAMS was unclear as to the relationships between ICES activities, particularly those associated with monitoring and assessment, and the work of the EEA. WGEAMS anticipated receiving information from the ICES Secretariat and from the EEA to assist with this item.

d) To review information collated intersessionally on procedures to assess the combined effects of exposure of organisms to groups of chemically similar, or dissimilar, contaminants.

Justification: Most national and international pollution control measures are based on the regulation of individual compounds or groups of compounds. It has long been recognized that this may reflect a fragmented view of the mechanism of impact of marine pollutants, because in reality organisms are usually exposed to complex mixtures of similar and dissimilar substances. The purpose of this agenda item is to revisit the problems of synergism and antagonism between contaminants, and the possibilities of interactions between apparently unrelated substances, and hopefully to assess whether current monitoring and assessment procedures can take account of these processes.

e) To prepare a short report on Websites that provide information of relevance to the work of WGEAMS.

Justification: The amount of information available on the WWW is rapidly increasing, and can form a valuable resource for marine environmental scientists. WGEAMS hopes to prepare a short document giving direction to sources which members have found to be particularly helpful.

f) To review material collated intersessionally on non-oestrogenic effects of endocrine disruptors.

Justification: There is increasing interest in ICES and elsewhere in endocrine disrupting compounds. However, the emphasis is mainly on those which disrupt the reproductive systems of organisms, for example, the environmental oestrogens. Recent research indicates that other aspects of the endocrine (hormonal) systems of marine organisms can be affected by environmental contaminants, and WGEAMS hopes to review these other mechanisms and assess whether they suggest the need for new monitoring targets or assessment procedures.

g) To review the final report of the Baseline Study of Contaminants in Baltic Sea Sediments.

Justification: This is a continuation of an item from the 1997 WGEAMS terms of reference. It is hoped that the final report will be available for 1998.

h) To conclude the preparation of proposals for a workshop on risk evaluation and environmental monitoring.

Justification: This is a continuation of an item from the 1997 WGEAMS terms of reference. WGEAMS felt that it was unable to complete the task in 1997, and has agreed to work intersessionally to identify appropriate experts to assist in the formulation of a symposium programme.

i) To review the outcome of the Study Group on Monitoring Programmes for Contaminants in Sediments.

Justification: This is a continuation of an item from the 1997 WGEAMS terms of reference. No report from this Study Group was available for the 1997 meeting.