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REPORT OF THE
WORKING GROUP ON ENVIRONMENTAL ASSESSMENT AND MONITORING STRATEGIES

Öregrund, Sweden

18–22 March 1996

International Council for the Exploration of the Sea

Conseil International pour l'Exploration de la Mer

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1 OPENING OF THE MEETING

The 1996 meeting of the Working Group on Environmental Assessment and Monitoring Strategies (WGEAMS) was opened by the Chairman, Dr I.M. Davies at 09.00 hr on 18 March 1996 at the National Board of Fisheries, Institute of Coastal Research, Öregrund, Sweden. Dr O. Sandström welcomed everyone on behalf of the Institute.

The terms of reference (C.Res. 1995/2:14:6) for the meeting are given below:

The Working Group on Environmental Assessment and Monitoring Strategies (Chairman: Dr I. Davies, UK) will meet from 18–22 March 1996 in Öregrund, Sweden, to:

a) Examine the current status of the Cooperative ICES Monitoring Studies Programme and make recommendations as to whether it is still required and, if so, in what form;

b) assist in the development of monitoring guidelines for polycyclic aromatic hydrocarbons in sediments (with WGMS) and biota (with MCWG), including the number of replicate samples per area to characterise the sampling area (OSPAR 1.1);

c) Assist (with MCWG) in the development of guidelines for the sampling of marine biota for studies of non-*ortho* and mono-*ortho* CBs (OSPAR 2.2);

d) Consider the current (revised) guidelines on chemical monitoring of fish and shellfish in relation to ICES advice on monitoring strategies;

e) Review developments following the OSPARCOM/ICES Workshop on Biological Effects Monitoring held in Aberdeen in October 1995, in relation to ICES advice on monitoring strategies;

f) Discuss progress with the development of the HELCOM COMBINE (BMP and CMP) and prepare any draft advice considered necessary, particularly in terms of better sampling strategy and further improvements in the quality of the database (HELCOM 4);

g) Assess the implications of the results of the ICES/HELCOM Baseline Study of Contaminants in Baltic Sea Sediments for future sediment monitoring strategies;

h) Review the marine component of the Arctic Monitoring and Assessment Programme with a view to providing advice on further developments, taking into account the impact of Arctic conditions on the monitoring programme and interpretation of the results;

i) Compare existing results for the monitoring of contaminants in eggs of the six seabird species identified in the 1995 WGEAMS report, and report on the application of food chain bioaccumulation models, liaising with the Working Group on Seabird Ecology as required;

j) Report on the relative effectiveness of the preparation of Environmental Assessments on a regional or a subject basis, in the light of experience in, for example, the North Sea and the Baltic Sea areas;

k) Develop an approach to decision making regarding the appropriate power of temporal trend monitoring programmes;

l) Discuss developments in statistical aspects of monitoring, in relation to the new OSPARCOM and HELCOM programmes;

m) Examine the feasibility of, and potential contributions to, an Environmental Status Report for the ICES area on an annual basis and report to the Advisory Committee on the Marine Environment by the end of 1995.

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 (WGEAMS96/2/1) was adopted with the addition of two subjects under item 19.

3 ARRANGEMENTS FOR THE PREPARATION OF THE REPORT

The Chairman, I. Davies, reminded the Working Group that the ICES Secretariat had requested that the report of the meeting be drafted and approved by the end of the meeting, as is usually the case. Sections of the report were therefore drafted throughout the course of the week, and time was set aside on the final day for approval of the drafts, including the recommendations.

Photocopying and word processing facilities, and other encouragements towards self-sufficiency, were kindly provided by the host Institute.

4 REPORTS OF ACTIVITIES IN OTHER FORA OF INTEREST

4.1 ACME

J. Piuze noted that ACME has incorporated many pieces of advice from the 1995 WGEAMS report into its own report for 1995. Included in particular are sections on the use of seabird eggs in contaminant monitoring, the update of monitoring guidelines, and major marine environmental issues of the next decade. A section on recommended ICES activities in environmental monitoring was also used by ACME to prepare the paper CM 1995/Gen:7 (WGEAMS96/5/3).

WGEAMS then took time to discuss its status and future, so as to bring the issue to the attention of its parent committee (ACME). The turnout at the last three meetings has not seen more than seven countries in attendance: this may reflect reduced travel budgets in ICES Member Countries, but it may also be the result of an increase in the number of committees and groups dealing with monitoring in OSPAR, HELCOM, AMAP, etc. The ICES structure itself has several working groups dealing with various aspects of monitoring: WGEAMS, WGSAEM, MCWG, WGMS and WGBEC, to name major ones.

WGEAMS felt that if ICES is going to be competitive and efficient in the field of environmental monitoring, it may have to make its structure less burdensome, and hence less resource demanding. Therefore, ACME should examine the possible amalgamation of a number of existing working groups. ICES should also think about implementing more rapid and efficient means of passing on its advice, more in tune with the often urgent needs of its customers. Again, WGEAMS felt that this is a topic which should be examined by ACME.

4.2 The 1996 Joint Meeting of WGEAMS and WGSAEM (JEASA)

The Chairman reported that this meeting (WGEAMS96/4/1) had been held in Stockholm for two and one half days immediately preceding the current meeting. Four members of WGEAMS had attended. The main results of the meeting were as follows:

1) The draft TIMES document on setting objectives for temporal trend programmes had been approved, and the final draft would be sent to the ICES Secretariat by the end of August.

2) The meeting had discussed the characterization of areas of sediments (spatial distribution monitoring) for PAHs. The meeting had available some information on variance factors, but had agreed to work inter-sessionally to compile a number of case studies to try to progress the work more quickly.

3) The meeting had made an initial assessment of the power of temporal trend studies of contaminants in sediments, and concluded that in general the variances were lower than those in biota programmes, and that therefore smaller changes might be detectable.

4) The meeting had discussed the setting of targets for the power of temporal trend programmes. They had identified two approaches to this problem. The first was based upon a risk assessment procedure, considering the risks associated with erroneous conclusions. The second considered that the environmental response to changes in inputs was likely to be less rapid and less marked than any changes in the inputs in response to control measures, and therefore that programmes of sufficient power to detect changes in inputs were unlikely to be powerful enough to detect the corresponding environmental changes. Case studies investigating the relationship between input changes and environmental changes would be collated intersessionally.

5) The meeting proposed that some form of Theme Session or Symposium should be held to clarify the meaning and role of risk evaluation assessment in environmental monitoring and assessment.

6) The meeting proposed that ICES arrange a special meeting to progress the work on statistical aspects of sediment monitoring, to follow the successful pattern established in relation to temporal trends in biota.

4.3 Report of the OSPAR/ICES Workshop on Biological Effects Monitoring Techniques

The Chairman reported (WGEAMS96/4/3) that an OSPAR/ICES Workshop on Biological Effects Monitoring Techniques had been held in Aberdeen in October 1995. The aim of the Workshop was to define appropriate suites of biological effects techniques (and associated chemical analyses) to address the contaminant-based causes for concern expressed in the Oslo and Paris Commissions' (OSPAR) new Joint Assessment and Monitoring Programme (JAMP) in relation to certain heavy metals, PAHs, and TBT. The Workshop proposed a series of programmes and also made some recommendations on the need for quality assurance (QA) procedures, training opportunities, sampling guidelines and locations. The Workshop further considered the monitoring of biological effects of contaminants in a broader sense, but did not reach a final agreement on this subject. The report of the Workshop was subsequently presented to the 1996 meeting of the OSPAR Working Group on Concentrations, Trends and Effects of Substances in the Marine Environment (SIME 1996).

4.4 Report of OSPAR MON 1995

K. Stange and H. Heinrich reported (WGEAMS96/8/2) that the OSPAR Ad Hoc Working Group on Monitoring (MON 1995) met at the offices of the ICES Secretariat in Copenhagen from 13–17 November 1995. The purpose of MON 1995 was to revise the old JMP guidelines and to develop new guidelines with respect to the principles and methodologies of the future OSPAR monitoring programme (JAMP).

MON 1995 agreed on draft guidelines for most of the topics. Nevertheless, the need for further work on the drafts, on formulating and quantifying detailed statistical objectives, and on harmonizing the structures of the different guidelines, was recognized. This work should be carried out intersessionally and at a follow-up meeting at the end of 1996 (MON 1996 in Sweden).

Concerning eutrophication MON 1995 agreed on (1) draft monitoring guidelines for nutrients, chlorophyll *a*, phytoplankton, oxygen, and soft-bottom macrozoobenthos, (2) a working document for green macroalgae (macrophytobenthos), and (3) a working document for hard-bottom macrozoobenthos.

It was noted for the nutrient guidelines that the minimum requirements for the eutrophication monitoring were not sufficient for the support of phytoplankton measurements and modelling activities. Guidance for organic P and N compounds was therefore included.

The draft guidelines for phytoplankton measurements comprise not only conventional methods for the identification of species but also allow the application of sophisticated organochemical techniques (e.g., HPLC) for this purpose.

The intersessional preparation of guidelines for monitoring benthic organisms before MON 1996 should consider the possibility to fit all respective working documents into one single guideline for benthic organisms.

Six separate documents were presented by Germany as suggestions for revised guidelines for sampling and analysis of metals and CBs in fish, mussels and seabird eggs, respectively. A subgroup attempted to merge these into one set of guidelines for biota, with separate technical annexes for metals and organic contaminants. This task could not be completed during the time available at MON 1995. The draft document will be further revised intersessionally and at MON 1996.

MON 1996 was asked to revise the JMP guidelines for metals in sediments with a view to remove reservations held by Germany and the Netherlands. MON 1995 agreed to insert a footnote against the paragraph regarding the appropriate sediment fraction to analyse for spatial monitoring. There is at present no size fraction considered suitable by all OSPAR Contracting Parties for Convention-wide spatial surveys.

4.5 Reports from OSPAR SIME

M. Joanny reported on the OSPAR SIME 1996 meeting (Oslo, 22–26 January 1996) which was mainly dedicated to the preparation for the implementation of the Joint Assessment and Monitoring Programme (JAMP) by the drafting of a 'work strategy' for each of the JAMP issues. Each 'work strategy' includes objective, lead country, progress to date, available information, gaps in knowledge, future work and future meetings. SIME 1996 prepared the terms of reference for a workshop on background concentrations (to be held in Germany), and a workshop on ecotoxicological criteria (to be held in the Netherlands), which were revised and adopted later by its parent committee, the Environmental Assessment and Monitoring Committee (ASMO). The question of co-sponsorship by ICES of these workshops is still open.

SIME 1996 noted also that it could be problematic to link the implementation of JAMP and the preparation of the Quality Status Reports (QSRs), and that a clarification of tasks was necessary between Regional Task Teams (RTTs), the function of lead countries for particular subjects, and SIME. A number of other technical issues were discussed at SIME 1996, among them a proposal to establish a joint ICES/OSPAR steering group on biological quality assurance.

4.6 Report from OSPAR ASMO March 1996

M. Joanny reported that only the draft report of the March 1996 ASMO meeting was available by the time of the WGEAMS meeting. It was noted that the agenda of ASMO 1996 had been too heavy to allow time for specific strategic discussions, and only problems related to third tier working groups were discussed. ASMO prepared and adopted terms of reference for a workshop on eutrophication modelling and a workshop on habitats and species. ASMO also discussed the data management policy of the OSPAR Secretariat, with a view to increase its capability on certain types of data. The present role of ICES as data centre for raw data on concentrations and effects of substances was considered to remain as it is. On this occasion, WGEAMS was reminded that OSPAR programmes cover atmospheric and riverine inputs. These subjects are normally not included in the ICES field of competence/activity, but nevertheless are necessary parts in the design of an assessment and monitoring programme.

5 CURRENT STATUS OF THE COOPERATIVE ICES MONITORING STUDIES PROGRAMME AND WHETHER IT IS STILL REQUIRED

WGEAMS noted that the ICES Coordinated Monitoring Programme, later renamed the Cooperative ICES Monitoring Studies Programme (ICES CMP, WGEAMS96/5/1, 96/5/2), had been initially designed almost 20 years ago. At that time, it represented a pioneering effort to create a broad-scale cooperative monitoring programme, involving many laboratories in ICES Member Countries. The programme had considered biota, sediment and water as chemical monitoring targets, and had established valuable principles in relation to the need for clear guidelines, quality assurance, and careful selection of target matrices. These had provided the basis for the foundation of monitoring activities under OSPAR (WGEAMS96/6/1) and HELCOM.

The OSPAR Joint Monitoring Programme (JMP) in particular had drawn heavily on ICES experience and expertise, and had taken over large aspects of the ICES CMP from ICES, to the extent that the ICES CMP had been reduced to the study of temporal trends of contaminants in biota. The data made available to ICES was a large sub-set of those submitted to the JMP, with little additional information. The data had only rarely been thoroughly assessed outside the JMP context.

WGEAMS concluded that while the ICES CMP had been a vital and seminal programme in its initial years, it had failed to develop and adapt to changes in international monitoring efforts. It was now not clear who took active responsibility for the management and review of the voluntary programme and data, or who reviewed its objectives. As a consequence, the objectives do not meet ICES' own recommendations on the design of objectives for temporal trend monitoring programmes, or provide an example of a well-structured and managed programme. Clearly, some changes are needed.

WGEAMS considered whether ICES required a monitoring programme of this type as a component factor supporting the credibility of its advice on monitoring issues. WGEAMS took the view that ICES did not need to have a role in routine monitoring programmes, indeed that it should not have such a role. The quality and reliability of ICES monitoring advice is based upon the experience and expertise of the members of its Working Groups, gained largely through involvement in national monitoring activities. On the contrary, there might be a benefit in increased neutrality (actual or perceived) of advice if ICES does not feel obliged in any way towards its own routine monitoring programmes. Therefore, it is the view of WGEAMS that the ICES CMP should not be continued in its present form.

WGEAMS went on to consider the role of ICES in monitoring, as outlined in the ACME discussion document C.M. 1995/Gen:7, (WGEAMS96/5/3). WGEAMS noted within that document that ACME foresaw the role of ICES as including:

a) advisory functions, for example, in relation to programme design and review, quality assurance, methods (e.g., modelling and remote sensing) and statistical aspects;

b) activity in intercomparison studies, particularly if current international opportunities through QUASIMEME do not persist;

c) data banking facilities, including the ability to bring together diverse environmental information, for example, on contaminant trends, fish stocks, and hydrographic changes.

By analogy with the initial role of ICES monitoring activities to provide new perspectives and opportunities, the WGEAMS noted that there was scope within the new definition of the ICES for monitoring activity, in a broad sense. Many of the tasks outlined above make use of data and reports from existing programmes, or involve the design of new programmes. However, there is scope for ICES involvement in the practical aspects of the coordination and execution of field programmes related to new developments in monitoring strategies and techniques.

There is a recurring need for 'one-off', or more investigative monitoring activities. Recent examples include the Bremerhaven Workshop, and the OSPAR DIFFCHEM survey of 'new' contaminants (WGEAMS96/6/4). ICES is well positioned to contribute practically in this field, at the forefront of new monitoring developments. The strategic role of ICES in identifying new problems, contaminants, and monitoring and assessment procedures has already been recognized. These functions fall well within the expertise and traditional areas of activities of several Working Groups. For example, JMSBEC has recently advised on the coordination of chemical and biological effects techniques in sediments (WGEAMS96/8/1), MCWG has reviewed a series of reports on specific environmental contaminants, members of WGBEC are active in the rapid development of effects measurement techniques, and WGEAMS has provided strategic advice for several years. ICES therefore has the structure and expertise that can assess the significance of 'new' contaminants in established or new uses, consider new monitoring tools and procedures, test the application of new techniques, and assess their usefulness. These functions are not well covered by the Commissions, but are often close to the needs and interests of laboratories represented at ICES Working Group meetings.

In order to fulfill these functions, ICES, through its working groups, needs to be involved in collaborative practical work. ICES can act as a forum for the planning and execution of 'one-off' exercises, for example, to determine the scale of the distribution of a novel contaminant (cf. the recent DIFFCHEM programme, WGEAMS96/6/4). This can be achieved, for example, through building on the substance-specific reviews from MCWG. ICES can design and coordinate field and laboratory programmes to test and assess the usefulness of new measurement techniques and strategies for monitoring programmes with a view to their possible adoption in international programmes. ICES can act as a catalyst for the development of coordinated field exercises (cf. the Bremerhaven Workshop) to address particular environmental problems or test new techniques.

These functions do not represent a new role for ICES. They are a reaffirmation of the traditional role of ICES, but adapted to changed circumstances. Success would depend upon the identification of new areas (contaminants, techniques, etc.) which are not fully covered in the JAMP and similar existing programmes. These may be identified in various ways, e.g., from regional QSRs, or from Working Group reports. At the moment, the work will necessarily have to be carried out at national expense, and in the past this has sometimes proved to be a significant hurdle. While it is possible for laboratories to individually or collectively approach funding agencies (e.g., the European Union) for support, there would be very considerable benefits, to both ICES and the participating laboratories, if ICES could develop closer links with funding agencies and become recognized as a source of independent, sound, scientific advice.

6 MONITORING GUIDELINES FOR POLY-CYCLIC AROMATIC HYDROCARBONS IN SEDIMENTS AND BIOTA

It was noted that this item was part of a request from OSPAR (item 1.1), which also included a request for advice on appropriate analytical detection limits. WGEAMS assumed that MCWG (WGEAMS96/6/3, 96/6/6, 96/6/5) would handle that aspect. WGEAMS also noted that MCWG had discussed PAHs and had planned some intersessional work to allow them to address the questions of appropriate methods, variance components, and the drafting of guidelines at their 1997 meeting.

This request for advice had also been raised at the JEASA meeting in Stockholm. It had been agreed to work intersessionally to collate coherent data sets on the variances associated with measurement of the spatial distributions of PAHs, to form a basis for more complete analysis at the proposed special meeting, or at the 1997 JEASA or WGSAEM meetings. WGSAEM 1996 would attempt to define as closely as possible the precise data requirements for this task.

WGEAMS noted that the possible monitoring of PAHs was a new activity for OSPAR coordinated monitoring. The main reason for interest in these compounds was their potential to give rise to deleterious biological effects. The combination of established mechanisms for effect, and 'new' contaminants gave OSPAR an opportunity to apply the newly established strategies of integrated chemical and biological monitoring methods. The question as presented to the WGEAMS was phrased from a purely chemical viewpoint, and therefore was lacking in a biological component. WGEAMS recommended that OSPAR consult the report from the OSPAR/ICES Workshop on Biological Effects Monitoring Techniques, and put into effect methods for the definition of guidelines that took into account the need for both chemical and biological measurements. Addressing the question of PAHs purely from a chemical point of view is unlikely to indicate the most appropriate sampling or other strategy for an integrated programme.

7 DEVELOPMENT OF GUIDELINES FOR THE SAMPLING OF MARINE BIOTA FOR STUDIES OF NON-*ORTHO* AND MONO-*ORTHO* CBS

As for the PAH compounds discussed under the previous agenda item, the monitoring of non-*ortho* and mono-*ortho* CBs is a new activity for OSPAR (request item 2.2), and these compounds have clear potential for biological effects. An integrated chemical and biological effects approach would therefore seem appropriate. WGEAMS noted that MCWG 1996 (WGEAMS96/6/6, 96/7/1) had also discussed the introduction of planar CBs into monitoring programmes.

WGEAMS consulted the JAMP list of issues of concern, and noted that planar CBs were referred to in relation to human health risk, effects on marine ecosystems, and effects on enzymes in marine mammals. WGEAMS discussed appropriate strategies, and concluded as follows:

a) *Human health.* A programme of commercial fish and shellfish sampling was required to establish the broad distribution of these compounds in seafood, and allow an initial risk assessment to be made. As only a few laboratories are able to carry out these analyses reliably, a lead laboratory approach will be necessary.

b) *Ecosystem effects.* It is necessary to establish concentrations, initially in likely hot spots, in fish, shellfish and bird eggs. These measurements should be accompanied by appropriate biological effects measurements in an integrated programme.

However, the analytical difficulties again indicate that a lead laboratory approach may well be necessary. As a first approximation, it has been suggested that it may be possible to use the concentrations of other CB congeners (or some expression of total CBs) as indicators of the concentrations of planar molecules. This approach has considerable penalties arising from the necessary assumptions concerning the ratios of planar to other CBs, and does not provide any increase in information. If the objective of the monitoring or research activity is to obtain new and additional information concerning non-*ortho* and mono-*ortho* CBs, the WGEAMS agreed that specific determinations of these compounds are necessary.

c) *Effects on enzymes in marine mammals.* WGEAMS considered that this was a research target, not suitable for routine monitoring. It was not clear whether there was sufficient information available to allow the prediction of enzyme level effects from concentrations of planar CBs in blubber (or other tissue). WGEAMS considered that the study of enzyme-level effects was not the optimum strategy. There were many indications that toxic organic compounds had given rise to marked effects on reproduction, immunocompetence, and other gross physiological effects in marine mammals. WGEAMS recommended that attention be paid to these effects rather than to enzyme activities. WGEAMS could see no justification at this time for attempting temporal trend monitoring. WGEAMS agreed with MCWG 1996 that new separate guidelines should not be developed for planar CBs (although at the same time recognizing that differences in analytical technique will be needed), but these compounds should be considered as a subset within the general CB guidelines.

8 CURRENT (REVISED) GUIDELINES ON CHEMICAL MONITORING OF FISH AND SHELLFISH IN RELATION TO ICES ADVICE ON MONITORING STRATEGIES

WGEAMS considered the efforts that had been made to amend the JMP guidelines (WGEAMS96/6/1, 96/6/7) to meet the requirements of the new JAMP. The MON 1995 meeting held in Copenhagen had been devoted to this task, and draft guidelines on a range of topics had been prepared during the meeting. In most cases, the draft guidelines were not considered to be complete, and further work was planned for MON 1996. The objectives of the JAMP (WGEAMS96/8/2) were structured differently to those for the JMP. In particular, the JAMP had identified a series of issues of concern, and the previous objective a) of the JMP relating to public health risk had been subsumed into more general objectives relating to biological effects of contaminants, and their assessment on spatial and temporal bases.

Draft guidelines in a consistent format had been developed at MON 1995 relating to CBs and metals in fish, shellfish (mussel) and seabird eggs. These were largely of a technical nature, and did not directly provide solutions to more strategic issues relating to the objectives of the programme, statistical questions, or the integration of chemical and biological effects measurements.

In discussing the documents, the WGEAMS noted that there were several ways in which documents relating to the new JAMP were structured. These included:

a) documents based on JAMP issues of concern (e.g., JAMP programme descriptions);

b) documents based primarily on matrices (e.g., the MON 1995 draft guidelines);

c) documents based primarily on contaminant groups (e.g., OSPAR/ICES Workshop report);

d) documents based on monitoring purposes (cf. the listed Purposes a) to d) of the JMP, and the structure of the MON 1995 draft guidelines).

WGEAMS concluded that this diversity of presentations did not assist in the compilation of a coherent series of documents leading from overall aims, through defined objectives, into detailed technical guidelines. There should be benefit in ensuring that future versions of the documents concerned approach the monitoring programme in a consistent manner.

WGEAMS agreed with SIME and ASMO that it was impractical to expect that the biological effects and chemical components of the JAMP could be sufficiently integrated to allow significant amounts of new data to be included in the QSR 2000 reports. A more profitable strategy would be to concentrate on research to determine the sources of variance in the chemical and biological effects measurements, so that optimal sampling strategies (e.g., time of year, numbers of samples, pooling strategies) could be determined prior to the instigation of international monitoring programmes. WGEAMS thought it likely that the chemical and biological effects measurements would have rather different factors controlling the overall variances, and that optimization would therefore involve elements of compromise. It is likely that, compared to chemical analyses, many of the biological measurements will show much more significant seasonal variations. While existing chemical programmes are primarily directed at obtaining an estimate of the mean (or similar) value of a contaminant in a particular matrix at a particular location, biological effects measurements may be directed at either the population or at the individual members of the population. If the former is the case, then pooling of samples for chemical or biological analysis might be

appropriate, while under other circumstances individual analyses could be necessary. It may therefore be appropriate for temporal trend programmes established under the JMP to continue (until they are considered to have served their purpose), and that biological effects programmes with integrated chemical analyses should be established as separate activities.

E. Andrulewicz noted that within HELCOM, temporal trend monitoring (WGEAMS96/10/1) had been primarily directed at assessing the improvements that had occurred following regulatory action on inputs. HELCOM normally looked to ICES for advice on strategic and technical matters. HELCOM had not yet considered the integration problems like those raised by the new JAMP.

WGEAMS agreed that in addition to procedures predicated upon defined contaminant groups there was a need to develop monitoring approaches that used a top-down strategy to identify impairment of important biological processes. Such an approach would use biomarkers to analyse the problem rather than detect it in the manner foreseen by the OSPAR/ICES Workshop report (WGEAMS96/4/3).

WGEAMS was concerned that many of the analytical methods required to fulfill the programmes outlined by the OSPAR/ICES Workshop were not widely available throughout the OSPAR area laboratories. Before these methods could be introduced into routine monitoring, a period of testing, definition, QA development, and training would be needed, as indicated in the OSPAR/ICES Workshop report. This should then be followed by detailed application of the suites of methods to determine the most efficient and effective sampling and analysis strategies. Clearly, this will take some time if it is to be carried out thoroughly. It might therefore be advisable to consider introducing some of the new integrated procedures on a limited investigative basis, possibly using the lead expert laboratory approach, while other laboratories develop the necessary expertise.

WGEAMS noted that several countries had expressed concern over the power and cost of existing temporal trend programmes, and that interest had been expressed in the possibility of amending the JMP guidelines to optimize the procedures. The VIC programme (WGEAMS96/16/1) had been introduced to provide information on variance components and the consequences of alterations to sampling and analytical strategies, on which changes to the guidelines could be based. WGEAMS supported the VIC initiative, and also supported comments in the report from the joint WGEAMS/WGSAEM (WGEAMS96/4/1) meeting regarding the need to establish sources of variance in biological effects measurements.

The new draft guidelines from MON 1995 (WGEAMS96/8/2) now included apparently contradictory advice on fish sampling procedures. WGEAMS did not consider this to be a major problem, as existing programmes would continue to use the previous guidelines to maintain continuity, while any new programmes would be subject to a thorough assessment of variance components before sampling strategies were finalized.

9 REVIEW DEVELOPMENTS FOLLOWING THE OSPAR/ICES WORKSHOP ON BIOLOGICAL EFFECTS MONITORING IN RELATION TO ICES ADVICE ON MONITORING STRATEGIES

The 1995 WGEAMS meeting reviewed and commented on a strategy document on biological effects monitoring prepared by WGBEC (ICES CM 1995/ENV:5). Generally, the Group expressed concern that the strategy concentrated on indicators of exposure and bioassays, but paid much less attention to longer-term direct indicators of ecosystem health. An exception to this was reference to benthic fauna community structure, although this must be considered to be a poor indicator of chemical pollution. WGEAMS 1995 agreed (WGEAMS96/1/1) that a combination (integration) of chemical and biological observations should concentrate chemical effort on the most relevant environmental compartments and tissues, and that biological observations should utilize a group of measurements at different levels of biological organization. WGEAMS 1995, however, supported the conclusions of the WGBEC strategy paper, but recommended that their comments should be taken into account in the preparation of the final document. The general approaches should be utilized at a proposed joint OSPAR/ICES workshop later in 1995, when more detailed advice should be prepared.

The OSPAR/ICES Workshop on Biological Effects Monitoring Techniques (WGEAMS96/4/3) was held in Aberdeen in October 1995, and was provided with a list of suggested biological effects measurements methods (BEWS/4/1). Based on the conceptual framework drawn up by SIME 1995 and the JAMP contaminant-based issues of concern (WGEAMS96/6/2), four subgroups addressed monitoring techniques suitable for PAHs, TBT, selected metals, and the identification of general regions of concern where undesirable effects were being caused by unknown contaminants, or a mix of contaminants. The work was strongly contaminants-oriented in keeping with the expression of causes for concern in the JAMP matrix. The reports from the subgroups, as amended for the final report of the Workshop, illustrate that the strategy had been 'bottom-up', i.e., concentrated on identifying and applying measurement methods that were to a certain extent developed and known to indicate exposure to specified groups of contaminants. The broader, more problem-oriented strategy, indicated by WGEAMS 1995 as a necessary additional approach, had not been followed, probably through an emphasis on effects measurements

that could be linked to identified groups of contaminants.

WGEAMS discussed the results of the OSPAR/ICES Workshop and found that the previous criticisms of the WGBEC strategy still were to some extent valid. WGEAMS felt that there had been rather too much emphasis on the monitoring of biomarkers of exposure to certain chemicals in areas where such exposure is known to occur, when a chemical analysis would probably, in some cases, provide a more accurate estimate of exposure. The strategy suggested by WGEAMS in areas where there are known contaminant problems is to combine chemical analysis and biological effects measurements in such a way as to increase the net gain in information. The strength of biological effects studies should lie in the elucidation of the biological consequences of exposure, expressed at as high a level in the biological system as possible. It was also recognized that the application of biomarkers in monitoring was not straightforward, as some measurements, e.g., EROD activity, may be influenced also by natural variations in ambient conditions, stress, etc.

It was noted that the report of the subgroup of the OSPAR/ICES Workshop on the identification of areas of concern (from a contamination point of view) had not been agreed by the Workshop. This subgroup had suggested a mixture of bioassays, biomarkers and top level monitoring of benthic fauna communities. A summary document on this subject was presented to SIME 1996 (WGEAMS96/9/2), separate from the agreed part of the Workshop report, where it was acknowledged that while a number of assay procedures could be recommended as having reached an appropriate stage of development for use in monitoring programmes, the appropriate strategies, sampling locations, and 'guidelines' were not yet clear.

WGEAMS agreed with the comments in the OSPAR/ICES Workshop report that many bioassay procedures may not be sufficiently sensitive to provide useful new information in most monitoring situations. WGEAMS also concluded that benthic infaunal and epifaunal communities were strongly influenced by factors other than toxic contaminants, and that therefore the results from such programmes would not be readily linked to chemical contamination.

With a few exceptions, the OSPAR/ICES Workshop had suggested monitoring species and techniques that have not yet been evaluated against basic criteria (e.g., field variability, appropriate sampling times, sensitivity in comparison to other possible techniques, stability and consistency of response within and between individuals, locations and times) which are necessary for the reliable design of contaminants-related monitoring.

WGEAMS generally considered the OSPAR/ICES Workshop to have been a step forward towards a more developed integrated monitoring of chemical contaminants and biological effects. However, WGEAMS agreed that the potential for an additional level of effectiveness of biological effects monitoring, related to the risk that vital functions of the organism may be damaged, had not been exploited. It must be the case that the main justification for biological effects monitoring is the detection and prevention of deleterious biological effects in organisms of direct importance firstly to man, and secondly to other members of the marine ecosystem. The apparent emphasis in the OSPAR/ICES Workshop on molecular-level biomarkers serves to reduce the attention on measurement processes that allow conclusions to be drawn about the overall health/status/condition of the populations being monitored. WGEAMS felt that there was a comparative lack of emphasis on such factors as, in relation to fish populations, for example, age composition, growth rate, and age and size at first maturation. These parameters have been demonstrated to respond to contaminant stress, for example, in the Baltic Sea area. Information of this nature should be obtainable on sufficiently large samples to allow better interpretation of biomarker responses in terms of possible effects on higher levels of organization.

WGEAMS noted that difficulties had been encountered at the OSPAR/ICES Workshop, and subsequent OSPAR meetings, in developing an appropriate framework within which to employ biological effects measurements at higher levels of biological organization. The relevant OSPAR JAMP monitoring issues are expressed in terms of defined contaminants, or at least the identification of areas where contaminants are causing deleterious effects. WGEAMS considered that the twin emphases on defined contaminants, or geographical areas affected by contaminants, were directing attention either to biological responses at the molecular (low) level making interpretation at higher levels more difficult, or else to matrices where contaminants were occurring at undesirable levels (cf. discussions of benthic faunal communities, or sediment/pore water bioassays). What was missing, and inhibiting the development of the potential of integrated chemical and biological monitoring, was a matching emphasis on the 'health' of, for example, fish populations. Biological measurements offered the potential to view the marine environment from this high level of biological organization that was directly relevant to the use of marine resources by man, and to the integration of effects at lower levels of organization. In such a structure, chemical measurements and biomarker studies would be used to investigate the causes of effects observed in populations. The populations would be subject to contaminant stress, and a range of other stress factors as well, but of primary importance would be the occurrence of the effects which could then be investigated through integrated studies.

WGEAMS therefore suggested that JAMP monitoring issue 1.17 be reinterpreted in a wider way, in terms of

concern for the occurrence of biological effects at high levels of biological organization that had clear potential direct consequences for the health of important components of the marine ecosystem, for example, fish populations. Observations should be directed at the populations of concern, and at expressions of fundamental aspects of the overall performance of the organisms. Such aspects would include reproduction, immunocompetence, liver function, and growth/-survival. In a few cases, an appropriate high-level biological effect can be linked closely with a narrow group of chemicals, for example, the imposex/intersex response to TBT compounds. However, normally a more investigative chemical approach will be necessary.

In some cases, good methods to study these aspects of biology are available, but in others there is a need for basic studies on, e.g., immunocompetence, to develop robust and simple measurement procedures suitable for use in monitoring programmes involving fairly large numbers of fish. The table below was drawn up to indicate suggestions as to how such a programme might be structured, combining effects measurements with fundamental aspects of the performance of the species being monitored. There are clear opportunities for combining aspects of this programme with the contaminant-based procedures outlined by the OSPAR/ICES Workshop.

ENDPOINTS FOR MONITORING, AND AVAILABLE METHODS

Reproduction	Liver Function	Immuno-competence	Growth
Age at maturation	EROD	No good methods yet available	Routine methods
Size at maturation	Histopath-ology	(White blood cell counts)	
Gonadosomatic index	Liver nodules		
Reprod. in viv. blenny	Liver size (LSI)	(Leucocrit)	
(Vitellogenin)	Lysosomal stability		
(Steroid hormones)			
Imposex/intersex			

10 PROGRESS WITH THE DEVELOPMENT OF THE HELCOM COMBINE (BMP AND CMP)

E. Andrulewicz presented a brief account of the history of the development of the HELCOM COMBINE programme (WGEAMS96/10/2, 96/10/3), emphasizing that it sought to unify monitoring activities in the open Baltic Sea (BMP) with new monitoring concerns and opportunities in the coastal area (CMP). The programme also now includes the monitoring and assessment of nutrient and contaminant inputs to the Baltic Sea. The HELCOM Working Group structure has recently been streamlined such that most business was now handled through only two groups, one concerned with monitoring and assessment (EC MON), and the other with nature conservation issues (EC NATURE). The present Assessment is being carried out on a sub-regional basis, and then will be combined into a holistic report.

HELCOM BMP

The BMP concentrates on problems of eutrophication and contaminants. The current outline of the programme was similar to that discussed in the 1995 WGEAMS report, which noted and encouraged the novel and developmental aspects of the proposed programme. Dr Andrulewicz expected considerable support for stations established for the mapping of nutrient and oxygen - hydrogen sulphide levels, for benthic macroflora and macrofauna mapping, and some support for high frequency sampling stations for hydrochemistry and phytoplankton. Sampling from ferries was likely on the routes Helsinki-Travemünde and Helsinki-Tallinn, and some automatic hydrographic monitoring buoys have been established. WGEAMS welcomed the likely contributions from the countries concerned, which suggested that the programme would be viable. They also supported the general method of operation in COMBINE whereby the mandatory component was kept small, but was supplemented by a project-based approach to other problems (e.g., the Baseline Study of Contaminants in Baltic Sea Sediments).

The effects component of the BMP was essentially limited to biological effects of eutrophication (e.g., on pelagic production). The component concerning the effects of contaminants was much less clearly defined. WGEAMS recommended that HELCOM should not proceed independently in this area, but should either await new developments within the OSPAR programme, or participate in the development activities.

HELCOM Database

There had been some difficulties with the HELCOM BMP database, to the extent that the future running of the database had been put out to tender. No decision had yet been taken on the results of the tender process.

WGEAMS noted that the establishment of databases for HELCOM was not a straightforward task. It is important that the data formats and database structures are correct, and that appropriate decisions are made as to which data should be included. WGEAMS emphasized that it was necessary to ensure that the new databases were compatible with each other. The architecture and access arrangements must allow for simultaneous access to all databases at a reasonable speed from a single computer terminal. The

access must be such that the data are readily and easily available to many users with different types of query and different output formats. The overall system architecture must be such as to allow for expansion to include different types of data in the future, for example, data on inputs, hydrochemistry, biological effects, etc., and for simultaneous access to these new databases also to be possible from a single computer screen remote from the databases.

HELCOM CMP

The Coastal Monitoring Programme (CMP) is a new development for HELCOM. It is hoped that it will be integrated into a single unit with the BMP. The group (EC MON) to progress the design of the HELCOM CMP and BMP will meet at the end of March 1996.

WGEAMS noted that there was considerable concern over eutrophication problems in coastal waters, even more than in offshore waters. There had been considerable efforts made to decrease the inputs of nutrients to coastal waters (although in some cases reductions in nitrogen inputs had not been reflected in either sea water nitrate levels or reduced plankton growth). WGEAMS considered that there was insufficient explicit attention paid to coastal eutrophication in the HELCOM CMP outline provided to them. Estuaries and coastal lagoons need to be included as priority areas for eutrophication investigations.

There were several organisms listed as possible targets for the monitoring of trace metals. WGEAMS recommended that clear statements of the objectives of monitoring trace metals in organisms should be prepared, so that decisions can be made as to the most appropriate target organisms. WGEAMS suggested that it was likely that the list could be reduced to two species, possibly perch and blenny, and that one factor to be included in the decision was the suitability of the species for biological effects studies.

There were clearer links between the contaminant-related effects measurements in the offshore and coastal areas, and the comments above in relation to the new OSPAR JAMP apply equally well to developments in the HELCOM CMP. There might be potential to increase links between effects studies in the HELCOM and OSPAR areas through harmonization of target species (e.g., through the use of viviparous blenny, and possibly flounder, in the HELCOM area and in estuaries in the OSPAR area) and analytical techniques. The lead laboratory approach to new contaminants fits well with the HELCOM project-based philosophy for matters outside the mandatory COMBINE activities.

WGEAMS recommended that HELCOM consider following the integrated chemical and biological effects strategy recommended by ICES. If HELCOM wished to base such a programme on defined contaminants of interest, advice is available in the report of the OSPAR/ICES Workshop in October 1995 (WGEAMS96/4/3). If the primary causes for concern were expressed as impairment of processes/functions of the fish (e.g., reproduction or immunocompetence), different approaches would be necessary and ICES should be asked for advice. The new programme offered the opportunity for the design of a forward-looking innovative programme incorporating the best current procedures and strategies which the WGEAMS hoped would be exploited by HELCOM.

11 IMPLICATIONS OF RESULTS OF ICES/HELCOM BASELINE STUDY OF CONTAMINANTS IN BALTIC SEA SEDIMENTS FOR FUTURE SEDIMENT MONITORING STRATEGIES

The report of the above-mentioned Baseline Study was not yet available, and therefore this agenda item was deferred until a future meeting.

12 REVIEW OF MARINE COMPONENT OF THE ARCTIC MONITORING AND ASSESSMENT PROGRAMME

K. Stange presented an overview of the development and status of the Arctic Monitoring and Assessment Programme (AMAP). New data generated within the AMAP programme are currently being reported to the Thematic Data Centres (ICES is responsible for marine data) and made available for the assessors. The first phase of AMAP will be completed in the spring of 1997 with the presentation of two products: a State of the Arctic Environment Report, presented to the Ministers of the eight participating countries, summarizing the results of AMAP, and an AMAP Assessment Report, a technical and scientifically presented assessment of all validated data available on the status of the Arctic environment.

WGEAMS noted that the current AMAP monitoring programme was essentially a compilation of programmes contributed by the eight Arctic nations, rather than a prescribed integrated programme, and that it should provide a baseline statement from which the next phase could be developed. The form and content of the next phase of AMAP have not yet been decided. A programme for the continuation of AMAP will be developed, based on the findings of the first AMAP assessment and (presumably) the Audit Report. WGEAMS felt that the most appropriate way they could contribute to this process and provide some advice on the development of the AMAP programme at this stage was to review the comments made during the audit (AMAP 1993:5, WGEAMS96/12/2) of the marine part of the current AMAP programme (AMAP 93:3, as made available to WGEAMS by the AMAP Secretariat in the form of an updated version 1995:X, WGEAMS96/12/1, WGEAMS96/12/4). The Group noted that the Audit Report had addressed many important issues and had

pointed out strengths and weaknesses in the design of the marine sub-programme, but that the audit comments had not been taken into account in the execution of the first part of AMAP since the programme had already been implemented at the time the Audit Report was made available.
WGEAMS noted that the JMSBEC had already considered some aspects of the AMAP programme, and that comments were included in their draft report for 1996 (WGEAMS96/12/3).

As a general comment, the WGEAMS felt that the revised AMAP appendix on marine monitoring was basically the same as the original version, that it had incorporated almost none of the comments from the Audit, and that it still needed major revisions. It was also felt that this document could not represent the description of a future AMAP monitoring programme, in that such a programme would have to be based largely on the results of the Assessment Report to be completed later this year.

WGEAMS offer the following comments on the Audit Report, which are ordered in keeping with the structure and section headings in that report:

a) **Objectives**

It was noted that the first five objectives, spelled out more clearly in the Audit, were all related to contaminants. Thus, they did not necessarily lead into objective 6 (assessment of the current state of the marine environment), which is broader and includes climate variability, as discussed in the introduction and in the ocean climate monitoring section of the marine component document.

b) **Rationale**

To the re-arranged list of questions in the Audit Report, one could add questions on climate, for example, concerning the kind of monitoring that would best reveal climate changes, and also concerning the effects of climate change on biological communities.

To the first question (What is the priority of contaminants, i.e., which do we worry about?) should also be added the extra question: 'Why?' There is no clear expression of the causes for concern behind the selection of priority contaminants. If the causes for concern can be stated, then monitoring can be more effectively targeted. On a related theme, it is not clear in question 6 (What are good indicators for the status of contaminants?) whether the 'status of contaminants' refers to concentrations or effects or both.

Finally, questions 10 and 11 are really not immediately directly relevant to the monitoring programme, as they are concerned with assessment of the need for, and practicality of, control measures, and with the prediction of the likely environmental responses.

c) **Media and organisms to be monitored**

The Audit comments on this section appear to be strongly advocating benthic faunal communities as a major monitoring target. WGEAMS were sceptical as to whether the results of such monitoring could be clearly related to the contaminants which seem to be the main concerns of the programme, and therefore concluded that benthic community analysis should not be undertaken to the detriment of other key media which more directly reflect chemical contamination.

Concerning the essential species to be included in the monitoring of the marine environment, it should be pointed out that the Glaucous gull is highly migratory, and that interpretation of contaminant levels for that species may prove difficult.

d) **Monitoring biological effects**

The specificity of the problems (biological causes for concern) in the Arctic should be taken into account in deciding on biological effects monitoring. If the biological causes for concern can be defined, then monitoring programmes can be designed to address these concerns. Furthermore, decisions should be taken on the basis of the recent work conducted in ICES on the integration of chemical and biological monitoring techniques.

It should be underlined also that the DNA-adduct technique is not appropriate for use in relation to radionuclide contamination.

WGEAMS also noted that UV-B effects on plankton cannot be routinely measured at this time, as this is still in the realm of research. It agreed however with measuring biological effects along known contamination gradients.

Finally, given that the major threats from contaminants in the Arctic appear to be at the higher trophic levels, it was suggested that the measurement of egg contamination as well as of breeding success for seabirds could prove useful. Pathological measurements on higher animals were also recommended.

e) **Geographical area**

The rivers to be monitored are not all identified in the AMAP text, and some clarification is needed, bearing in mind the need (in relation to contaminants) to select those rivers which provide the largest inputs of contaminants rather than the largest inflows of fresh water. The steps outlined for selecting appropriate sampling sites rightly correspond to the objectives listed in the first section, but WGEAMS does not agree that

sites for biological effects monitoring (bullet 5) should be determined in this way. The procedure outlined might be suitable in relation to benthic faunal community studies, but may well not be appropriate for effects measurements which are more clearly related to contaminants.

It must also be noted that the word 'loads' is wrongly used for 'concentrations' in the fourth bullet.

The Audit speaks of remote sensing for identifying sources of contaminants, and for identifying hydrographic boundaries (e.g., fronts). While remote sensing can contribute usefully to the latter targets, WGEAMS is not clear how remote sensing can contribute to the identification of contaminant sources. Again, an undue stress seems to be placed here on sampling related to the benthic fauna.

f) **Sampling frequency**

Any plans for sampling frequency should be based on the results of the AMAP assessment currently under way. Such planning should take account of the temporal variability of the monitoring targets, and the required statistical power of the monitoring programmes.

g) **Radionuclides**

WGEAMS agrees with the Audit that there is no need to conduct a separate sub-programme on radionuclides, thus duplicating the IAEA programme in the Arctic. On the other hand, steps should be taken to include relevant IAEA data into the AMAP reports.

h) **Monitoring ocean climate**

Again WGEAMS agrees that there are several major international programmes for monitoring ocean climate, and that these should not be duplicated. However, linkages should be established to ensure that the pertinent information is collected and made available to AMAP.

i) **Numerical modelling**

Physical models are available for ocean circulation, particle transport, etc. Nevertheless, reliable models for the transport of contaminants in the environment or in the food chain are still difficult to come by. AMAP is not developing models, but would need such tools to assist in the interpretation of the current assessment.

j) **Quality assurance**

Most of the necessary steps are already covered in the ICES criteria for marine data banking. Existing structures (e.g., ICES recommendations, QUASIMEME) should be used wherever possible for good QA practices, and so as to avoid duplication of effort. AMAP laboratories should be encouraged to join appropriate laboratory testing schemes and intercomparison exercises.

k) **Acceptability of data already collected**

WGEAMS concurs with the Audit comments that data must be evaluated before incorporation into the data base. The ICES system provides some controls on the data quality through the requirement that data are accompanied by supporting QA information.

l) **Links with other monitoring programmes**

The Audit emphasizes that the North Sea Task Force (NSTF) procedures should not be taken as a model for AMAP. What is important in relation to the NSTF is to ensure that good use is made by AMAP of the lessons learned during the North Sea process leading to the QSR.

13 RESULTS FOR MONITORING CONTAMINANTS IN EGGS OF SIX SEABIRD SPECIES AND APPLICATION OF FOOD CHAIN BIOACCUMULATION MODELS

WGEAMS examined the possible use of seabird eggs in monitoring contaminants in biota at its 1995 meeting (WGEAMS96/1/1), based on an intersessional review (WGEAMS 1995/7/1, WGEAMS 96/13/1). In conclusion, the WGEAMS considered seabird eggs to be potentially useful in marine monitoring of contaminants, taking into account, e.g., that the species should be selected carefully and that regional particularities had to be considered. Observations of harm to populations, correlated with high contaminant concentrations, was one important reason why bird egg monitoring should be encouraged.

After this 1995 review, additional papers, mainly from Canada, have been sent to the WGEAMS. In, e.g., the Gulf of St. Lawrence (WGEAMS96/13/2, 96/13/5, 96/13/6), high pesticide concentrations in the eggs of gannets and other species have been observed, with simultaneous evidence of reproductive problems. The populations recovered as levels of DDE and other contaminants declined. Generally, the Canadian observations add to the general picture, as presented in the review, of seabird populations being vulnerable to chemical pollution, and that egg monitoring programmes have recorded decreasing concentrations during population recovery periods. The new information does not alter the conclusions drawn in the review on the usefulness of bird eggs for monitoring. An evaluation made by the Canadian Wildlife Service of Environment Canada on the most important factors that should be considered in seabird egg monitoring also

corresponds with opinions expressed in the papers included in the review.

WGEAMS then considered the scale of monitoring of contaminants in birds' eggs within the ICES community, and the degree to which chemical monitoring was linked to biological effects measurements. There has been continuing activity (since 1969) in Canada, linking contaminant concentrations in eggs to eggshell thickness and breeding success for several species, and sampling every four years. Determinands include DDT, PCBs, chlorobenzenes, mirex, chlordane, etc., and mercury. Samples are preserved in a tissue bank. There had been marked effects of organic contaminants on the breeding success of seabirds in Canada, notably on the gannet, and monitoring activity would continue. Due to differences in feeding habits, the Canadian programmes used different species to reflect different inputs of contaminants to the sea. For example, species feeding inshore (e.g., herring gull, double-crested cormorant) were considered to reflect land-based sources of contaminants, while offshore surface feeding species (e.g., Leach's storm petrel) reflected atmospheric inputs of contaminants to the sea surface, and offshore subsurface feeders (e.g., Atlantic puffin) reflected general contamination of deeper waters offshore. A similar strategy was being adopted for Arctic seabird populations. WGEAMS was a little wary in accepting that data from different species could necessarily be directly compared, and felt that the direct association of species with input sources might over-simplify the situation. However, the linkage between egg chemistry and biological effects was a clear strength of the programme.

German monitoring of pesticides and metals in bird eggs is continuing within the trilateral cooperation in the Wadden Sea among Germany, the Netherlands and Denmark. Common tern and oystercatcher will be monitored. In the near future, samplings will only be made in Germany and in the Netherlands. The common tern and oystercatcher are both among the species recommended in the WGEAMS report from the 1995 meeting.

No new seabird egg monitoring activities have been started within the ICES area during the last year.

Sweden was continuing (WGEAMS96/13/4) with the monitoring of contaminants in guillemot eggs, and shell thickness. The concentrations of the 'common' organic contaminants have fallen substantially, but there were still significant effects on eggshell thickness, and the programme will continue.

There was limited activity in the UK, mainly centred on the chemical analysis of gannet (*Sula bassana*) eggs at seven breeding sites around the UK coast, although recently effort has been concentrated on four sites around Scotland. The programme has been under way since 1971. Most of the sampling sites have shown reductions in contaminant (DDE, HEOD, PCB, and Hg) concentrations, although this was particularly the case at sites where concentrations had initially been highest. In the last decade, there have been relatively small changes, with the only significant changes being a decline in DDE at Bass Rock.

There were continuing observations of breeding success at seabird colonies in Norway, but this was not supported by chemical data.

There was continuing activity on both chemical analysis and breeding success of common terns and oystercatchers, centred on the German Bight. It was possible that the Netherlands might join with the responsible German laboratory in this programme, but Denmark was currently unable to do so.

A project was under way in Canada to model contaminant transfer in freshwater and terrestrial ecosystems, including 18 species of birds, which could possibly be adapted to the marine environment. The model covers exposure through water, the atmosphere, and diet.

The Chairman of the ICES Working Group on Seabird Ecology has been approached (WGEAMS96/13/3) concerning the application of food chain bioaccumulation models to contaminants in seabird eggs. He was not aware that this type of model had been applied to eggs. Similarly, the most active group in Germany (led by Dr P.H. Becker of the Institut für Vogelforschung, Wilhelmshaven) had no experience of such models.

WGEAMS concluded that there was clearly a need for more research in this area. As indicated in the 1995 ACME report, different species adopt different mechanisms for the transfer of lipids (and presumably associated contaminants) into eggs, and coupled with different migratory and feeding behaviour, this suggested that the development of bioenergetic models incorporating lipid metabolism, and bioaccumulation models of organic contaminants could add to the interpretation of chemical and biological effects monitoring data. WGEAMS recommended that the development of such models be encouraged.

In relation to bioaccumulation models, WGEAMS noted the recent developments in and application of multivariate statistics to the interpretation of CB and pesticide data from cetaceans. This work could now distinguish the effects of breeding activity on contaminant concentrations, and recognize differences in the ability of species to metabolize synthetic organic contaminants, thereby altering the relative concentrations of these compounds from those in prey

species. It was thought likely that a similar approach could be beneficially applied to seabirds and their eggs.

Only few attempts have been made to model the transfer of contaminants in marine food chains with seabirds as targets. One project is under way in Canada to develop models for terrestrial and freshwater systems. These could also be applied to marine environments. The modelling covers three types of exposure: water, atmosphere and food. Validations are made with available data on contaminants. The project will be finished by March 1997, but should yield results around September 1996.

WGEAMS noted that the sampling, etc., of seabird eggs was now included in the new draft guidelines for the JAMP. However, there were few data immediately available to allow the potential of seabird eggs to detect temporal trends in contaminants to be assessed from a statistical point of view. WGEAMS agreed to work intersessionally, in contact with members of the WGSAEM, to collate and make available data on variance factors in seabird egg analysis. WGEAMS recommended that ACME be asked to include the assessment of the power of seabird egg monitoring programmes in the work programme of an appropriate Working Group for a 1997 meeting, with a view to comparing the likely sensitivity of egg monitoring programmes with programmes based upon other biota or sediment analyses.

14 RELATIVE EFFECTIVENESS OF THE PREPARATION OF ENVIRONMENTAL ASSESSMENTS ON A REGIONAL OR A SUBJECT BASIS

As an introduction to this agenda item, WGEAMS received brief accounts of past experience and current activity on the preparation of Environmental Assessments in both Europe (HELCOM, NSTF, OSPAR) and Canada.

E. Andrulewicz reported that the HELCOM Baltic Monitoring Programme (BMP) started in 1979 and has been carried out without major changes until now. Results of the BMP have been assessed periodically. The First Periodic Assessment of the Marine Environment of the Baltic Sea Area (1980–1985) and the Second Periodic Assessment of the Marine Environment of the Baltic Sea Area (1984–1988) have been completed. The Third Periodic Assessment (1989–1993) is under development, supervised by the HELCOM Steering Group for the Coordination of the Third Periodic Assessment (HELCOM EC BETA). The main change in the strategy of preparation of the Third Assessment, compared to the previous two, is the introduction of a sub-regional element to the approach.

J. Piuze reported that formal, wide-reaching environmental assessments were not normally prepared in Canada. The Federal Green Plan, which has run for the last five years, would yield detailed information on many environmental matters, including contaminants. There was an intention to prepare national overviews, for example, on metallic and organic contaminants in freshwater and marine environments, as well as various regional documents for the general public, for example, a document has recently been prepared providing an overview of the Gulf of St. Lawrence.

The eight countries involved in AMAP have variously been allocated particular responsibility for preparing certain aspects of the Arctic Assessment Report (AAR). The AAR has been partitioned on a subject basis, and reports will be prepared by a series of multinational committees, each dealing with a particular subject over the whole Arctic area.

M. Joanny recalled that the NSTF North Sea QSR (1993) had been prepared on a combination of a subject and sub-regional approach. A series of subject-based reports had been prepared by international bodies, or single countries, and made available to the QSR process. The material in these reports had then been disaggregated for inclusion in the Sub-Regional Reports (SRRs), and then re-aggregated again during the preparation of the overall holistic North Sea QSR. The process whereby the SRRs should have formed the basis of the holistic QSR had failed, fundamentally due to the late completion of some of the SRRs. It was noted that the subject-based reports for the QSR had been prepared by groups of experts, who had been able to apply consistent approaches and assessment criteria. In contrast, the scientific content of the SRRs had been to some extent modulated by the need to achieve bilateral or multilateral international agreement in the drafting panels. There were considerable differences between the style, degree of detail and quality of the SRRs, as had been noted in the reports of the WGEAMS 1993 and ACME 1993. The assessment procedures differed between reports, as did the use of terminology in describing and assessing the situations. As a result, the holistic QSR sometimes did not well reflect the SRRs.

In preparing the NSTF North Sea QSR, the subject-based reports had been disaggregated by the countries responsible for the Sub-Regional Reports so that comments on these subjects could be included in the SRRs. Had the preparation of the holistic QSR progressed as planned, the drafting panel would then have had to re-assemble the subject-based reports from the parts included in each SRR to present their overall view.

It was noted that OSPAR was proposing to adopt a rather similar procedure leading to the QSR 2000 report, although it was hoped that the timetable established would avoid some of the scheduling difficulties

encountered in preparing the North Sea QSR. There was some confusion over the relationship between national responsibilities for the preparation of Regional QSRs, and lead countries for particular subjects within (and across) the QSRs. It was felt that the system of preparing SRRs covering all aspects of the QSR served national needs well, but did not necessarily serve international needs with the same effectiveness.

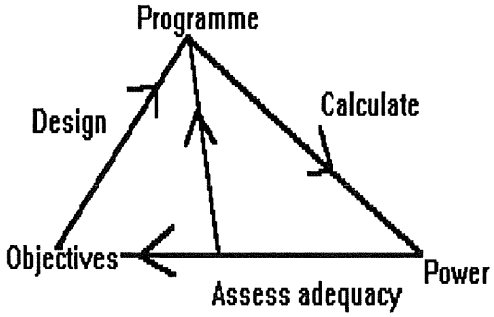
WGEAMS considered that there were attractions in the HELCOM approach in which the final documents were a combination of subject-oriented papers, and regional reports, which were not duplicative. The role of the coordinating group (BETA) in preparing the final publication was primarily that of collation and of preparing short summaries. However, the dissolution of the assessment machinery after each assessment was complete meant that considerable time was spent before each new assessment recreating the appropriate committees and groups of experts. This process significantly added to the time needed to prepare assessments. WGEAMS suggested that EC MON should consider taking the handling of assessments as a permanent task, so the Periodic Assessments would require less of an administrative lead-in time, enabling more rapid completion of the assessment after the next monitoring period.

WGEAMS was of the opinion that, from the evidence currently available, the preparation of subject-based reports provided an effective method for drafting large parts of a QSR, and simultaneously obtaining agreement of all the appropriate experts. From experience in NSTF and HELCOM, the time required to prepare QSRs could be shortened if a mechanism could be found by which initial drafts of complete regional reports could be prepared relatively quickly, and then be subject to editing and amendment by the appropriate experts at meetings convened for that purpose.

15 APPROACH TO DECISION MAKING REGARDING THE APPROPRIATE POWER OF TEMPORAL TREND MONITORING PROGRAMMES

I. Davies reported that the question of the appropriate power of monitoring programmes had been raised and discussed at the joint meeting (WGEAMS96/4/1) of WGEAMS and WGSAEM (JEASA) in Stockholm the previous week. That meeting had suggested two approaches to deciding on the appropriate level of power, as described in their draft report, which may be viewed in the context of a cyclical relationship between objectives, programmes, and power, and may be illustrated as below.

a) The JEASA meeting had suggested that temporal trend monitoring was often undertaken in response to regulation (usually reduction) of the inputs of some contaminants to the environment, as a result of a perceived need to reduce the concentration of these substances (or their biological effects) in the environment.



There would be some gradient of reduction of input, perhaps approximated as X% per year for N years. As an initial simplification, the monitoring target in the environment could be considered to respond, but the response might be slower, or to a lesser degree, than the change in input. This response could be expressed as Y% per year for M years. In most cases, the gradient of the response would be less than the gradient of the change of input. Monitoring programmes of appropriate power to detect the change in input would have much less power to detect the changes in the environment. Knowledge (or estimates) of the relationship between the two gradients could allow programmes of adequate power to be designed for the environmental compartment, or alternatively allow assessment of the power to detect the predicted change. The Joint Meeting had agreed to try to collate case studies which illustrated this relationship between changes of input and response.

b) Secondly, the JEASA meeting considered that risk assessment procedures, with monetary values assigned wherever possible, could be used to assess the overall benefits of a successful programme, or the potential costs of risks associated with unsuccessful programmes. The conscious consideration of the consequences of failure to detect changes that had occurred, or of false positives, could then give rise to a reasoned assessment of the appropriate level of expenditure on the monitoring, and hence the intensity of the monitoring effort.

WGEAMS was aware that there were efforts in hand, notably in the USA and the Netherlands, directed at deriving quality criteria, often for sediments, that were aimed at ensuring the adequate protection of a high proportion, perhaps 90%, of the species present. The derivation of the values was approached from a probabilistic standpoint, and could therefore be said to include an element of risk assessment. However, the WGEAMS noted that such systems could entail unexpectedly high risk if the 10% of species that were not protected were fundamental and essential

components of the ecosystem, e.g., were the primary producers.

WGEAMS discussed both of these approaches at some length. In some cases, it was possible to readily conceive of programmes that could be analysed in monetary terms. Examples included PSP monitoring, where there were clear consequential costs of such events as closure of fisheries, or deaths/illness resulting from failure to detect serious outbreaks of PSP.

Other examples had much less clear financial consequences, for example, environmental monitoring in response to Ministerial Declarations of the need to reduce inputs of certain contaminants to the North Sea. In such cases, the justification for expenditure was more closely linked with the political needs of the responsible persons, for example, in the consideration of the consequence of 'getting the conclusion wrong', e.g., not detecting a trend after expensive reductions in inputs. In such cases, there might be pressure to reverse the controls, on the grounds that they had no effect. A more likely outcome was thought to be that if the environmental monitoring did not detect a change, reference would be made back to input monitoring, which would be much more likely to show the reductions, and to ascribe the apparent lack of change in the environment to the complexities of the processes involved. In other words, the consequences of failure are relatively small, as the input monitoring acts as a reliable fall-back body of data, and the environmental programme might be viewed as less essential.

It became clear that in most cases attempts to estimate the ratios between the costs of monitoring programmes and the value of the resource being protected, or the cost of failing to detect changes, can rapidly leave the scientific field and depend upon more political considerations, possibly including assessments of the social value of resources and the value of national policy in international fields. The need to be certain, or the degree of tolerable uncertainty, was often a rather subjective, or even emotive, question, but would be strongly influenced by the severity of the consequences of error. To members of the WGEAMS, there were often many imponderable (unscientific?) factors that needed to be included in risk assessments. Some countries had environmental economists who might be able to advise on such matters, and it was noted that commercial insurance companies were expert in the assessment of risk, including environmental risk (for example, associated with possible climate change).

M. Joanny pointed out that, in many cases, the design of monitoring programmes was constrained by the resources that could be devoted to them in the face of competing claims and tasks. In such cases, sub-optimal programmes might be adopted, with inadequate power, but which limited the annual expenditure. An alternative to increased annual expenditure might be to accept detection of trends over a longer period. Power assessments in the April 1995 assessment of temporal trends in contaminant concentrations in Baltic Sea biota had indicated that programmes of relatively low power over 10–year periods could have markedly improved power over 20–year periods. If extensions to the length of the programme would be acceptable, it might be possible to reduce the annual effort and retain or improve the overall power over the longer period in comparison to a programme over a shorter period.

To continue the consideration of the influence of cost on the power of programmes, it was noted that there might be potential to improve the power of biota-based programmes through alteration of the target species or tissue, although such action had the disadvantage of the discontinuation of existing data series, and might take some time to match the 'accumulated' power of the existing programme.

WGEAMS finally returned to questions of risk assessment, and estimation of the benefits or penalties of successful or unsuccessful programmes. In some cases, the consequences of a programme detecting an anticipated change could be estimated. Examples were given of recovery monitoring, where there was a clear target value to be achieved (e.g., a food standard) before a benefit could accrue (e.g., reopening a fishery). The prediction of the rate of change and appropriate monitoring target were complicated if there was an accumulated history of contamination, for example, in the form of contaminated seabed sediments that could continue to exert effects after reductions in the contaminant input.

In general, monitoring to a target value appeared to the WGEAMS to be more amenable to quantitative risk assessment procedures, particularly if the consequences of being above or below the target, and the confidence of the estimate of the true position obtained from monitoring, could be clearly identified. However, it was noted that many targets or quality standards for the environment or seafood already had significant safety factors built into them. It might therefore be concluded that monitoring in relation to such targets, for example, watchdog or general compliance monitoring, might be satisfactory with rather low power. This would be reflected in high variance between data points, but permit increased intensity of sampling if there were some indication that conditions might be becoming unsatisfactory.

WGEAMS supported the proposal from JEASA that a Workshop, Theme Session or Symposium be organized in the field of risk evaluation and assessment in relation to monitoring targets and objectives, and environmental assessment.

16 DEVELOPMENTS IN STATISTICAL ASPECTS OF MONITORING IN RELATION TO THE NEW OSPAR AND HELCOM PROGRAMMES

I. Davies briefly reminded the meeting of some of the developments that had taken place recently regarding statistical aspects of monitoring programmes. These included the approval in principle of the draft TIMES document on temporal trend monitoring objectives (subject to editing and review), the awareness of the need for statistical definition of programmes at MON 1995 (WGEAMS96/8/2) but the lack of inclusion of statistical targets in the revised draft guidelines, the suggestion at the joint meeting with WGSAEM to collate case studies of sediment programmes with a view to ICES sponsoring a special meeting (WGEAMS96/4/1), and the development of VIC (WGEAMS96/16/1). At MON 1995, the alternative strategies discussed by WGEAMS 1995, namely either to design standard guidelines and accept different power at different locations, or to stipulate the minimum power and allow variation in sampling and analysis strategies to achieve this target, had been pointed out but no advice had been given to SIME/ASMO as to the more appropriate alternative.

WGEAMS supported the recommendations mentioned above from the Joint Meeting, and the need to assess variance components in biological effects measurements. The latter was a large task, and it was suspected that in many cases adequate data were not yet available.

E. Andrulewicz pointed out that the recent assessment of data for temporal trends of contaminants in biota in the Baltic had included an assessment of the power of all time series available to ICES (WGEAMS96/10/1). In the case of many organic contaminants, the apparent power to detect changes of 5% or 10% per year in concentrations had been rather low, but significant trends had been detected. This suggested that the actual trends had been rather large. In most assessments, data series which show no trend are either disregarded or else merely noted as showing no trend. It might be possible to make more use of these data by stating in assessment reports the confidence limits of the detected trends in data series where trends are detected, and stating the maximum trend that might have occurred at the other stations without being detected (with a certain confidence level).

Furthermore, this suggested that the comparison of the statistical performance of temporal trend monitoring programmes in terms of the power (WGEAMS96/16/3) of each to detect a defined rate of change might give a misleading impression of the relative value of the data series. A more useful expression would take into account the expected or likely (or 'interesting') rate of change, and the power of the programme to detect such a change.

E. Andrulewicz agreed that the development of new components of COMBINE gave an opportunity to introduce statistical considerations into the design at an early stage. He hoped that sufficient statistical advice would be available within HELCOM. He found the suggestion of defining the minimum power of programmes helpful, as it presented the possibility of reducing effort in areas where variability was low. He hoped that HELCOM programmes would include the collection (or collation) of data on variance components, pilot studies where data were not available, and statistical analysis of the data prior to the final design of the programmes.

WGEAMS then discussed whether it was possible to devise methods whereby the choice between fixed sampling, etc., guidelines, and the freedom implied by the definition of minimum power, could be approached in a less stark manner. One suggestion raised was that guidelines could be written with the aim of achieving, in the generality of cases, some particular level of inter-annual residual variance. If the annual rate of change and the period of a programme are fixed, the power is a function of this residual variance. This residual variance could then be viewed as a 'design criterion' for the trend programme. Individual laboratories could then choose between following the technical guidelines in detail, or else using different schemes which they could demonstrate would achieve the same or lower residual variance.

Some members of the group questioned the practicality of this approach, on the grounds that in areas (for example, contaminated areas) where field variances tended to be high, it would be necessary to undertake more sampling and analyses than in areas where natural variance was lower. This strategy might also have undesirable consequences for the precision of chemical analyses and Quality Assurance. It was also noted that the current methods for the assessment of the power of monitoring programmes do not take into account the possibility of future changes in the natural variability of the property being measured. In discussion, some alternatives were suggested, including the extension of the assessment period in such areas, i.e., the particular rate of change would only be detectable after a rather longer time in more variable sampling areas.

A further alternative might be to consider the desired power of the programmes to detect the expected, or likely, or 'interesting' rate of change at each location, and to calculate the maximum acceptable residual variance from this. A possible consequence of this might be to reduce the effort required in contaminated areas (where rates of change in response to control measures might be larger than in less contaminated areas), thereby to some extent counterbalancing the influence of the higher natural variance in these areas.

17 FEASIBILITY OF, AND POTENTIAL CONTRIBUTIONS TO, AN ENVIRONMENTAL STATUS REPORT FOR THE ICES AREA ON AN ANNUAL BASIS

A suggestion was received from Norway in 1995 putting forward the idea of ICES publishing an annual environmental status report for the entire ICES area. Such a report could include topics like ocean climate, marine production, trends in pollution, fish diseases, unusual events, etc. WGEAMS (WGEAMS96/1/1) and ACME briefly considered the suggestion in 1995, but left a more thorough examination to 1996.

WGEAMS discussed the idea and concluded that, while a status report on the physical state of the North Atlantic environment could probably be produced annually without problem, it would be much more difficult to do the same for the chemical and biological effects data. However, since there are already various reports on the state of the environment prepared on a regular basis by governments, organizations, or Commissions, it was felt that maybe what is needed is not a scientific report of the environmental status of the ICES area in a given year, but rather a short yearly bulletin of highlights designed to inform the public.

E. Andrulewicz explained that HELCOM publishes annually a four-page report for the public. A similar publication, discussing broad issues of interest to many ICES countries, could be prepared within ICES for the North Atlantic and adjacent seas, covering hydrographic conditions, fish stocks and catches, notable environmental events and major ICES news. WGEAMS recognized that:

1) this would be relatively easy to produce;

2) it would be of interest to politicians as well as to the public;

3) it would raise the ICES profile with the public; and

4) it would encourage integration of both fisheries and environmental information from ICES.

To be successful, such a bulletin would have to be translated into several languages, potentially with the help of each Member Country. An alternative to this newsletter idea would be to provide similar information on an Internet web site rather than on paper. The public reached would be somewhat different, but probably wider, and the translation into many languages would no longer be an absolute requirement.
A possible process to compile this annual report would see suggestions gathered by Working Groups under an agenda item at each of their annual meetings, and then passed on to ACFM or ACME. The Advisory Committees would then select items of choice and suggest them to the Consultative Committee who would transmit the resulting draft to the ICES Secretariat for publication.

WGEAMS also commented that each working group could, in its annual meeting report, provide a short summary text that could be placed on the ICES website once the working group report had been formally adopted.

18 PROPOSALS FOR CHAIRMANSHIP

I. Davies explained that he had now acted in the capacity of Chairman for three meetings of the Working Group, in Gdynia, Aberdeen, and Öregrund. It was ACME policy that the chairmanship of working groups should be periodically reviewed, at intervals of three years. Chairmen are formally appointed by the ICES Council, on the recommendation of Committees. However, it was open to Working Groups to make known to ACME their own suggestion for Chairman, although ACME was under no obligation to agree with any proposal.

WGEAMS recommended that I. Davies continue to act as Chairman for a further period.

19 ANY OTHER BUSINESS

19.1 Monitoring Effects of Residues of Fish Medicines in Sediment at Fish Farms

I. Davies reported that an item on this subject was in the terms of reference for the next meeting of WGEIM, and that WGEAMS or WGSAEM was also mentioned as possibly contributing to the item. He undertook to assess whether it was an appropriate subject to bring to the attention of WGEAMS at its next meeting.

19.2 Evaluation of the Effects of Pollutants on the Abundance and Quality of Cetacean Prey

This item had arisen from a recent meeting of the International Whaling Commission (IWC) (WGEAMS 96/19/1), and had been passed to WGEAMS from ACME through J. Piuze.

WGEAMS discussed the question in two parts:

a) Do pollutants significantly affect the abundance of cetacean prey?

A number of examples were discussed of circumstances in which harm had, or could have been, done to top predators from contaminants in prey species. For example, reproduction in Baltic seals has been reduced without prey species abundance being adversely affected, and crabs around Canadian pulp mills have been known to be unaffected by up to 90 ppm 2,3,7,8-TCDD in their

tissues, when the permissible limit for human foodstuffs is 0.02 ppm. WGEAMS considered that it was unlikely that prey abundance would be significantly affected by contaminants, as it would require widespread and rather severe impact. WGEAMS felt that before the prey species suffered toxic impact of the contaminants, biomagnification would have resulted in such high concentrations in the cetaceans that they would already have been severely affected by the toxicants.

b) Do pollutants affect the quality of cetacean prey?

The answer to this question must be that pollutants do affect prey quality, in the sense that the prey species could accumulate the pollutants from the environment. In order to provide advice on the degree to which prey species were contaminated (WGEAMS96/19/2), it would be necessary to obtain information on cetacean diets and feeding locations.

As an initial step, the WGEAMS recommends that the Chairman of ICES Marine Mammals Committee approach the IWC for information on the diets of relevant cetaceans, and on their feeding locations within the ICES area. It should then be possible for an appropriate Working Group to assemble information on contaminant concentrations in the prey, from data held in the ICES databank, or elsewhere. An approach to the further evaluation of the significance to the cetaceans of the concentrations of contaminants in prey species might involve modelling of the transfer of contaminants through food chains into cetaceans.

20 CONSIDERATION AND APPROVAL OF RECOMMENDATIONS

WGEAMS agreed the recommendations, as included in Annex 4 to this report.

21 PROPOSALS FOR A FURTHER MEETING

Following a generous offer from M. Joanny, the WGEAMS recommended that it meet for a period of five days in March 1997 at IFREMER, Nantes, France to consider, *inter alia*, the matters listed in Annex 4.

22 CONSIDERATION AND APPROVAL OF THE MEETING REPORT

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

23 CLOSURE OF THE MEETING

On behalf of the WGEAMS, the Chairman thanked the Institute of Coastal Research for their hospitality and cordiality, and closed the meeting at 12.30 hrs on Friday 22 March 1996.

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.

5. Examine the current status of the Cooperative ICES Monitoring Studies Programme and make recommendations as to whether it is still required and, if so, in what form.

6. Assist in the development of monitoring guidelines for polycyclic aromatic hydrocarbons in sediments (with WGMS) and biota (with MCWG), including the number of replicate samples per area to characterize the sampling area (OSPAR 1.1).

7. Assist (with MCWG) in the development of guidelines for the sampling of marine biota for studies of non-*ortho* and mono-*ortho* CBs (OSPAR 2.2).

8. Consider the current (revised) guidelines on chemical monitoring of fish and shellfish in relation to ICES advice on monitoring strategies.

9. Review developments following the OSPAR/ICES Workshop on Biological Effects Monitoring held in Aberdeen in October 1995, in relation to ICES advice on monitoring strategies.

10. Discuss progress with the development of the HELCOM COMBINE (BMP and CMP) and prepare any draft advice considered necessary, particularly in terms of better sampling strategy and further improvements in the quality of the database (HELCOM 4).

11. Assess the implications of the results of the ICES/HELCOM Baseline Study of Contaminants in Baltic Sea Sediments for future sediment monitoring strategies.

12. Review the marine component of the Arctic Monitoring and Assessment Programme with a view to providing advice on further developments, taking into account the impact of Arctic conditions on the monitoring programme and interpretation of the results.

13. Compare existing results for the monitoring of contaminants in eggs of the six seabird species identified in the 1995 WGEAMS report, and report on the application of food chain bioaccumulation models, liaising with the Working Group on Seabird Ecology as required.

14. Report on the relative effectiveness of the preparation of Environmental Assessments on a regional or a subject basis, in the light of experience in, for example, the North Sea and the Baltic Sea areas.

15. Develop an approach to decision making regarding the appropriate power of temporal trend monitoring programmes.

16. Discuss developments in statistical aspects of monitoring, in relation to the new OSPAR and HELCOM programmes.

17. Examine the feasibility of, and potential contributions to, an Environmental Status Report for the ICES area on an annual basis and report to the Advisory Committee on the Marine Environment by the end of 1995.

18. Proposals for Chairmanship.

19. Any other business.

20. Consideration and approval of recommendations.

21. Proposals for a further meeting.

22. Consideration and approval of the Meeting report.

23. Closure of the meeting.

ANNEX 2

List of Participants

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ANNEX 3

List of Meeting Documents

WGEAMS 96/1/1	Report of the Working Group on Environmental Assessment and Monitoring Strategies. Aberdeen, 1995
WGEAMS 96/1/2	Draft report of the Joint Meeting of the Working Group on Biological Effects of Contaminants and the Working Group on Marine Sediments in Relation to Pollution. Nantes, 1994
WGEAMS 96/1/3	Report of the Joint Meeting of the Working Group on Marine Sediments in Relation to Pollution and the Working Group on Biological Effects of Contaminants. Aberdeen, 1995
WGEAMS 96/1/4	Report of the Working Group on Environmental Assessment and Monitoring Strategies. Gdynia, 1994
WGEAMS 96/2/1	Draft agenda
WGEAMS 96/4/1	Draft Report of the Joint Meeting of the Working Group on Environmental Assessment and Monitoring Strategies and the Working Group on Statistical Aspects of Environmental Monitoring. Stockholm, 1996
WGEAMS 96/4/2	Report of the Working Group on Marine Sediments in Relation to Pollution. Ostend, 1996
WGEAMS 96/4/3	Report of the Joint Meeting of the Working Group on Environmental Assessment and Monitoring Strategies and the Working Group on Statistical Aspects of Environmental Monitoring. Aberdeen, 1995
WGEAMS 96/4/4	Report of the Joint Meeting of the Working Group on Marine Sediments in Relation to Pollution and the Working Group on Biological Effects of Contaminants. Ostend, 1996
WGEAMS 96/5/1	The ICES Coordinated Monitoring Programme, 1981
WGEAMS 96/5/2	Details to be followed for sample collection, preparation and analysis in the conduct of cooperative monitoring
WGEAMS 96/5/3	ICES role in environmental monitoring. A discussion paper prepared by ACME (C.M.1995/Gen:7)
WGEAMS 96/6/1	Principles and Methodology of the Joint Monitoring Programme. A11: Guidelines for the Sampling and Analysis of Organisms and the Reporting of Results under the Joint Monitoring Programme (JMP)
WGEAMS 96/6/2	Implementation of the Joint Assessment and Monitoring Programme–1995. Oslo and Paris Commissions, 1995
WGEAMS 96/6/3	Analytical variance of the determination of PAHs in standard solution, cleaned sediment extract and raw sediment extract (from 4th round QUASIMEME report)
WGEAMS 96/6/4	Draft results from DIFFCHEM new contaminants project
WGEAMS 96/6/5	Sampling variability, by Foppe Smedes
WGEAMS 96/6/6	8.2.1 Develop monitoring guidelines for PHAs in sediment and biota. Marine Chemistry Working Group, 1995
WGEAMS 96/7/1	8.2.6.3 Report of the investigation on CB patterns in marine mammals. Marine Chemistry Working Group, 1995

WGEAMS 96/8/1 4.1 Strategy for Incorporating Biological Effects in an integrated monitoring programme. 1995 ACME Report

WGEAMS 96/8/2 Working Document for the preparation of Guidelines for the sampling and analysis of organisms and the reporting results under the Joint Assessment and Monitoring Programme (JAMP). MON 1995

WGEAMS 96/8/3 Extracts from the JMP Manual

WGEAMS 96/9/1 Report of the OSPAR/ICES Workshop on Biological Effects Monitoring Techniques. Aberdeen, 1995

WGEAMS 96/9/2 Annex 13: General biological effects monitoring programmes. Draft Summary Record - ASMO 1996

WGEAMS 96/10/1 Report of the ICES/HELCOM Workshop on Temporal Trend Assessment of Data on Contaminants in Biota from the Baltic Sea. ICES CM 1995/Env:10. Copenhagen, 1995

WGEAMS 96/10/2 Matters related to COMBINE. 4.3 Revision of the BMP and related Guidelines: Revision of the marine monitoring (BMP) of COMBINE. EC MON 1/96, 4.3/2, 1996

WGEAMS 96/10/3 Coastal Monitoring Programme, an outline of the programme and the present status of the activities within the Contracting Parties (ref. WGEAMS 96/10/2)

WGEAMS 96/12/1 AMAP Monitoring Programme. Marine Monitoring in the Arctic Environment. Draft Revision 1.0, Sept. 1995

WGEAMS 96/12/2 4.5 Marine Monitoring. Audit Report of the AMAP Implementation Plans: Results of the Auditing, 1993

WGEAMS 96/12/3 8. Integration of Biological and Chemical Measurements for AMAP. JMSBEC 1996

WGEAMS 96/12/4 AMAP Monitoring Programme. Species List for Arctic Monitoring. Draft Revision 1.0, Sept. 1995

WGEAMS 96//13/1 Seabird eggs in Monitoring of Pollutants and their biological effect. Report of O. Sandström, Institute of Coastal Research, Öregrund, Sweden to WGEAMS 95

WGEAMS 96/13/2 Seabirds as Monitors of Environmental Chemicals. JMG 19/4/6

WGEAMS 96/13/3 Request on Item 13 from I. Davies to B. Furness

WGEAMS 96/13/4 Bignert, A., Goethberg, Jensen *et al.* 1993. The need for adequate biological sampling in ecotoxicological investigations: a retrospective study of twenty years pollution monitoring. The Science of the Total Environment, 128: 121–139

WGEAMS 96/13/5 Noble, D., and Burns 1990. Contaminants in Canadian Seabirds. State of the Environment Fact Sheet No. 90-1. Ministry of Supply and Services, Canada

WGEAMS 96/13/6 Noble D, 1990. Contaminants in Canadian Seabirds. SOE Report 90-2, Ministry of Supply and Services, Canada.

WGEAMS 96/16/1 Working Document — Proposal for **V**oluntary **I**nternational **C**ontaminant monitoring (VIC) for temporal trends with the aim to test sampling strategies for a co-operative revision of guidelines by 1998. SIME 96/23/1

WGEAMS 96/16/2 N. Green and M. Nicholson: Proposal for **V**oluntary **I**nternational **C**ontaminant monitoring (VIC) for temporal trends with the aim to test sampling strategies for a co-operative revision of guidelines by 1998. WGSAEM 1996

WGEAMS 96/16/3 4.3 Monitoring to Identify Temporal Trends: Statistical Requirements. 1995 ACME Report

WGEAMS 96/19/1 Internationl Whaling Commission: Report of the Workshop on Chemical Pollution and Cetanceans. IWC Resolution 1995-10

WGEAMS 96/19/2 Report of the Study Group on Seals and Small Cetaceans in European Seas. Cambridge, 1995. ICES CM 1996/N:1

ANNEX 4

Recommendations

Ordered by agenda item number

4.1. ACME is encouraged to review the present structure of Working Groups, including the possible amalgamation of working groups, with a view to increasing the efficiency with which ICES advice is supplied to the Commissions and other customers.

4.2. ACME is encouraged to support the proposal from JEASA that a Theme Session/ Symposium/Workshop be organized to clarify the role of risk evaluation and assessment in monitoring and related activities.

4.2. ACME is encouraged to arrange for a special meeting to address statistical aspects of sediment monitoring, as recommended by JEASA.

4.5. WGEAMS endorses the requirement identified at SIME 1996 for the creation of mechanisms for the establishment of quality assurance procedures for biological effects monitoring.

4.6. ACME is invited to consider whether ICES should develop advisory capacity in relation to riverine and atmospheric inputs of contaminants to the sea.

5. The ICES CMP should not continue in its present form.

WGEAMS recommends that the ICES agreed role in monitoring should be interpreted as including the opportunity for ICES to build on the expertise and experience of Working Group members to initiate, plan, and coordinate 'one-off' field exercises to, for example, explore new measurement techniques, new monitoring strategies, or investigate the occurrence and/or effects of 'new' contaminants.

ICES should seek to develop better and more direct relations with primary international science funding agencies, for example the EU, with a view to becoming recognized as a source of considered and balanced views on priority areas for funding.

6. WGEAMS recommends that OSPAR/ASMO be encouraged to adopt an integrated chemical and biological effects approach to the monitoring of PAHs in the sea, as recommended by the OSPAR/ICES (Aberdeen) Workshop, and should not seek to develop chemically oriented guidelines without concurrent consideration of the needs of biological effects programmes concerning PAHs.

7. WGEAMS recommends that a similar approach be adopted towards the ecosystem effects of non-*ortho* and mono-*ortho* CBs, and that the chemical component of such a programme should include determination of the compounds of interest, and should not rely upon assumed ratios between planar CBs and other contaminants.

WGEAMS recommends that the investigation of the occurrence of planar CBs in marine foodstuffs be undertaken by a very small number of lead laboratories.

WGEAMS considers that the effects of planar CBs on marine mammals is a research objective not suitable for monitoring activity at this time, and that there is no justification for international temporal trend studies at this time. WGEAMS recommends that biological effects measurements in marine mammals should not be directed at enzyme-level effects but at significant whole-organism effects, for example, on reproduction. WGEAMS agreed with MCWG that new guidelines for planar CBs should not be developed, but that advice should be incorporated into the main CB guidelines.

8. WGEAMS recommends that OSPAR ensure that documents being developed in support of the new JAMP have a coherent and consistent structure, to avoid possible sources of confusion. WGEAMS recommends that the defined ASMO monitoring issues/causes for concern should be the basis for the documents, rather than environmental matrices/compartments, or 'monitoring purposes' as used in the JMP outline.

WGEAMS considers that in order to ensure the optimum integration of chemical and biological effects procedures in monitoring programmes, it is necessary to have a thorough understanding of the variance

components, including natural seasonal variations and analytical variances in both chemical and effects measurements, and recommends that this task be directed at an appropriate Working Group.

WGEAMS is of the opinion that existing temporal trend monitoring programmes should generally continue, and that new integrated procedures should gradually be introduced, after necessary field testing and the development of QA procedures, as separate activities, possibly after an investigative/lead laboratory phase of development.

WGEAMS recommends that ACME support the VIC initiative, and that it is necessary to undertake similar activities in relation to biological effects measurements to facilitate optimum programme design.

9. WGEAMS recommends that the strategy described in section 9 of this WGEAMS report be used as the basis for the development of a programme of biological effects studies, and supporting integrated chemical measurements, to supplement the strongly contaminant-oriented monitoring objectives discussed at the OSPAR/ICES (Aberdeen) Workshop. WGEAMS considers that the potential of 'top-down' approaches, starting at high levels of biological organization and fundamental processes affecting the health of populations of important marine species, has not been realized within the new JAMP.

10. WGEAMS recommends that the HELCOM COMBINE should include more specific reference to coastal eutrophication, for example, in estuaries and lagoons, as an important monitoring target in the Baltic area.

WGEAMS recommends that HELCOM clarify the objectives behind the need to monitor trace metals in marine organisms with a view to selecting the most appropriate target organisms.

11. WGEAMS recommends that HELCOM consider adopting the integrated chemical and biological monitoring strategies recommended by ICES, and that HELCOM refer to the report of the OSPAR/ICES (Aberdeen) Workshop for guidance on contaminant-oriented programmes, and approach ICES for advice on programmes directed at the health of, for example, fish populations.

12. WGEAMS endorsed the views expressed by JMSBEC 1996 on aspects of the AMAP programme, and invites ACME to consider the various additional comments on the AMAP Programme and Audit Report in the body of the WGEAMS 1996 report.

13. WGEAMS noted that very little new information was available on the monitoring of contaminants in seabird eggs beyond that covered in their 1995 report.

WGEAMS could find no evidence of the application of food chain bioaccumulation models (linked with bioenergetic models) in studies of seabirds and their eggs, and suggests that this is a field worthy of new research activity.

ACME is recommended to include the assessment of the statistical power of seabird egg monitoring programmes, in comparison with programmes based on other organisms or sediments, in the terms of reference of an appropriate Working Group in 1997, to take advantage of the information on variance components to be collated intersessionally by WGEAMS.

14. WGEAMS suggests that there seem to be advantages, in terms of speed and consistency of assessment, for Environmental Assessments to be based, where possible, on a series of subject-based whole-region reports, and that sub-regional reports should cover other aspects of the assessment not covered by the subject-based reports.

WGEAMS recommends that HELCOM consider retaining the topic of assessment on the agenda of EC MON during monitoring periods to reduce the delay caused by re-constituting assessment groups prior to each assessment.

15. ACME is invited to consider the arguments presented on power in trend monitoring, in relation to the opportunities for directing part of an integrated chemical and biological effects programme at measurements and processes that provide indications of the 'health' of populations of important organisms, at a high level of biological organization.

16. WGEAMS recommends that a compilation of similar data on variance factors in biological effects measurements is undertaken with a view to developing optimum sampling and analysis strategies for integrated chemical and biological monitoring programmes.

WGEAMS recommends that ACME support the request from JEASA for a special ICES meeting to consider statistical aspects of the power of sediment monitoring programmes.

17. WGEAMS recommends that ACME support the outline proposal contained in this WGEAMS report for an annual ICES popular publication, covering hydrography, fish stocks/catches, environmental highlights, and brief ICES news.

WGEAMS recommends that ACME consider methods by which the ICES web site may be used to disseminate information about ICES activities and the reports from Working Groups, as outlined in this WGEAMS report.

18. WGEAMS recommends that Dr I.M. Davies, UK, be invited to continue to act as Chairman of the WGEAMS for another term.

19.1 WGEAMS recommends that ACME inform IWC that it is unlikely that contaminants would significantly affect the abundance of cetacean prey species in the ICES area.

It is clear that contaminants do affect the quality of cetacean prey, to the extent that the prey species accumulate some contaminants from the environment. WGEAMS recommends that ACME ask the Chairman of the ICES Marine Mammals Committee to approach the IWC for information on the diets of relevant cetaceans, and on their feeding locations within the ICES area. An appropriate Working Group (perhaps MCWG) should then be asked to assemble information on contaminant concentrations in the prey, from data held in the ICES databank or elsewhere, for transmission to IWC.

21. Proposals for further meetings

21.1 WGEAMS recommends that it meet for a period of five days in March 1997 at IFREMER, Nantes, France under the Chairmanship of I. Davies, immediately following a joint meeting with WGSAEM, to undertake, *inter alia*, the following tasks:

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

b) 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;

c) prepare plans for a Theme Session/Symposium/Workshop on risk evaluation in environmental monitoring and assessment, jointly with WGSAEM;

d) review the outcome of the OSPAR Workshop on Background Concentrations;

e) review the outcome of the OSPAR Workshop on Ecotoxicological Assessment Criteria;

f) review the outcome of the OSPAR Workshop on Nutrient/Eutrophication Modelling;

g) review the outcome of the proposed special meeting on variance components and objectives in sediment monitoring programmes;

h) receive information gathered intersessionally on variance components in seabird egg analysis;

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

21.2 WGEAMS recommends that a joint meeting of WGEAMS with the Working Group on Statistical Aspects of Environmental Monitoring be held under the Chairmanship of R. Fryer at IFREMER, Nantes, France for 2–3 days immediately preceding the WGEAMS meeting, to undertake the following tasks:

a) review progress with compilation of coherent data sets on variance components in sediment analysis, and review the outcome of the special meeting held previously to review these data in relation to the design of sediment monitoring programmes;

b) prepare comments on information on variance components in seabird egg analysis, and develop a method for comparing the relative capabilities of monitoring programmes based on seabird egg analysis, and the analysis of other biota or sediments;

c) review case studies collated intersessionally from which estimates nay be derived of the relationship between changes in contaminant inputs and environmental responses;

d) prepare plans for a Theme Session/Symposium/Workshop on risk evaluation in environmental monitoring and assessment.