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THE ICES ADVISORY COMMITTEE ON THE MARINE ENVIRONMENT, 1993

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MEMBERS OF THE ADVISORY COMMITTEE ON THE MARINE ENVIRONMENT

1992/1993

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Mr S. Carlberg ¹		Chairman, Marine Environmental Quality Committee
Dr M. Reeve ¹		Chairman, Biological Oceanography Committee
Professor T. Osborn ¹		Chairman, Hydrography Committee
Professor H. Ackefors ¹		Chairman, Mariculture Committee
Dr R.C.A. Bannister ¹		Chairman, Shellfish Committee
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¹Participated in June 1993 ACME meeting

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³Participated in ACME meeting from 1 to 4 June 1993

FOREWORD

From 1972 until 1992, environmental advice from ICES was given through the Advisory Committee on Marine Pollution (ACMP). In 1992, the ACMP was dissolved and a new Committee, the Advisory Committee on the Marine Environment (ACME), was established. The purpose of establishing this new Advisory Committee was to treat the discussion of environmental issues within ICES in a broader perspective. Thus, it is the intention that this new Committee will assess and report on the present state of knowledge regarding the risks to the marine environment and its biota from a wide range of causes including contaminants, fishing activity, marine sand and gravel extraction, diseases, introductions and enhancements, changes in nutrient inputs, and changes in climate. The ACME held its first meeting from 1-11 June 1993. At this meeting, a significant proportion of the time and energy available was devoted to consideration of the remit, goals and working procedures of this new Committee. In addition, a scientific review of the North Sea Task Force's Quality Status Report on the North Sea was carried out during this meeting. The present report reflects mainly the discussion carried out at the ACME meeting that dealt directly with requests for advice made by the Commissions to ICES and should, therefore not be interpreted as a review of all activities that were carried out at the meeting. The ACME will, during the course of the coming year, be examining its reporting procedures and in that context would welcome input in the form of written comments from any readers or users of this report with respect to the present form of the report and how it could be improved.

Katherine Richardson
Chairman, ACME

EXECUTIVE SUMMARY

This report presents a summary of the deliberations of the ICES Advisory Committee on the Marine Environment (ACME) at its first meeting in June 1993. The report addresses questions posed to ICES by the regulatory commissions, specifically the Oslo and Paris Commissions and the Helsinki Commission, as well as other issues considered relevant by the ACME. These deliberations were based on the most recent reports of the following ICES working and study groups:

BEWG	Benthos Ecology Working Group
MCWG*	Marine Chemistry Working Group
SGCBS	Steering Group for the Coordination of the Baseline Study of Contaminants in Baltic Sea Sediments
SGDAB	Study Group on the Dynamics of Algal Blooms
SGQAB	Steering Group on Quality Assurance of Biological Measurements in the Baltic Sea
SGQAC	Steering Group on Quality Assurance of Chemical Measurements in the Baltic Sea
SGSSC	Study Group on Seals and Small Cetaceans in European Seas
SGZP	Study Group on Zooplankton Production
WGBEC*	Working Group on Biological Effects of Contaminants
WGBME	Working Group on the Baltic Marine Environment
WGEAMS*	Working Group on Environmental Assessment and Monitoring Strategies
WGEEMS	Working Group on the Effects of Extraction of Marine Sediments on Fisheries
WGITMO	Working Group on Introductions and Transfers of Marine Organisms
WGMS*	Working Group on Marine Sediments in Relation to Pollution
WGPDMO	Working Group on Pathology and Diseases of Marine Organisms
WGPME*	Working Group on Phytoplankton and the Management of their Effects
WGAEM*	Working Group on Statistical Aspects of Environmental Monitoring

*These groups report directly to ACME

Reports of the following other activities were also considered:

Joint Meeting of the Study Group on the Dynamics of Algal Blooms and the Working Group on Shelf Seas Oceanography

Joint Meeting of the Steering Group on Quality Assurance of Biological Measurements in the Baltic Sea and the Steering Group on Quality Assurance of Chemical Measurements in the Baltic Sea

Joint Meeting of the Working Group on Marine Sediments in Relation to Pollution and the Working Group on Biological Effects of Contaminants

Workshop on the Distribution and Sources of Pathogens in Marine Mammals

REQUESTS FROM THE OSLO AND PARIS COMMISSIONS

Section 2 of this report contains brief statements of the progress made on the tasks requested by the Commissions, with reference to the particular sections of the report where more details are provided. A summary of the results of this work is given below.

Design and optimization of monitoring programmes

As requested previously by the Commissions, ICES has now completed a revision of the Guidelines for the Use of Sediments in Monitoring Programmes. The revised guidelines begin with generic advice on monitoring, sampling, analysis and data interpretation. More specific details on techniques are contained in four technical annexes to the guidelines. The ACME recommends that these guidelines be adopted for use in the Joint Monitoring Programme (JMP) or its successor.

The ACME began a general review of monitoring programmes in the ICES geographical area, including a brief review of the North Sea Task Force Monitoring Master Plan and the draft Strategy for a Joint Monitoring and Assessment Programme (JMAP) of the Commissions. The ACME supports a number of the characteristics of the draft JMAP but cautions that the preparatory period before the initiation of this programme should be long enough to ensure that all details are fully worked out among all cooperating countries.

Development and evaluation of monitoring techniques

The results of Step 3b of the ICES/IOC/OSPARCOM Intercomparison Programme on the Analysis of Chlorobiphenyls (CBs) in Marine Media show further improvement in the analytical capability for measuring these contaminants in marine sediments and marine mammal tissues. Step 4 of this programme is being conducted during 1993.

The Fifth Intercomparison Exercise on the Analysis of Nutrients in Sea Water is being conducted during 1993, with the participation of about 150 laboratories. One of the coordinators of this exercise has prepared a document containing practical notes on nutrient determinations in sea water, which will be published in the ICES Techniques in Marine Environmental Sciences series in early 1994.

Phase 2 of the Intercomparison Exercise on the Analysis of Trace Metals in Suspended Particulate Matter (SPM) is being conducted during 1993, with 25 laboratories participating.

Finally, ICES has been planning to conduct a second stage of the Intercomparison Programme on the Analysis of Polycyclic Aromatic Hydrocarbons (PAHs) in Marine Media, but it has not yet taken place owing to the lack of an adequate number of participants. The ACME proposes that the Commissions encourage participation in this programme so that better, more comparable information can be obtained on the distribution of PAHs in the marine environment.

In terms of the request to consider the need for an intercomparison exercise on measurements of lipids in marine samples, a preliminary intercomparison of these determinations in fish muscle tissue showed large variations in results. No plans have been prepared for the conduct of an intercomparison exercise at this time, however, because relevant on-going work is expected to provide further information.

Data assessment

The two main data handling tasks during 1992/1993 for Joint Monitoring Programme data have been to prepare data sets for and assist in the conduct of assessments by the OSPARCOM Ad Hoc Working Group

on Monitoring (AHWGM) for contaminants in sediments in 1992 and contaminants in fish and shellfish in 1993.

The assessment of data on contaminants in sediments for spatial distribution and temporal trends by AHWGM in December 1992 revealed that the data sets to be assessed often suffered from a lack of quality assurance information to be able to assess the validity of the data, and a lack of data on normalizing factors that should be measured to compensate for differences in granulometry and chemical composition among sediments. On the basis of the experience gained in this assessment, the JMG has made a number of recommendations to prevent similar situations from arising in the future.

During 1993 preparations have been under way for the AHWGM assessment of data on contaminants in fish and shellfish for temporal trends. The preparations for this assessment have involved the application of an improved error-checking procedure of the data sets, some of which extend back to 1978, to ensure that all relevant data are contained in the data sets to be assessed, along with the compilation of appropriate information on quality assurance procedures. This assessment is to be conducted in November 1993.

REQUESTS FROM THE HELSINKI COMMISSION

Section 3 of this report contains brief statements of the progress made on the tasks requested by the Helsinki Commission, with reference to the particular sections where more details are provided. A summary of this information is given below.

In terms of intercomparison activities, the results of Step 3b of the ICES/IOC/OSPARCOM Intercomparison Programme on the Analysis of Chlorobiphenyls (CBs) in Marine Media show further improvement in the analytical capability for measuring these contaminants in marine sediments and marine mammal tissues. Step 4 of this programme is being conducted during 1993.

The Fifth Intercomparison Exercise on the Analysis of Nutrients in Sea Water is being conducted during 1993, with the participation of about 150 laboratories and good representation from Baltic Sea laboratories. One of the coordinators of this exercise has prepared a document containing practical notes on nutrient determinations in sea water, which will be published in the ICES Techniques in Marine Environmental Sciences series in early 1994.

Phase 2 of the Intercomparison Exercise on the Analysis of Trace Metals in Suspended Particulate Matter (SPM) is being conducted during 1993, with 25 laboratories participating.

Finally, ICES has been planning to conduct a second stage of the Intercomparison Programme on the Analysis of Polycyclic Aromatic Hydrocarbons (PAHs) in Marine Media, but it has not yet taken place owing to the lack of an adequate number of participants. The ACME proposes that the Commission encourage participation in this programme so that better, more comparable information can be obtained on the distribution of PAHs in the marine environment.

Quality assurance activities conducted specifically for the Baltic Sea are being coordinated by two Steering Groups, one covering biological measurements and the other chemical measurements. The group concerned with biological measurements has recommended that the biological monitoring procedures for the Baltic Monitoring Programme (BMP) be subjected to review before quality assurance procedures are developed. Quality assurance of chemical measurements is being handled in the ICES/HELCOM Workshop on Quality Assurance of Chemical Analytical Procedures for the Baltic Monitoring Programme in Hamburg in October 1993.

With regard to further improvements to the Baltic Monitoring Programme, information on initial progress is provided in this report.

A brief summary of the final plans for the 1993 Baseline Study of Contaminants in Baltic Sea Sediments is provided in this report. Samples for this study were collected during a four-week cruise of the R/V 'Aranda' during June and July 1993. Although arrangements have been made for the analysis of many of the parameters to be covered in this study, funding is still required for most of the analyses of organic contaminants.

In terms of investigations relevant to the estimation of net inputs of contaminants to the Baltic Sea, plans have been made for a coastal zone/open sea flux study in the Gulf of Finland. Owing to other newly planned relevant studies, this may be conducted in cooperation with one or more of these.

Finally, in terms of investigations of the January-February 1993 inflow of saline water to the Baltic Sea, the ACME noted that, despite efforts of the Helsinki Commission, it still takes a very long time to obtain permission for research vessels from one country to enter the national waters of another country in the Baltic Sea. The ACME wishes to draw the attention of the Helsinki Commission to the need to obtain a more flexible application of the existing HELCOM Resolution concerning the access of research vessels to conduct research work in the waters of Baltic Sea countries, at least in urgent cases such as those related to major water inflows and unusual algal blooms, but also for marine research in general.

OTHER ISSUES OF INTEREST

Fisheries-related issues: Two major issues dealing with fish diseases in wild stocks - *Ichthyophonus* infection in herring in European waters and the M-74 syndrome observed in Baltic salmon - were referred to the ACME from the ICES Advisory Committee on Fishery Management (ACFM). A summary of the ACME deliberations on these issues can be found in Sections 9.1 and 9.2. A copy of these sections has been forwarded to the relevant fisheries Commissions.

Environmental Issues: Other major issues considered were:

- (1) the Revised 1993 Code of Practice to Reduce the Risk of Adverse Effects Arising from Introductions and Transfers of Marine Species (Section 12.2) and guidelines for research to evaluate the ecological effects of the release of genetically modified organisms to the marine environment (Section 12.3);
- (2) the preparation of a new Zooplankton Methodology Manual (Section 7.2);
- (3) the development of a programme to investigate the dynamics of harmful algal blooms in coastal oceans (Section 10); and
- (4) information on the abundance of seals and small cetaceans in European seas, survey methodology for the collection of information on the by-catch of small cetaceans in fisheries, and the results of a Workshop on the Distribution and Sources of Pathogens in Marine Mammals (Section 11).

1 INTRODUCTION

The Advisory Committee on the Marine Environment is the Council's official body for the provision of scientific advice and information on the marine environment, including marine pollution, as may be requested by ICES Member Countries, other bodies within ICES, and relevant regulatory Commissions. In handling these requests, the ACME draws on the expertise of its own members and on the work of various expert ICES Working Groups and Study Groups. The ACME considers the reports of these groups and requests them to carry out specific activities or to provide information on specific topics.

The ACME report is structured in terms of the topics covered at the ACME meeting on which it has prepared scientific information and advice; the topics include both those for which information has been requested by the Commissions or other bodies and those identified by the ACME to enhance the understanding of the marine environment. Information relevant to the Commissions' requests and specific issues highlighted by the ACME for their attention is summarized in Sections 2 and 3, where the individual work items from each Commission are listed and related to relevant sections of the main text.

2 PROGRESS ON TASKS FOR THE OSLO AND PARIS COMMISSIONS, INCLUDING AUTOMATIC DATA PROCESSING OF JMP DATA

2.1 Progress on Tasks on the 1993 Work Programme

A summary of the progress on the 1993 programme of work requested by the Oslo and Paris Commissions is given below, along with reference to the relevant sections and annexes of the report, where more detailed information may be found.

(A) Design and optimization of monitoring programmes, following their four defined purposes

A1 to keep under review the question of new contaminants that may be of interest to JMG; this should be regarded as a current awareness exercise and implies an expectation that advice will be provided on those contaminants which ICES considers may give cause for concern in the future;

No overviews on new contaminants in the marine environment are included in this ACME report.

(B) Development and evaluation of monitoring techniques and guidelines, including sampling, analytical methods and quality assurance

B1 to report on the results of Step 3b of the intercomparison exercise on CBs in sediments;

A summary of the results of Step 3b of the ICES/IOC/OSPARCOM Intercomparison Programme on the Analysis of Chlorobiphenyls (CBs) in Marine Media is given in Section 7.5 of this report. These results show that the performance of the participating laboratories as a whole has improved by comparison with the performance in Step 2, although not all of the results are satisfactory. The full report on the results will be published in 1994.

B2 to report on the development of biological effects techniques, and progress in their application in research and monitoring studies;

Some information on the conduct of measurements of biological effects of contaminants in relation to sediments is contained in Section 6.4 and Annex 2 of this report.

B3 to report routinely on all on-going and planned ICES intercalibration exercises, preferably by means of a full report to JMG on the intercalibration exercises carried out;

1) Steps 3a and 3b of the ICES/IOC/OSPARCOM Intercomparison Programme on the Analysis of Chlorobiphenyls (CBs) in Marine Media have been completed. This programme concerns the analysis of CBs in marine sediments (see item B1, above) and marine mammals. Information on the results of Step 3a was provided in Section 12.1 of the 1992 ACMP report (ICES Cooperative Research Report No. 190, pp. 45-46); information on the results of Step 3b is contained in Section 7.5 of the present report. The full reports on the results of these two steps of the programme will be published together in the ICES Cooperative Research Report series in early 1994. The final stage of this programme (Step 4) is being conducted during the second half of 1993.

2) The Fifth Intercomparison Exercise on the Analysis of Nutrients in Sea Water is being conducted during 1993, with the participation of about 150 laboratories (see Section 7.8, below). A draft report on the results of this exercise will be available for review in early 1994.

3) Phase 2 of the Intercomparison Exercise on the Analysis of Trace Metals in Suspended Particulate Matter (SPM) is being conducted during 1993, with 25 laboratories participating (see Section 7.9, below). It is anticipated that a draft report on the results will be available during early 1994.

4) The second stage of the Intercomparison Programme on the Analysis of Polycyclic Aromatic Hydrocarbons (PAHs) in Marine Media had been planned to be conducted in the second half of 1991. However, it has not yet taken place owing to the lack of an adequate number of participating laboratories. Further information on the history of this programme is contained in Section 7.7, below. The ACME encourages the continuation of this programme so that better, more comparable information can be obtained on the distribution of PAHs in the marine environment.

- B4** to consider the need for an intercomparison exercise for measurements of lipids in marine samples and, if appropriate, to draw up proposals for such an exercise. These proposals should include the design, timetable and financial costs of this exercise;

A preliminary intercomparison of lipid determinations in fish muscle tissue showed large variations in results, especially for lean tissues. On the basis of this exercise, several recommendations concerning lipid determinations have been made, as specified in Section 7.6. Given the fact that additional information on lipid extractions will be obtained from Step 4 of the Intercomparison Programme on CBs, further work on lipid determinations will be postponed until the results of that exercise are available.

- B5** to provide copies of relevant descriptions of methods of sampling and analysis as published in "Techniques in Marine Environmental Sciences";

No leaflets were published in this series during 1992. The following leaflets will be published in early 1994:

No. 17 Nutrients: Practical notes on determinations in sea water

No. 18 Contaminants in marine organisms: Pooling strategies for monitoring mean concentrations.

Copies will be provided to the Secretariat of the Oslo and Paris Commissions.

(C) Data Handling

- C1** to keep under review the experiences with the ADP handling of the JMP data and technical problems of access to the JMP data by other computers;

A review of the experiences with the automatic processing of JMP data is provided in Section 2.2, below. This review shows that there still are a number of problems concerning the submission of quality assurance information relevant to the data sets to be assessed. In addition, for data on contaminants in sediments, the results of measurements of appropriate normalizers have not always been submitted. A new PC-based "screening" program has been distributed by the ICES Data Centre to help data originators find errors in their data sets and identify when essential data, such as on quality assurance procedures, are missing, before the data have been submitted to ICES. This should improve the data submissions to the ICES Data Centre and decrease the amount of time required to validate the data sets before they can be considered ready for assessment.

(D) Assessment of Data

- D1** to prepare a report on the biological availability of contaminants in sediments and dredged material and the relevance of sediment quality standards;

An initial handling of this topic is given in Section 6.4, which provides preliminary recommendations for the coordination of biological effects and chemical measurement procedures to enable a more comprehensive assessment of sediment quality to be made. More detailed information on these procedures is provided in Annex 2.

- D2** to keep under review and report as appropriate on the results of studies on the relationship between fish diseases and pollution;

As reported in Section 9.4 of this report, further work has been done on the analysis of fish disease prevalence data in order to prepare maps showing the prevalences of the diseases studied. This work was still considered preliminary, as additional data need to be submitted and all data need to be validated. The work will continue in 1994.

- D3** to confirm the accuracy of the information on spawning periods given in the Report on the 1990 Supplementary Baseline Study of Contaminants in Fish and Shellfish;

This information was provided in the 1992 ACMP report (ICES Cooperative Research Report No. 190, pp. 10-11).

(E) Others

There are no others tasks.

2.2 Automatic Data Processing (ADP) Issues

The ACME reviewed information on the status of ICES automatic data processing (ADP) activities in relation to the handling of data from the Joint Monitoring Programme (JMP) of the Oslo and Paris Commissions (OSPARCOM) and the Monitoring Master Plan (MMP) of the North Sea Task Force (NSTF). In addition to data on contaminants in marine media (biota, sediments, and sea water), the data sets handled by the ICES Environmental Data Bank include fish disease prevalence data and data on biological effects measurements.

Processing and assessment of monitoring data

The two main data handling tasks in 1992/1993 for ICES in relation to OSPARCOM have been to prepare

data sets for and assist in the conduct of assessments by the OSPARCOM *Ad Hoc* Working Group on Monitoring (AHWGM). An assessment of data on contaminants in sediments for spatial distribution and temporal trends was held in Copenhagen in December 1992, and an assessment of data on contaminants in fish and shellfish for temporal trends is to be held in November 1993.

The preparation of data sets for assessment by the AHWGM involves incorporation of the submitted data into the Environmental Data Bank, validation of the data, preparation of preliminary data sets for review by assessment group members, and preparation of data products during the assessment meetings themselves. It should be noted that the present demands for data handling for assessments are placing a continuous, year-round work load on the ICES Environmental Data Bank staff.

The AHWGM assessment of data on contaminants in sediments for spatial distribution and temporal trends

The meeting of the ICES/NSTF/OSPARCOM *ad hoc* Working Group on Sediment Baseline Study Data Assessment (SEDMON) in Spring 1992 revealed some insufficiencies in the data held in the Environmental Data Bank. There was a lack of quality assurance (QA) information (method descriptions and data on the results of analyses of reference material) and data from analyses of normalizers (co-factors measured to compensate for differences in granulometry and chemical composition among sediments).

Accordingly, in order to ensure the completeness of the data sets to be analyzed at the AHWGM assessment of the spatial distribution and temporal trends of contaminants in sediments, the ICES Secretariat made a series of requests to the data originators, asking them to submit the missing information. Two countries did not supply the information requested; six countries took the opportunity to submit new data or additional data; two countries submitted data after the agreed deadline, and one country submitted additional data during the first week of the AHWGM assessment meeting. One country withdrew data during the second week of the assessment meeting. As a consequence of this, the data set to be analysed at the AHWGM assessment meeting was not ready before the end of the first week of the meeting, leaving only a single week to conduct the actual assessment.

A representative of the ICES Secretariat described the above-mentioned problems at the meeting of the Joint Monitoring Group (JMG) of the OSPARCOM in January 1993 and identified two major reasons for the problems, namely, a lack of internal coordination within the participating countries and the tight time schedules. After discussing these problems, the JMG made a num-

ber of recommendations to prevent similar situations from arising in the future.

The AHWGM assessment of data on contaminants in fish and shellfish for temporal trends

The ICES Secretariat is presently involved in the preparation of data sets for the AHWGM assessment of temporal trends of contaminants in fish and shellfish. This is being done according to the new procedures adopted by the JMG. The data to be included in the assessment are from samples taken in 1991 and earlier.

Before data are included in the ICES Environmental Data Bank, an error-checking procedure is applied to the data. This procedure has been continuously improved, and has revealed a series of errors/inaccuracies in data from previous years. Moreover, there is a growing knowledge that the data on measurements of contaminants in biota in themselves are insufficient for an appropriate study of temporal trends. Additional biometric data have to be taken into consideration (sex, age, length, weight), which must be supplied together with the data on concentrations of contaminants. Finally, the need for appropriate QA information is becoming more important when data are to be compared and eventually aggregated.

The described need for additional information has resulted in a series of requests to the data originators to check, correct or supplement data previously submitted to the Data Bank. It is anticipated that these requests could create problems for some data originators, especially when they concern 'old' data (e.g., from the late 1970s or the 1980s).

The actual procedure for the statistical analysis of temporal trends in contaminant concentrations in biota has been considered by a subgroup of the ICES Working Group on Statistical Aspects of Environmental Monitoring with further development occurring during Summer 1993.

Development of the ADP system

The present format for reporting data to the Environmental Data Bank has been in use for some years. The use of this reporting format has, however, shown the need for further development of the format, and this issue has been reviewed by several working groups.

The Chairman of AHWGM will elaborate specifications for information on QA required in relation to data submissions under the current JMP. As a consequence of this, the format will be revised for the Data Bank to hold additional types of QA information, as well as a larger quantity of such information.

Other changes to the data reporting format will include (1) improvements regarding the reporting of information on the sampling of sediments and the initial handling of sediment samples, (2) expansion of the format for fish disease data to permit data to be reported on a less aggregated level, and (3) some changes regarding the reporting of data on measurements of EROD (ethoxyresorufin-O-deethylase) activity in fish liver.

ADP tasks for 1993/1994

The procedure for checking errors in data submissions will be further developed. A test version of a PC-based 'screening' program has been developed for distribution to the data originators in Summer 1993.

The ICES Environmental Data Bank will serve as the project data centre for the Baseline Study of Contaminants in Baltic Sediments. This will require minor modifications to the reporting format to ensure the

'traceability' of data. In connection with this, a primitive data entry program will be developed. If this proves successful, a more sophisticated version will be developed to be used by all data originators.

A substantial part of the work of the Environmental Data Bank will be to prepare the meeting of the AHWGM as described above. Other tasks will be the validation of data on fish disease prevalence for the next meeting of the Working Group on Pathology and Diseases of Marine Organisms (WGPDMO) and the validation of data on contaminants in sea water for the meeting of the Marine Chemistry Working Group (MCWG), both to be held in early 1994.

Finally, OSPARCOM has asked ICES to calculate the costs of establishing a benthos data bank at ICES, based in part on previous work in relation to the benthos data collected under the Monitoring Master Plan of the North Sea Task Force.

3 PROGRESS ON TASKS FOR THE HELSINKI COMMISSION

The present status of work on 1993 requests by the Baltic Marine Environment Protection Commission (Helsinki Commission) is as follows:

Continuing responsibilities

1. To continue the work on evaluating the size of seal populations in the Baltic Sea and to assess their condition in relation to contamination;

A major report on the size and status of seal populations in the Baltic Sea was provided in Section 18 of the 1992 ACMP report (ICES Cooperative Research Report No. 190, pp. 76-82). A 1993 up-date of information on these seal populations, briefly summarized in Section 11 of this report, indicates that there has been no change of any significance.

2. To provide information on "new contaminants", particularly those of special concern to the Baltic marine environment;

No overviews on new contaminants in the marine environment have been included in this report.

3. To report routinely on planned and on-going ICES intercomparison exercises, and to provide a full report on the results;

- 1) Steps 3a and 3b of the ICES/IOC/OSPARCOM Intercomparison Programme on the Analysis of Chlorobiphenyls (CBs) in Marine Media have been completed. This programme concerns the analysis of CBs in marine sediments and in marine mammals. Information on the results of Step 3a was provided in Section 12.1 of the 1992 ACMP report (ICES Cooperative Research Report No. 190, pp. 45-46); information on the results of Step 3b is contained in Section 7.5 of the present report. The full reports on the results of these two steps of the programme will be published together in the ICES Cooperative Research Report series in early 1994. The final stage of this programme (Step 4) is being conducted during the second half of 1993.

- 2) The Fifth Intercomparison Exercise on the Analysis of Nutrients in Sea Water is being conducted during 1993, with the participation of about 150 laboratories (see Section 7.8, below). A draft report on the results of this exercise will be available for review in early 1994.

- 3) Phase 2 of the Intercomparison Exercise on the Analysis of Trace Metals in Suspended Particulate Matter (SPM) is being conducted during 1993, with 25 laboratories participating (see Section 7.9, below). It is anticipated that a draft report on the results will be available during early 1994.

- 4) The second stage of the Intercomparison Programme on the Analysis of Polycyclic Aromatic Hydrocarbons (PAHs) in Marine Media had been planned to be conducted in the second half of 1991. However, it has not yet taken place owing to the lack of an adequate number of participating laboratories. Further information on the history of this programme is contained in Section 7.7, below. The ACME encourages the continuation of this programme so that better, more comparable information can be obtained on the distribution of PAHs in the marine environment.

- 5) In addition to the ICES-wide intercomparison exercises mentioned in the preceding paragraphs, ICES has initiated specific quality assurance activities for the Baltic Sea. Section 7.3 of this report briefly summarizes the plans for the development of quality assurance procedures for biological measurements in the Baltic Sea; this work will require cooperation with a number of groups concerned with specific types of biological measurements. As reported in Section 7.4, quality assurance procedures for several chemical measurements (nutrients in sea water and metals in biota) are the subject of the ICES/HELCOM Workshop on Quality Assurance of Chemical Analytical Procedures for the Baltic Monitoring Programme (Hamburg, 5-8 October 1993).

4. To provide advice on further improvement of the BMP, particularly better sampling strategy and further improvement of the quality of the BMP data base;

The ACME has embarked on a general review of monitoring strategies and their translation into monitoring programmes. Progress in this review, including issues relevant to the Baltic Monitoring Programme, will be presented in the 1994 ACME report. As part of the initiation of this work, a brief review of suggestions for revisions to the BMP is provided in Section 5.3, below.

Special studies

5. To coordinate the Baseline Study of Contaminants in Sediments 1993;

A brief review of the final plans for the Baseline Study of Contaminants in Baltic Sediments is given in Section 8.1. The sampling and sample preparation activities will be conducted according to schedule, but finances are still required for many of the analytical activities, particularly for analyses of organic contaminants.

6. To review proposals for research actions in the Second Periodic Assessment and indicate which research activities ICES would be willing to coordinate;

A response to this request was provided in Section 16.1 of the 1992 ACMP report (ICES Cooperative Research Report No. 190, p. 68). No further work has been done on this issue.

7. To report on plans for and progress in investigations relevant to the estimation of net inputs of contaminants into the Baltic Sea;

Initial plans for a coastal zone/open sea flux study in the Gulf of Finland were reported in Section 16.2 of the 1992 ACMP report (ICES Cooperative Research Report No. 190, pp. 68-69). Recently, it has become known that there are a number of similar plans for flux studies in the

Baltic Sea by other international groups. In order to obtain the maximum benefit of these studies, the ACME sees a need for the coordination of these studies and proposes that the Working Group on the Baltic Marine Environment take a leading role in the coordination process (see Section 8.2).

8. In cooperation with the Baltic Marine Biologists, to prepare a preliminary report on fish diseases in the Baltic Sea and to provide plans for future studies of fish diseases in the Baltic Sea;

As noted in Section 9.3, the Baltic Marine Biologists (BMB) held a sea-going workshop in October 1991 on methodological aspects of fish disease studies in the Baltic Sea. The ACME encourages the ICES Working Group on Pathology and Diseases of Marine Organisms to establish strong communications with the BMB Working Group on Fish Diseases to ensure that this request is carried out and that information on fish disease studies in the Baltic Sea is widely available.

9. To provide guidance in developing a suitable model for the Baltic Sea for assessing long-term changes in concentrations of relevant substances in Baltic marine compartments.

ICES recently established a Study Group on Environmental Modelling in the Baltic Sea that would be able to consider this topic.

4 NORTH SEA TASK FORCE: REVIEW OF THE QUALITY STATUS REPORT AND OTHER ISSUES

4.1 Review of the Quality Status Report

ICES is a co-sponsor of the North Sea Task Force (NSTF), along with the Oslo and Paris Commissions. As such, it has closely followed the development of the North Sea Quality Status Report (QSR), prepared by the NSTF at the request of the North Sea Environment Ministers. In addition, ICES has been involved in the collation and assessment of many of the data used and in the preparation of reports on a number of topics (e.g., benthos, ecosystem effects of fisheries) that have formed the basis for various sections of the QSR. There has been an understanding since the early days of the cooperation surrounding the NSTF that the Advisory Committee on Marine Pollution (ACMP) within ICES would carry out a review of the scientific chapters of the QSR prior to the submission of this report to the Ministers.

In late 1992, the ACMP was dissolved and a new committee, the Advisory Committee on the Marine Environment (ACME), was established in its place. The responsibility for conducting the review of the QSR was transferred to this new Committee. The review was carried out in the month prior to and during the first four days of the first ACME meeting. Most of the review was carried out by ACME members themselves. In cases where relevant scientific expertise was not found among the ACME membership, relevant members of the ICES community (Working Group Chairmen, etc.) were drawn upon. In addition, all sections dealing with fish and/or fisheries were forwarded to the ICES Advisory Committee on Fishery Management (ACFM) for review.

None of the chapters of the QSR were completed at the time that this review was carried out and much of the review work was based upon Version 2 of the text, which was missing the figures and most of the references. At the ACME meeting, the NSTF Secretariat made available Version 2A of Chapters 1 – 5. As far as possible, the ACME attempted to make its comments on these new versions. However, in cases where new information was presented between Versions 2 and 2A, it was not possible for the ACME to carry out a complete review of Version 2A.

The text of Chapters 1 – 5 was considered to be in a nearly final state and, in an effort to be as positive as possible in its criticism, the ACME, in many cases,

offered proposals for alternative text where it was the consensus of the Committee that the existing text was misleading or imbalanced. The ACME recognized that the final document will be professionally edited; therefore, minor editorial comments were not made. As Chapter 6 was in a less final state than the preceding five chapters, the review comments are of a more general nature. The review was carried out on Version 3 of Chapter 6.

The extensive review document which was prepared during the ACME meeting was forwarded to the NSTF Secretariat on 9 June 1993.

4.2 Other NSTF Issues

In addition to its extensive review of the Quality Status Report, the ACME conducted a general review of the experience gained in the implementation of the NSTF Monitoring Master Plan and the implications for the future development of this programme. This is summarized in Section 5.2, below.

Finally, the ACME was informed that the Oslo and Paris Commissions, as co-sponsor of the North Sea Task Force, intended to advise North Sea Ministers at the Intermediate Ministerial Meeting in Copenhagen in December 1993 that the objectives of the NSTF have been successfully achieved and, accordingly, that the NSTF should be debriefed by the end of 1993. The OSPARCOM have agreed to incorporate a large number of the activities coordinated by NSTF into its new structure, beginning in 1994.

The ACME recommended that the ICES Council endorse the proposal of the other co-sponsor, OSPARCOM, that the NSTF be debriefed by the end of 1993. The ACME affirmed that ICES will continue to conduct its traditional types of environmentally related activities, that for the North Sea have been associated with the North Sea Task Force during its period of existence. This includes the coordination of scientific research, the development of monitoring procedures and associated quality assurance guidelines, data handling and assessment activities, assessments of the populations of marine mammals, and other similar activities. ICES will also continue the conduct of new activities that were established on the basis of NSTF requirements, e.g., studies of ecosystem effects of fishing activities.

5 MONITORING STRATEGIES AND REVIEW OF MONITORING PROGRAMMES

5.1 Draft Strategy for a Joint Monitoring and Assessment Programme (JMAP) of the Oslo and Paris Commissions

The ACME considered a document that had been presented at the eighteenth meeting of the Joint Monitoring Group (JMG) of the Oslo and Paris (OSPAR) Commissions (The Hague, January 1993) that proposed a strategy for a Joint Monitoring and Assessment Programme (JMAP) to be carried out under the new OSPAR Commission. JMAP would culminate in an assessment of the quality status of the entire OSPAR Convention Area by the year 2000.

The ACME was informed that the JMAP would eventually replace the present North Sea Task Force (NSTF) Monitoring Master Plan (MMP) and the OSPARCOM Joint Monitoring Programme (JMP). The ACME was also informed that a major goal of the new Convention for the Protection of the Marine Environment of the North-East Atlantic (The OSPAR Convention, signed in September 1992) is the protection of the marine environment. Article 6 of this Convention deals with the assessment of the quality of the marine environment. This Article constitutes the basis for conducting monitoring activities for compliance, trends, and research, with the aim of determining whether and where pollution occurs, evaluating the effectiveness of measures taken, and identifying priorities for action.

The ACME noted that the JMAP document, as it stands, puts the emphasis on the process and the timetable for developing a monitoring programme, rather than on an actual strategy for monitoring. However, it was realized that the proposal was a draft which would be further developed for completion at the final meeting of the JMG in January 1994.

The ACME noted with satisfaction that it was proposed that JMAP should seek to avoid duplication of effort by ensuring that all comparable data collected under other monitoring programmes would be taken into account, and that priority issues would be identified using testable hypotheses, thus helping to focus on gaps and on new problems. The ACME indicated its support of the following important characteristics of JMAP: (1) the development of assessment criteria for chemical parameters, the absence of which has hampered the assessment of data collected under current monitoring programmes; (2) the development of Ecological Quality Objectives (EcoQOs) for biological parameters; (3) the importance given to biological effects monitoring, despite the difficulties in application and interpretation; (4) the collection of data on inputs of contaminants to the marine environment; and (5) the importance accorded to quality

assurance and quality control of sampling and analytical procedures, as well as to the statistical validity of the sampling strategy.

In terms of the further development of JMAP, the ACME suggested that a definition should be given of 'research monitoring', since the understanding of this term varies between countries. It also recommended that the use of models for monitoring purposes, as well as the need for proper data handling systems, be addressed in a strategy for JMAP. Finally, before implementing the programme, an evaluation of its potential to meet the stated aims should be conducted.

The ACME further noted that the ICES Working Group on Environmental Assessment and Monitoring Strategies (WGEAMS) had been requested to review the present NSTF MMP and the OSPARCOM JMP in order to provide advice on monitoring activities to be carried out within the framework of the new OSPAR Commission. In discussing JMAP, the WGEAMS had stressed that it is essential that all monitoring and assessment activities under a Convention be conducted under one umbrella to ensure full coordination. A single, completely integrated programme should be initiated only after a preparatory period long enough to allow all details to be fully worked out among all cooperating countries.

The WGEAMS had further commented that station positions should be carefully selected to address particular topics of concern, and that the measurements necessary at each individual station should be clearly defined. This would require the elaboration of very specific targets for the programme and each of its components. However, this does not mean that the programme would be rigidly fixed, since evolution should take place at the stage of the assessment of the programme, when previous mandatory parameters no longer considered a cause for concern would be removed, and new ones inserted as required.

5.2 North Sea Monitoring Master Plan: Review of Lessons Learned

The Monitoring Master Plan (MMP) of the North Sea Task Force (NSTF) has been reviewed from different aspects by two ICES Working Groups: the Working Group on Environmental Assessment and Monitoring Strategies (WGEAMS), and the Benthos Ecology Working Group (BEWG). Some general remarks on the monitoring activities and results of the MMP were made based on, among others, experience from the preparation of the NSTF Quality Status Report (QSR).

A strong point of the monitoring programme is that data were collected in areas far enough from local pollution sources to be used as reference areas. However, the established offshore sampling stations did not always give adequate results for a full assessment, or gave useful information for certain areas only. On the whole, there were insufficient data to allow an adequate assessment of the parameters covered by the programme. One of the major reasons for this insufficiency was that the agreed monitoring plan often was not carried out completely and sometimes monitoring guidelines were not followed. This meant that mandatory determinands were not measured and/or too few stations were sampled. A good example of the latter is that data have been provided for a number of organic contaminants in sediments or biota, but only from one or several stations. Furthermore, information on the 'supporting parameters' (e.g., salinity, fat content) were often missing. In terms of non-compliance with monitoring guidelines, this problem particularly affected the monitoring of contaminant concentrations in sediments, where analysis of different size fractions of sediments had rendered impossible the assessment of certain data sets in relation to the main compilation of data. Finally, it was observed that as neither the MMP nor the JMP provide biological monitoring data, except for certain measurements of biological effects of contaminants, it may be worthwhile to encourage monitoring programmes on communities and populations of groups of biota.

For the benthos monitoring data, in particular, it was noted by the BEWG that only a portion of the samples had been worked up and that, due to a lack of resources, the data thus available had been subjected to a preliminary analysis only. Since this provided only a partial coverage of the areas sampled, the station network used for the benthos monitoring cannot yet be evaluated. This factor needs to be taken into consideration when future monitoring is planned. Nevertheless, the results of the work carried out under the MMP and the ICES North Sea Benthos Survey in 1986 have identified important natural regional-scale differences in the types of benthic assemblages. The BEWG strongly supports the incorporation of a benthos component in future national and international monitoring plans because of its unique advantage as an integrator of environmental effects over time. However, this requires that due respect is paid to quality assurance already at the planning stage concerning, *inter alia*, sampling frequency, representativity of stations, internal consistency of data, and intercomparability of data among institutes, and also that provisions are made for the accumulation of data series of sufficient duration to reveal temporal trends.

The ACME was reminded that a critical problem in the MMP had been identified by the Working Group on Biological Effects of Contaminants in its 1992 report, namely, that before commencing monitoring work,

monitoring agencies must clearly identify what question they expect specific biological effects monitoring measurements to answer. Such a question had not been addressed before the inclusion of EROD and oyster embryo bioassay measurements in the NSTF MMP, and this had hindered the evaluation of the data obtained under this part of the programme.

The ACME endorsed the following recommendations made by the WGEAMS to improve the monitoring programme and associated activities: (1) before designing a monitoring programme, the purpose of the programme should be clearly defined; (2) the monitoring programme should provide sufficient information to enable an adequate assessment of the defined subjects of concern; and (3) the choice of determinands and locations of sampling should be related to the subjects under consideration. This can mean, for instance, that the monitoring programme is not uniform for the entire area, but rather that certain determinands are considered relevant only for certain areas.

It was noted that monitoring programmes are conducted at the local level, the national level, and the international level. Considerable costs are associated with monitoring, including sampling activities, particularly those requiring sea-going research vessels, analysing the samples, and ultimately working up and assessing the data. Accordingly, to be cost-effective, monitoring programmes must have clear aims and objectives, and these objectives will often differ depending on the level (local, national or international) of the programme. Where it is feasible for an international programme to utilise components of national programmes, this should clearly be done. However, it is essential that all aspects of an international programme, including guidelines for sampling and analysis, and quality assurance procedures, be agreed by all participating countries and adhered to by their laboratories, to ensure that all data submitted can be assessed on an equal basis.

Based on the review made by these two working groups, the ACME questioned whether the MMP was too ambitious for the participating countries and their resources for monitoring, or whether the countries had made an appropriate balance between national and international monitoring programmes.

Finally, the ACME noted that the WGEAMS had carried out a systematic and comprehensive evaluation of all sub-regional assessment reports (as available by the end of February 1993) prepared under the North Sea Task Force. This evaluation resulted in the production of a series of matrix tables in which the Working Group classified, *inter alia*, the status of the data used in the reports, the completeness of the assessment and, more importantly, the gaps in information for each category of data for each sub-region. In general, the ACME con-

sidered that this review provided very useful information, but felt that it was too late to influence the final drafting of the sub-regional assessment reports. However, the ACME was unanimous in its view that the information referring to gaps in knowledge should be conveyed to the Commissions as soon as possible in order to assist them in their work on the preparation of future assessments, particularly of the North Sea.

5.3 Revision of the Baltic Monitoring Programme (BMP)

The ACME noted that the Helsinki Commission (HELCOM) has requested ICES, as a continuing task, to provide advice on revision of the Baltic Monitoring Programme (BMP). The Environment Committee of HELCOM has initiated this revision by defining in a much clearer way the aims of all monitoring activities under the Commission and uniting them under one administrative umbrella in order to facilitate their management, including, for example, the introduction of more stringent quality assurance procedures. The HELCOM Environment Committee has also invited specific proposals for changes or additions to the programme. Some of the Baltic Sea countries provided proposals that are briefly noted below.

The Finnish proposal argued for the development of a new strategy of monitoring and the application of modern marine biological principles that would allow for a process-oriented study and monitoring of the pelagic ecosystem. This proposal recommended the use of remote sensing and autonomous measuring networks.

The German proposal also suggested the use of remote sensing and autonomous measuring networks for monitoring, particularly in the Transition Areas to the Baltic Sea. The proposal contained a number of suggestions for methodological improvements to the physical, chemical and biological measurements. It also contained suggestions for the inclusion of new parameters, e.g., measurements of contaminants in sediments, measurements of total organic carbon and total organic nitrogen in sea water as well as microbiological measurements, and, on a voluntary basis, measurements of heavy metals and chlorinated hydrocarbons in sea water.

Although most of the Polish proposals dealt with matters for which initiatives have subsequently been taken, one extremely important item remained, namely, consideration of how inhomogeneity in the water influences the results of the monitoring measurements and how this should be taken into account in the sampling design.

Finally, a Swedish proposal had been announced but was delayed because of an on-going revision of the national Swedish monitoring programme.

The ACME discussed this topic and took note of the on-going revision process. The ACME noted that several ICES steering groups are already producing specific advice for HELCOM on, among others, relevant quality assurance procedures and the Baseline Study of Contaminants in Baltic Sediments. Furthermore, the ACME recalled that general advice on monitoring had been provided for HELCOM in the 1991 and 1992 reports of the former Advisory Committee on Marine Pollution.

5.4 Arctic Monitoring and Assessment Programme (AMAP): Review of Marine Component

The Arctic Monitoring and Assessment Programme (AMAP) was established by the eight Arctic countries (Canada, Denmark, Finland, Iceland, Norway, Russia, Sweden, and the USA) to monitor the levels, and assess the effects, of anthropogenic contaminants in all components of the Arctic environment. The programme is part of the Arctic Environmental Protection Strategy adopted by the eight countries at the Rovaniemi Ministerial Conference in Finland (June 1991).

ICES was requested by the AMAP Secretariat to contribute to the review of the AMAP programme, as co-ordinated by the International Arctic Sciences Committee (IASC), by specifically reviewing the marine component of the programme. This component was first examined by Professor John Gray (University of Oslo) at the request of ICES. Based on Professor Gray's review document, the ACME agreed on comments on the marine component of AMAP. The detailed comments were forwarded to the AMAP Secretariat as formal ICES advice. A brief summary of the generic elements of these comments is given below.

The ACME found that the marine component of the Arctic Monitoring and Assessment Programme (AMAP) is comprehensive and includes a rationale for the suggested strategy. The objectives seem well conceived, although the ACME proposed a somewhat different structure, as follows:

- 1) Identify sources and quantify loads of contaminants entering the Arctic seas.
- 2) Establish the dispersion routes and environmental compartments likely to be affected by contaminants.
- 3) Establish the spatial extent of contamination, particularly in the sedimentary compartment in areas of deposition and in biota.
- 4) Assess the extent of effects of contaminants on biological systems.

- 5) Establish temporal trends in contaminants and their effects.
- 6) From the above, assess the current state of the Arctic marine environment.

The ACME felt that the section giving the rationale for the marine component of AMAP was excellent and gave a clear argument for the programme suggested. The ACME agreed that the collection of baseline data must not be done at the expense of collecting trend data or conducting process-oriented studies.

The ACME noted that good sampling design for the monitoring programme is vital to permit proper spatial assessments to be made and to have a chance of measuring effects over time. Much thought and effort need to be given to sampling locations. Knowledge of current patterns, frontal systems, and maps of depths and bottom sediment distributions will enable an assessment to be made of likely areas of deposition. From this, a proper stratified random sampling programme can be set up. If this information is not available for a local area or region, it should be obtained before a spatial sampling network can be designed. Too often, *a posteriori* statistical analyses show that the contaminants measured are correlated with depth or sediment parameters, such as grain size or organic carbon load, and that it is not possible to assess spatial or temporal trends without these data. Samples for chemical analysis must be taken to be able to assess variance. If the variance, rather than the mean, changes over time, then the sampling programme must be designed to measure variance. More effort needs to be given to sample design on the local and regional levels. A preliminary sampling programme (pilot study) can be very valuable in terms of refining the sampling design.

Multivariate statistical analyses should play an important role in analysing spatial and temporal trends, but they are unlikely to be successful if the basic sampling design is flawed.

For biological samples, a stratified random statistical sampling design should be used, which takes account of confounding variables such as depth, salinity and organic matter content. For analyses of contaminants in sediments, it is absolutely essential that depth, sediment particle size, and organic matter content be measured on the same samples as the contaminants, otherwise it will not be possible to interpret spatial and temporal differences. These measurements are thus essential and not optional.

The ACME agreed generally with the strategy outlined on the monitoring of biological effects. However, there is a logic in targeting these studies to areas of known or suspected contamination. If there is reason to believe that

polycyclic aromatic hydrocarbons (PAHs) or other organic contaminants are a problem, then mixed-function oxidase (MFO) activity could be measured. Likewise, if there is a suggestion that there is heavy metal contamination, then metallothioneins could be analysed in polychaetes, bivalves and fish. These techniques are best applied sequentially when contamination is found and it is desirable to know whether there are biological effects.

There are other well-proven techniques that are more general and measure a wide variety of effects, including techniques that measure genetic damage directly and should be applied where there is reason to suspect effects due to radionuclides. In addition, these genetic techniques (e.g., DNA adduct or chromosome breakage) have also been used to assess the effects of elevated levels of UVB radiation on open ocean phytoplankton and zooplankton. With the suggestion of high levels of UVB radiation in the Arctic, such techniques need to be applied routinely over time.

The ACME agreed with the plan to employ biological effects techniques along transects from pollution sources to uncontaminated areas.

In terms of the geographical arrangement of sampling stations, the ACME suggested the following strategy:

- 1) Sample along gradients from known land-based sources of contaminants.
- 2) Estimate loads of incoming contaminants to the Arctic in main oceanic systems.
- 3) Measure contaminant loads in predicted sink areas of sediment deposition.
- 4) Measure contaminant loads in selected biota (the essential species).
- 5) Based on statistical analyses of the spatial patterns, determine sites for biological effects monitoring.
- 6) Relate contaminant loads to biological effects using multivariate statistical analyses.

The ACME pointed out that remote sensing, with application of the latest techniques, should play a central role in assessing the sources of pollutants, measuring fluxes to the marine environment, and locating appropriate sampling sites such as fronts and other discontinuities. However, one procedure for which remote sensing is not appropriate in the Arctic is the measurement of marine primary production, which is usually maximal sub-surface and thus cannot be measured accurately by remote sensing methods.

The ACME strongly recognized the need for quality assurance at all levels of the programme, and particularly for biological effects measurements, where the conduct of intercomparison exercises will be required.

The need for obtaining true replicate samples, rather than sub-samples, was also stressed. In particular, chemical contaminant studies often have no replicates and thus variance cannot be measured.

The ACME pointed out that the issue of how the data obtained will be collated or stored is a major task and needs to be properly addressed at an early stage. It is no use collecting masses of data if there is no proper protocol for quality assurance of the data input and storage. A protocol should be devised urgently that can cater for appropriate reporting of all required parameters.

In addition, proper statistical analyses need to be planned from the outset. The use of multivariate and other appro-

priate analysis techniques needs to be stressed. Peer review is one part of the process, but objective statistical analysis of the data is also essential. Again, a unified data processing system is to be recommended.

Finally, concerning links with other monitoring programmes, the ACME agreed on the importance of coordinating AMAP to the extent possible with other ongoing monitoring programmes. However, it should be realized that, even within some of the other programmes, data are not always consistent or comparable at present, as methods, units or standardization procedures, etc., can differ. Thus, a great deal of care and effort will be needed to ensure the consistency and comparability of the data, not only with outside programmes, but especially within all components of AMAP.

6 MONITORING GUIDELINES AND TECHNIQUES

6.1 Sediment Monitoring Guidelines

The ACME noted that the Working Group on Marine Sediments in Relation to Pollution (WGMS) had completed its task of reviewing and rewriting the Guidelines for the Use of Sediments in Monitoring Programmes. This task had been requested by the Joint Monitoring Group (JMG) of the OSPARCOM following the difficulties encountered by some of its members in the interpretation and use of the existing guidelines.

The new Guidelines for the Use of Sediments in Monitoring Programmes comprise an introductory section which provides generic advice on monitoring, sampling, analysis and data interpretation, followed by four detailed technical annexes that deal, respectively, with (1) sampling and analysis, (2) normalization techniques for studies of the spatial distribution of contaminants, (3) statistical aspects of the planning of sediment monitoring surveys and interpretation of the results, and (4) analytical quality assurance in the planning stage of sediment monitoring programmes and assessment.

The guidelines do not include details of analytical methods, particularly with respect to organic contaminants. The Marine Chemistry Working Group (MCWG) has been requested to produce information on the analysis of organic contaminants in sediments for ultimate inclusion in the new guidelines.

The ACME welcomed these clear and detailed guidelines from WGMS and agreed to attach them to its report; they are contained in Annex 1. The ACME recommended that these new guidelines replace existing sediment monitoring guidelines.

6.2 Statistical Aspects of Environmental Monitoring

6.2.1 Progress in temporal trend monitoring of contaminants in biota and sediments

In the context of continuing work within ICES to develop and optimize statistical methods for the determination of temporal trends in contaminant concentrations in biota and sediments, the ACME reviewed the work of the Working Group on Statistical Aspects of Environmental Monitoring (WGS AEM). It was noted that the WGS AEM had also been requested to review and report on the use of generalized additive models, and on the multivariate weighting method applied to the determination of temporal trends. In addition, they had been requested to address the statistical analysis of phytoplankton bloom data for the determination of temporal trends.

The ACME was informed of new developments in statistical aids for interpreting temporal trends in concentrations of contaminants in fish and shellfish. In particular, the use of the Kalman filter, which provides a mechanism for modelling situations where the parameters of a relationship evolve over time, was tested on a time series of data on mercury concentrations in cod (*Gadus morhua*) and plaice (*Pleuronectes platessa*) muscle tissue and zinc in cod muscle for the years 1978-1990, taken off the coast of Belgium (ICES statistical rectangle 31F2). The Kalman filter estimates of the regression slopes showed a decrease from 1978 to 1986/1987, with minor fluctuations. After 1987, the slopes were relatively stable with the exception of mercury in cod, which showed an increase.

This use of the Kalman filter was considered to represent an improvement in trend analysis as it allows a reduction of the effects on statistical analysis of interannual variability due to variations in contaminant inputs. A data series of thirteen years' duration is short for the effective use of the Kalman filter, nevertheless, its potential to model meaningful relationships between contaminant concentrations and fish length seems established and continued application is justified. The importance of generating well-structured trend data sets of sufficient duration to allow intensive statistical investigation is emphasized by ACME.

The WGS AEM had also conducted work to identify the ideal characteristics of a monitoring organism, in the sense that contaminant trend signals in the organism would be large and easy to measure, and would also reflect the temporal variation in the inputs. This work emphasized the need for considerably more information on experimentally derived uptake and excretion rates of contaminants to provide an objective criterion for selecting species and tissues.

New work by members of WGS AEM described how temporal trend monitoring data might be used to predict future contaminant levels and to relate contaminant levels to environmental quality objectives. The technique reviewed by WGS AEM for the extrapolation of trends to the next three years following the last year of a data series was judged promising, as the plots generated convey much useful information.

Concerning the statistical power of the Cooperative ICES Monitoring Studies Programme (CMP), the ACME noted with great interest the results of a study of the power of this programme to detect temporal trends in contaminant concentrations in fish liver, fish muscle, and mussels. Data are characterized by a large variability, probably coupled with a relatively small trend.

Reducing the magnitude of the unexplained variability is essential to allow trends to emerge. The main results of this study were:

- with the exception of a few contaminants, statistical power was poor, i.e., trends are unlikely to be detected;
- statistical power varied with the contaminant;
- statistical power does not seem to vary with species or tissue type;
- low statistical power was mainly due to the large random between-year variability in contaminant levels found in most contaminant time series.

As a result of this study, the WGSAM proposed a mechanism, utilizing a small subgroup, to develop revisions to the guidelines for the temporal trend monitoring programme and agreed that this monitoring should continue.

Work conducted under the WGSAM on the potential usefulness of generalized additive models for trend data analysis indicated that the results were very similar to those obtained by the methods which have been used in the past. These techniques, however, provide a smoother curve of annual mean contaminant concentrations and thus yield cleaner presentations of the data.

The Working Group continued its review of the use of multivariate procedures for the analysis of temporal trends in contaminant concentrations, noting that recent developments in the procedure permitted its use on data sets with unequal residual covariance and regression coefficients, which are problems encountered in many contaminant data sets. The WGSAM was still not in agreement with respect to the utility of multivariate methods in relation to univariate methods. Univariate methods, determining trends for each contaminant individually, have a management appeal, but do not offer the insight that multivariate methods do through analysing the entire suite of contaminants simultaneously. Work on this issue will be continued.

The ACME was informed that a joint meeting of the WGSAM and the Working Group on Phytoplankton and the Management of their Effects had been held to examine issues related to the statistical analysis of data on phytoplankton blooms for temporal trends. The ACME noted that, on the basis of the experience gained by the French Phytoplankton Monitoring Network and Finnish phytoplankton monitoring under the Baltic Monitoring Programme, the following conclusions had been reached:

- a) statisticians should be included at the outset of the planning stage of monitoring programmes to investigate temporal trends and should participate closely and advise on all aspects of sampling and analytical strategies;
- b) these programmes should be established with clear objectives, as each different objective is likely to require a different, specifically tailored approach to site selection, frequency of sampling, and variables measured; and
- c) the determination of long-term trends will be more efficient if based on a sound understanding of the processes controlling phytoplankton activity.

6.2.2 Application of geostatistical techniques to the analysis of spatial distributions of contaminants in sediments

Under the WGSAM, the geostatistical technique of kriging was applied to the spatial analysis of two sets of data on trace metal concentrations in North Sea sediments. One set of data comprised observations at locations forming a grid-like pattern with two grid densities; the other comprised observations at sampling locations demonstrating no geographical pattern and highly variable inter-site distances. Kriging allows the estimation both of spatial averages of contaminant concentrations at nodes of regular grids covering the sampling areas and of the associated estimation variance. A comparison of the results for the two data sets showed that the use of a regular grid for sampling locations appears to be highly desirable if kriging is to be used as a tool for spatial interpolation and mapping. The ACME requested the Working Group on Marine Sediments in Relation to Pollution to examine the results of these analyses. The ACME felt that, for slowly varying contaminant concentrations in sediments, such an analysis might allow improvements in the estimation by identification of the areas requiring additional sampling, in the same way that geostatistical procedures have been used in mining prospecting. Geographical trends could, in this case, be estimated from non-consecutive years. The ACME recommended that such an investigation of the use of geostatistical techniques be continued.

6.2.3 Consideration of revisions to the sampling and analytical guidelines for the measurement of spatial distributions and temporal trends of contaminants and algal blooms

The ACME acknowledged the quality of the work performed by the WGSAM. It was stressed very strongly that, in the current situation, the power of statistical tools for trend determination was very poor due to either a lack of adherence to the sampling guidelines

and low analytical performance or a lack of adequate design of the CMP.

The ACME strongly supported the need expressed by WGSAM for a multidisciplinary group, composed of statisticians, chemists, biologists and an environmental manager, to adapt and/or redesign the temporal trend monitoring programme for contaminants in fish and shellfish. This need has to be considered together with similar considerations emerging from other groups.

6.3 Monitoring Nutrients/Eutrophication Parameters

The ACME noted that when considering nutrients and trying to relate nutrient fluxes to nutrient concentrations and nutrient trends, and those eventually to eutrophication effects, it is easy to arrive in a situation where two incompatible parameters are being compared. For example, nutrient supply is a flux while nutrient concentration is a state variable.

In the simplest view, there has been a marked increase in the amounts of nutrients (nitrogen and phosphorus) supplied to the North Sea by riverine discharges. In an effort to assess the effect on the North Sea, there has been a great deal of effort spent trying to ascertain a temporal trend in the nutrient concentrations in the water column. Since the attempt is to find the result of an increasing flux as an increasing concentration, there is an inherent assumption that the increased flux, integrated over the residence time of the water, is sufficient to make a detectable contribution to the concentration. Such is clearly the case in the continental coastal waters (where the riverine waters are 'contained' against the coast by the circulation pattern), during the winter period when there is limited phytoplankton production. However, during spring, summer, and autumn, there is sufficient growth of plant material to reduce the nutrient levels in the water column and, hence, to make a trend in nutrient concentrations difficult to discern and, if discerned, even more difficult to relate to a change in inputs. For the offshore North Sea, the nutrients that may arrive from riverine inputs are not sufficient to increase the nutrient concentrations in the water column.

The flux of nutrients from the land (via rivers and the atmosphere) to the coastal waters does not remain permanently in the water but, rather, some continues as a flux of nutrients out of the water into plant material. Hence, plant biomass may be affected by the increased nutrient flux. However, again the issue is to relate a concentration to a rate of supply. (Biomass in kg/m^3 is a measure of the nutrients/unit volume that are bound up as plant material, hence biomass is not a flux measurement but a concentration measurement.) The relationships that are seen between biomass and increasing nutrient flux (e.g., in the Dutch Wadden Sea) may be

due to the fact that phytoplankton production (which is related to the rate of use of nutrients) is, to first order in simple cases, a linear function of biomass and light supply. There are many effects that, in most cases, make the relationship highly non-linear, time dependent and otherwise very confusing.

In summary, concern about the effects of an increase in the nutrient flux into the North Sea has led to a search for a trend in nutrient concentrations in the water column to quantify the effect. The search for nutrient trends in the North Sea has focused on winter data to avoid the effects of biological production. However, it is this biological production that leads to the concern about the nutrient flux in the first place. The simple relationship that is desired – a relationship between the nutrient flux from the land and air and the "quality of the North Sea" (the degree of the eutrophication effect) – is elusive because the attempt is to find a relationship between a flux rate and a state variable (and a poorly defined one at that). The following points should be borne in mind:

It is the flux of nutrients that causes the 'problem'. The problems appear in the form of

- a) a large biomass of algae or phytoplankton producing a visual detracting or an oxygen depletion, or
- b) a biomass of toxic phytoplankton or algae.

When looking for changes in the North Sea resulting from reduced nutrient fluxes, parameters based on the planktonic populations may well show the effects sooner (or more clearly) than the chemical concentrations of the nutrients themselves. Certainly, both biological and chemical parameters should be monitored. If the increased inputs of nutrients to the North Sea have resulted in increased biological production in the coastal regions, there should also be an increase in the sedimentation of biogenic material in the deposition sites.

Attention is drawn to Section 10 of the 1992 ACMP report (ICES, 1992), where the relations between nutrient inputs, biological production and sedimentation were also discussed.

ICES, 1992. Report of the ICES Advisory Committee on Marine Pollution, 1992. ICES Cooperative Research Report No. 190, pp. 36-37.

6.4 Coordination of Chemical and Biological Effects Monitoring Procedures for the Assessment of Sediment Quality

A conceptual framework and initial recommendations for the coordination of biological effects and chemical

monitoring procedures to provide a more comprehensive assessment of sediment quality were discussed at a Joint Meeting of the Working Group on Marine Sediments in Relation to Pollution and the Working Group on Biological Effects of Contaminants in March 1993.

The Joint Meeting noted that some reasons for combined biological effects and chemical measurements in the monitoring and assessment of the environmental quality of sediments include:

- 1) to relate cause to effect, i.e., to understand the concentration-response relationship;
- 2) to indicate the presence of novel or unmeasured contaminants;
- 3) to assist in regulatory actions to control pollution, e.g., in deciding what to regulate; and
- 4) properly planned, coordinated programmes will lead to more robust assessments and give greater reliability to subsequent management action.

There are several weaknesses in previous monitoring programmes where chemical and biological effects studies have been executed to some extent independently, or at least in less than full coordination. In many cases, for example, the NSTF Monitoring Master Plan, the biological effects component could not be sufficiently defined at the outset, because the methods were (and, to some extent, still are) at a developmental stage. However, there is now a suite of procedures emerging which have shown adequate robustness, and have provided useful information for assessment purposes. Nonetheless, the capabilities of the biological effects methods and the significance of the results for the organism concerned vary greatly among procedures, and still leave uncertainty regarding the true environmental consequences of the effect. Chemical methodologies suffer from a similar problem. While the distribution of a range of contaminants on a regional scale can be determined, the ecological significance of elevated concentrations of contaminants in specific areas is often not clear.

Accordingly, a coordinated programme of biological and chemical measurements could probably provide useful additional information, provided that it was clearly directed and defined. The Joint Meeting had, therefore, agreed with the draft Joint Monitoring and Assessment Programme (JMAP) strategy document (see Section 5.1, above) that monitoring programmes for assessment purposes should be directed at clear environmental issues of concern, and that the clarity of the nature of the concern could be improved if objectives were expressed as testable hypotheses or concrete questions. In this way, the types of tests to be included in monitor-

ing programmes could be tailored to match the nature of the problem or concern.

It should be recognized that no one test is adequate for assessing the biological effects of contaminants in sediments. Any environmental assessment programme should ideally use a range of techniques, and be accompanied by relevant chemical measurements in a coordinated programme.

The ACME reviewed recommendations prepared by the Joint Meeting for the coordination of biological effects measurements and measurements of relevant sedimentological parameters (attached as Annex 2) and endorsed the proposed plan for the conduct of combined sedimentological and biological effects measurements, as follows:

- 1) Review existing data on hydrography, geology, biology, particle size distribution of sediments, sediment dynamics, waste disposal operations, human population distribution, and the use of the area (e.g., industry and land use).
- 2) Assess the adequacy of the available data and decide whether further studies are required to identify areas of likely impact.
- 3) If necessary, carry out surveys to correct inadequacies in the data set.
- 4) Taking account of the information considered under items 1 – 3, above, select areas of likely impact.
- 5) Carry out a suite of coordinated chemical and biological effects studies, as discussed in Annex 2, at a series of stations on a limited number of transects covering the main contaminant gradients in the area.

Finally, the ACME endorsed the recommendation that research work be undertaken to strengthen the understanding of the linkage between indicators of biological effects and concentrations of chemical contaminants. Research should also be conducted to increase understanding of the bioavailability of contaminants in sediments, particularly to organisms used in current biological effects programmes.

6.5 ¹⁴C Method for Monitoring Primary Production

The ACME noted that a proposal for a standard ¹⁴C method for monitoring primary production had been discussed in detail by the Working Group on Phytoplankton and the Management of their Effects (WGPM) at its 1993 meeting.

The establishment of a standard ^{14}C method has a long history and is of great importance for ICES and other intergovernmental and international scientific bodies (IOC, SCOR). During recent years, the earlier terms of reference to set up a simple and inexpensive ^{14}C method for monitoring studies have evolved into the development of a more complex methodology of measuring photosynthesis-irradiance (P-I) relations, instead of measuring a P_{max} (maximum rate of photosynthesis) at saturating irradiance. This means that more steps and, therefore, uncertainties are introduced. This is balanced by achieving a greater level of comparability to measurements made by other methods.

The present status is that the proposed method has been tested during Indian Ocean cruises within the Joint Global Ocean Flux Study (JGOFS). There are, however, still some technical problems with regard to the use of this proposed method. Before the next meeting in 1994 an attempt will be made, through the appointment of a small subgroup of the Working Group, to identify other potential users and participants in an exercise to evaluate the proposed standard methodology and the incubator that was designed to be used for this method. This subgroup will also be requested to coordinate the detailed planning of the evaluation exercise and facilitate the timely release of the technical specifications of the new incubator.

The ACME stressed the importance of the development of this new standard method, which offers the potential for quality assurance of the procedure and intercomparison of the results among laboratories. Because

primary production is one of the basic processes in biological oceanography, ICES should encourage the development and finalization of this procedure. However, a standard procedure might only be successful if it is supported by a large part of the international scientific community. Therefore, participation in the evaluation exercise should be extended to all potential users from ICES Member Countries, including scientists working in national and international programmes related to long-term monitoring of the marine environment. A possible link to ocean colour investigations (e.g., SeaWiFS), which will need ground-truth data on primary production for interpretation, indicates the need to develop a standard primary production method by which to evaluate attempts to use ocean colour as an index of production in the ICES region and globally.

The ACME strongly supports the development of this new method, noting, however, that it has evolved from a simple inexpensive measurement, intended for monitoring studies, to a more complex methodology. The ACME encourages the implementation of this standard procedure in order to allow comparisons of individual data series on primary production. Before such a procedure has been implemented, the establishment of a primary production database cannot be recommended. In the meantime, the Cruise Summary Report Database can be used to identify cruises where primary production data have been collected, to satisfy the needs of algorithm development for the ocean colour satellite.

7 QUALITY ASSURANCE PROCEDURES AND INTERCOMPARISON EXERCISES

7.1 Proposed Intercomparison Exercise on Measurements of Scope-for-Growth in Mussels

The measurement of scope-for-growth is being developed as a technique for assessing pollution-induced stress in mussels. It is a measure of the extent to which energy uptake exceeds the metabolic requirements of an organism under standard conditions, and it seems to have the potential to be used widely in biological effects monitoring in coastal waters. In its 1993 report, the Working Group on Biological Effects of Contaminants reviewed a proposal from Dr J. Widdows of the Plymouth Marine Laboratory, UK, to organize an intercomparison exercise on scope-for-growth measurements. The Working Group supported the need for the conduct of the intercomparison exercise, but decided that further work should be done on the proposal before it can be approved.

In reviewing this information, the ACME stressed the importance of developing simple standard methods for biological effects monitoring, and recognized the potential in the measurement of scope-for-growth in mussels. It was also aware that some scientists doubt the reproducibility of the results, but recognized that this can be expected at this stage in the development of the technique. The ACME fully endorsed the need for the intercomparison exercise, but despite the seemingly more cost-effective scheme discussed by the Working Group, the level of funding required is likely to be beyond the scope of ICES. Alternative sources of funds should therefore be pursued, once the revised proposal is submitted.

7.2 Zooplankton Production Methods

The ACME recognized that secondary production is the vital link between primary production and the harvest of commercial fish and shellfish stocks. Noting that 25 years have passed since the joint ICES/SCOR/UNESCO methods manual was published, it welcomed the current activities of the Study Group on Zooplankton Production. These activities, which involve the conduct of intercomparison workshops that will lead to the standardization of modern zooplankton sampling techniques and production measurement methodologies, are an essential component of the ICES Cod and Climate Change and the SCOR/IOC/ICES Global Ocean Ecosystems Dynamics (GLOBEC) programmes.

The ACME noted that the Study Group on Zooplankton Production, at its 1993 meeting in Las Palmas, continued to plan a series of workshops to examine zooplankton biomass and production measurement methodologies. The aim of these workshops is to provide material for a new Zooplankton Methodology Manual.

The manual will review current methodologies and recommend procedures for such well-established methods as biomass sampling by net tows and the measurement of physiological processes and rates, such as egg production, ETS (electron transport system), and gut fluorescence. It will also provide information and guidance on the current state of the art of new methodologies, such as acoustic and optical sampling techniques, and biochemical techniques, such as the aspartate transcarbamylase (ATC) method to assay productivity in mixed species samples.

The ACME noted that first drafts of chapters for the manual are proposed to be ready by the 1994 meeting of the Study Group, and final drafts should be completed by the time of the ICES Zooplankton Production Symposium in Plymouth (August, 1994), during which posters on the methods will be presented for general input to and discussion by the scientific community. Final publication is targeted for early in 1995.

There have been preliminary discussions between ICES and SCOR (and also UNESCO) with regard to joint publication of the Zooplankton Methodology Manual. There has also been communication with a SCOR Working Group (WG 93) which is making similar plans to develop a manual on plankton sampling.

7.3 Quality Assurance of Biological Measurements in the Baltic Sea

The ACME reviewed the report of the first meeting of the Steering Group on Quality Assurance of Biological Measurements in the Baltic Sea. It noted that national quality assurance (QA) programmes are in the planning phase in several Baltic Sea countries, and that the coordination of these national activities from their earliest stages is an important task for ICES and the Baltic Marine Environment Protection Commission (Helsinki Commission) (HELCOM). The ACME recognized that considerable attention had been paid to the strategic weaknesses of the current Baltic Monitoring Programme (BMP) under the Helsinki Commission, especially the pelagic part of the programme. The ACME agreed with the suggestion by the Steering Group that priority should be given to a process-oriented pelagic programme based on a high frequency of sampling and a holistic approach. The ACME stated that the strategic aspects of this programme were closely linked with quality assurance, and thus this discussion by the Steering Group was justified. The revision of the BMP Guidelines is an ongoing process within HELCOM and is to be discussed during the fourth meeting of the HELCOM Environment Committee in October 1993 (see also Section 5.3, above).

Concerning the methodological aspects at a parameter level, the Steering Group noted that a mandate to prepare relevant QA guidelines had already been given to the HELCOM Working Groups on Microbiology and Phytoplankton. The Steering Group recommended that similar requests be made to the Baltic Marine Biologists (BMB) Working Group on Zooplankton and the ICES Benthos Ecology Working Group to prepare QA guidelines on their relevant monitoring procedures. The ACME supported the view of the Steering Group that these expert groups are the most appropriate bodies for preparing QA guidance on methodology and will request the Benthos Ecology Working Group to start this work. The ACME considered that there would be benefit arising from active cooperation between the ICES Study Group on Zooplankton Production and the BMB Zooplankton Working Group. It noted that the ICES Symposium on Zooplankton Production, to be held in Plymouth in August 1994, will be an important forum for the discussion of zooplankton methodology.

The ACME pointed out that for some of the biological parameters the QA programme can and should be similar to the QA programme for chemical parameters. However, other parameters, including taxonomical information, will require their own specific approach. The organization of two HELCOM phytoplankton identification courses, in 1992 and 1993, was considered a good example of QA which is specific for the latter type of parameter. According to a tentative time schedule proposed by the Steering Group, the QA activities will proceed with the organization of two workshops (one on pelagic biological parameters, the other on zoobenthos) in 1994, and two intercomparisons/intercalibrations in 1995. The revised Baltic Monitoring Programme and the improved Guidelines are planned to be introduced in 1996 by the Helsinki Commission.

7.4 Quality Assurance of Chemical Measurements in the Baltic Sea

The ACME reviewed the report of the Steering Group on Quality Assurance of Chemical Measurements in the Baltic Sea and was pleased to note that progress has been made in the development and implementation of the project.

The ACME also noted that Germany has offered facilities in Hamburg at the Sülldorf Laboratory of the Bundesamt für Seeschifffahrt und Hydrographie, for the ICES/HELCOM Workshop on Quality Assurance of Chemical Analytical Procedures for the Baltic Monitoring Programme (BMP) and that final plans for this Workshop have been made. The Workshop, under the co-chairmanship of Dr U. Harms and Dr G. Topping, is to be held from 5 to 8 October 1993, immediately preceding the fourth meeting of the HELCOM Environment Committee.

The ACME noted that the final plans for the Workshop give priority to the measurement of certain contaminants which are considered mandatory under the HELCOM Baltic Monitoring Programme. In view of the limitations on time and resources, it was accepted that the Workshop should concentrate on quality assurance aspects of measurements of nutrients in sea water and metals in biota. Coverage of the measurement of other mandatory contaminants, e.g., organochlorine compounds in biota, will be restricted to presentations on state-of-the-art procedures for sampling and analysis of these compounds.

It is intended that participants mainly comprise analysts who are responsible for producing the BMP data. However, it was recognized that there was a need for managers of monitoring programmes to attend also, so as to provide an opportunity for them to be apprised of the importance of QA work in their programmes.

The Steering Group recommended that the following aspects be covered in the Workshop:

- 1) the importance and design of sampling strategies so that the aims of monitoring work can be achieved;
- 2) the need for, and a description of, collection procedures which assure that representative and uncontaminated samples are obtained;
- 3) the need for, and a description of, appropriate storage and pre-treatment procedures which maintain the integrity of samples prior to their analysis;
- 4) appropriate instrumental procedures which provide measurements of the required accuracy and precision;
- 5) the design and implementation of in-house (i.e., within the laboratory) quality control procedures to ensure that daily measurements fall within acceptable limits of accuracy and precision, as specified under (4), above;
- 6) the need for, and a description of, documented procedures for (5), above, so that laboratories can provide HELCOM data assessment groups with relevant QA data; and
- 7) the role and use of certified reference materials under (5), above, and the preparation and use of uncertified reference materials (sometimes referred to as laboratory or in-house reference materials).

The ACME noted that written presentations and other relevant documents will be distributed to participants before the Workshop. Presentations at the meeting will address, and provide practical advice on, those problems encountered by laboratories that have not yet gained full

experience in the field and laboratory work associated with the monitoring parameters covered.

The ACME was aware of the difficulties that some countries have to send participants to this Workshop and stressed that every effort should be made to enable analysts from all Baltic Sea countries to participate in the Workshop, because the success of the QA project will depend on full participation.

7.5 Results of Step 3b of the ICES/IOC/OSPARCOM Intercomparison Programme on the Analysis of Chlorobiphenyls (CBs) in Marine Media

The ACME reviewed the results of Step 3b of the ICES/IOC/OSPARCOM Intercomparison Programme on the Analysis of Chlorobiphenyls (CBs) in Marine Media, which is a step-by-step learning programme for the improvement of analyses of CBs in marine samples. This programme had been initiated based on a need for improving the comparability of CB data, particularly for studies involving marine mammals. The ACME noted that the results of this exercise had been reviewed by the Marine Chemistry Working Group (MCWG) at its 1993 meeting.

Step 3b of this exercise involved the analysis of an uncleaned sediment extract and/or an uncleaned seal blubber extract, as well as a repetition of Step 2, namely, the analysis of cleaned sediment and/or seal blubber extracts and a standard solution with unknown CB concentrations. With the exception of the standard solution, which was an obligatory part of the analytical exercise, the choice of samples (sediment and/or seal blubber) to be analysed was left to each participant. However, only those participants who had analysed similar matrices in earlier stages of the programme had their results included in the statistical analysis of the data. Each participant had been requested to purchase the relevant samples to defray the cost of this programme. A total of 52 laboratories participated in the exercise, 46 of which returned data by the deadline set for the evaluation of the results.

The ACME noted that the MCWG had concluded that the performance of the participating laboratories as a group had improved by comparison with the performance in Step 2, although not all of the results were considered to be satisfactory. The largest errors in this analytical work are still associated with the determination of some congeners in the lower concentration range, i.e., CB 52, CB 105 and CB 156 for sediments, and CB 28, CB 31, CB 105 and CB 156 for seal blubber. It was noted that the incomplete or partial separation of CB 138 and CB 163 was still causing problems in the quantification of these two congeners, and that this had affected the comparability of results. The MCWG agreed that it was

advisable to continue to report results for these congeners, but the data should be expressed as CB 138 + CB 163, since both congeners belong to the same metabolic group and the interlaboratory errors for these congeners were still greater than those arising from coelution.

The MCWG considered that now that the overall errors associated with these analyses had been reduced, it was important for analysts to focus on reducing errors associated with transcription, calculations and integration of the data.

The ACME noted that the MCWG would be proceeding to the final stage of this programme (Step 4), which would involve the analysis of a sediment sample and a seal blubber sample, and possibly also a fish sample because many of the participants routinely analyse fish in their monitoring work. The cost of organizing and providing the samples for Step 4 would again be covered by contributions from each participant and, for materials, from ICES. This exercise is to commence in August 1993 with the distribution of samples, followed by reporting results to the coordinator in mid-December 1993. The report on the results of Step 4 will be reviewed by the MCWG at its next meeting, along with a report on the quality of the data produced by each laboratory, that will serve as a basis for assessing the laboratory's capability in these analyses.

The ACME commended the work done by Dr J. de Boer and Dr J. van der Meer on the coordination of this exercise, and recommended that the reports on the results of Steps 3a and 3b should be published together in the ICES Cooperative Research Report series, after final review and editing.

7.6 Intercomparison Exercise on Measurements of Lipids in Marine Samples

The ACME noted that, in its 1993 Work Programme, the Oslo and Paris Commissions had requested ICES to consider whether an intercomparison exercise for measurements of lipids in marine samples was needed in view of the fact that some investigators were expressing concentrations of organic contaminants in marine samples on a lipid weight basis for the normalization of monitoring data.

In response, the MCWG had conducted a preliminary intercomparison of lipid determinations using a dried muscle tissue. A total of ten analysts had participated, and two techniques had been evaluated: (1) the Bligh and Dyer method, and (2) a method involving Soxhlet extraction with different solvents. Significant differences in results had been found between and within the two methods, the Soxhlet extraction procedure giving the lower lipid values.

On the basis of these findings, the MCWG agreed that the use of lipid content for the normalization of data on organic contaminants is questionable owing to the large variations in lipid determinations, especially for lean tissues. The ACME endorsed the MCWG recommendations on this topic, as follows:

- 1) The results from extractable lipid determinations should not be used for the normalization of data in monitoring programmes;
- 2) Lipid determinations should be done using one specific method, namely, the Bligh and Dyer (1959) method, which is considered to give the total lipid content;
- 3) Analysts should make sure that no moisture or solvent is retained in the drying step and that samples are dried to constant weight (at least at 50°C).

The ACME noted that the MCWG recommended that no further intercomparison exercises be considered until the results of Step 4 of the Intercomparison Programme on the Analysis of Chlorobiphenyls become available, as they will provide additional information on lipid extraction.

The ACME commended the organizers of this exercise, E. Nixon and J. de Boer, for their work on this topic.

Bligh, E.G., and Dyer, W.J. 1959. A rapid method of total lipid extraction and purification. *Can. J. Biochem. Physiol.*, **37**: 911 - 917.

7.7 Stage 2 of the Intercomparison Programme on the Analysis of Polycyclic Aromatic Hydrocarbons in Marine Media

The ACME noted that no further progress has been made on the second stage of the Intercomparison Programme on the Analysis of Polycyclic Aromatic Hydrocarbons (PAHs) in Marine Media, which had been planned to take place in the second half of 1991. Noting that this is the second year without further progress in this exercise, the ACME reviewed the history of the programme to serve as the basis for suggestions on how to enhance participation.

This intercomparison programme was initially proposed by the Marine Chemistry Working Group (MCWG) in 1986, with the aim of identifying the sources of error in the analysis of PAHs in marine samples and finding ways to reduce these errors. The Council supported the intercomparison programme (C.Res.1986/2:16), and participants met in early 1987 to decide on the details of the first stage of the programme.

It was agreed that the analysis of the following ten compounds would be covered in the programme: phenanthrene, fluoranthene, pyrene, benz[a]anthracene, chrysene, benzo[b]fluoranthene, benzo[a]pyrene, benzo[e]pyrene, benzo[ghi]perylene, and indeno[1,2,3-cd]pyrene. The analysis of these compounds could be conducted by gas chromatographic (GC) or liquid chromatographic (high-performance liquid chromatography (HPLC)) methods. The first stage of the programme was conducted in two steps, with a total of eighteen participants. Part of the reason for the small number of participants was that not all potentially interested laboratories had the requisite equipment at that time. No participation fee was required for this first stage of the programme, which was coordinated by Mr R. Law (MAFF Fisheries Laboratory, Burnham-on-Crouch, UK). This stage involved the analysis of standard solutions of the ten PAH compounds chosen for inclusion in the programme.

After final review of the results of this first stage in 1991, the plans for Stage 2 were prepared, involving the analysis of a cleaned sediment extract and a standard solution. The coordination of the exercise was expanded to include Dr W.P. Cofino and Mr F. Smedes, in addition to Mr Law, and a participation fee (based on a potential total of 17 participants) of DFL 1500 was requested to cover the costs of preparing the samples and other activities associated with the exercise. On this basis, only five laboratories agreed to participate, which was considered inadequate to justify the conduct of the exercise. The MCWG decided that the continuation of the work would only be possible if a larger group of laboratories were interested in participating. Efforts are now being made to enlarge the number of participants. A questionnaire is being prepared to obtain information from laboratories on their current practices and programmes for the analysis of PAHs. The questionnaire will also address the analysis of PAHs in monitoring programmes, the basic analytical methods, and potential interest in participating in intercomparison exercises in the near future.

The ACME supported the continuation of this programme, noting the importance of obtaining better and more comparable information on the distribution of PAHs in the marine environment.

7.8 Fifth Intercomparison Exercise on the Analysis of Nutrients in Sea Water

Under the quality assurance programme coordinated by the Marine Chemistry Working Group, intercomparison exercises are conducted at appropriate time intervals. It is the aim to organize nutrient intercomparisons every four years, and the Fifth Intercomparison Exercise on the Analysis of Nutrients in Sea Water (5/NUT/SW) is presently under way. The ACME noted that this exercise

is proceeding according to plan. Six samples (three for nitrate and nitrite determinations and three for ammonium and phosphate determinations) were distributed to each participating laboratory in late November/early December 1992. The deadline for the return of results to the coordinator was the end of April 1993. The ACME noted with appreciation that the total number of participants increased from 68 in the Fourth Intercomparison Exercise on the Analysis of Nutrients in Sea Water (4/NUT/SW) in 1989 to around 150 for 5/NUT/SW. This represents a substantial increase in participation by laboratories in ICES member countries, as well as the inclusion of laboratories from several other countries.

In analysing the results of this exercise, the coordinators, Mr D. Kirkwood and Dr A. Aminot, will attempt to give general information on the overall results as well as specific information for each laboratory. The interlaboratory variation will be extracted from the data, and the mean concentration for each nutrient will be compared to the known values. Assuming a core group of skilled laboratories (as in 4/NUT/SW), few differences are expected between the two sets of values. Absolute and relative differences between the individual results and the consensus values will be tabulated in order to help laboratories find the source of their discrepancies.

The ACME took note that a detailed draft report on the results of this exercise will be ready for the 1994 Marine Chemistry Working Group meeting. The ACME commended Mr Kirkwood and Dr Aminot for their hard work and devotion to the task and gratefully recognized the resources that they and their institutes have contributed to the successful conduct of this exercise.

7.9 Phase 2 of the Intercomparison Exercise on the Analysis of Trace Metals in Suspended Particulate Matter (SPM)

The ACME reviewed the progress in the conduct of Phase 2 of the Intercomparison Exercise on the Analysis of Trace Metals in Suspended Particulate Matter (SPM), as reported to the Working Group on Marine Sediments in Relation to Pollution (WGMS). The exercise is coordinated by Dr C. Pohl (Institute of Baltic Sea Research, Warnemünde, Germany). Out of 37 laboratories invited, 25 have agreed to participate. Samples for the exercise were prepared from water obtained from the Gulf of Bothnia (latitude 61°5.00'N; longitude 19°35.00'E) in the Baltic Sea at 115 m depth in November 1992. The SPM samples were obtained by pressure filtration of homogeneous water samples through pre-cleaned, pre-weighed Nuclepore filters (0.4 µm), which were then placed in pre-cleaned plastic dishes. The samples were distributed to participants in March 1993. The coordinator will prepare a report on the results of this intercomparison exercise for review by the WGMS at its 1994 meeting.

7.10 QUASIMEME Programme of the European Community

The ACME noted that the Quality Assurance of Information for Marine Environmental Monitoring in Europe (QUASIMEME) programme has now been formally approved and will receive funds from the European Community (EC) Measurements and Testing Programme. The laboratory responsible for managing the pilot programme is the Scottish Office Agriculture and Fisheries Department (SOAFD), Marine Laboratory, Aberdeen, Scotland. A Scientific Committee, which includes some members of the ICES Marine Chemistry Working Group, has been established to coordinate the various components of the programme. The meeting to launch this project was held in the Netherlands in late February 1993. Initially, participants will be requested to establish the long-term variance for their analyses of nutrients in sea water, trace metals in sediments, and chlorobiphenyls in fish oil. Participants who achieve the necessary target values for accuracy and precision will proceed to a continuous proficiency assessment scheme. Participants who do not achieve these target values will participate in a learning programme which will explore the causes of their bias and take measures to correct them. Other activities under QUASIMEME include the conduct of interlaboratory trials to establish the most appropriate sampling and storage conditions for samples of water, sediments and biota obtained for the above measurements.

The ACME welcomed the fact that provision has been made for some non-EC laboratories to participate in this programme.

7.11 Use of Certified Reference Materials in Sediment Studies

The ACME noted that, in its review of the Guidelines for the Use of Sediments in Monitoring Programmes, the Working Group on Marine Sediments in Relation to Pollution (WGMS) had compiled a technical annex covering quality assurance (QA) aspects of this work (see also Section 6.1, above, and Annex 1). It further noted that as part of this QA work the WGMS had drawn up a list of factors concerning the use of reference materials (RMs) that should be considered prior to the initiation and during the execution of a programme of sediment sampling and analysis that involves more than one laboratory. The programme coordinator plays a key role in controlling the use of RMs. This list is as follows:

- 1) A reference material (RM) of similar matrix composition to that of the field samples, and with similar concentrations of determinands, must be used. The programme coordinator should identify suitable materials.

2) Where commercial RMs are not available, suitable materials should be produced. This may occur by the production of a new certified reference material (CRM), probably by an acknowledged centre of excellence (e.g., the EC Community Bureau of Reference), or by the production of a RM for use in the particular study. The programme coordinator should organize this.

3) The coordinator should define the analytical requirements of the programme (the level of accuracy and precision to be achieved by the participants). Participants must demonstrate that they can achieve these requirements before the programme starts. Those who do not meet these criteria should not be permitted to participate in the programme.

4) The level of analytical competence must be controlled within the laboratories throughout the study.

5) A control chart showing analytical performance before and during the programme is to be provided by each participating laboratory at the stage of assessing the analytical data.

6) Analytical data on RMs must be reported in the required format to the coordinator or the programme data bank (e.g., ICES).

The ACME welcomed these clear guidelines from the WGMS on the use of reference materials in monitoring work concerned with measurements of contaminants in sediments and recommended that organizations coordinating monitoring programmes fully implement these guidelines in their programme.

8.1 Baseline Study of Contaminants in Baltic Sediments

The ACME considered the final plans for the Baseline Study of Contaminants in Baltic Sediments, as prepared by the Steering Group for the coordination of this study and presented at the 1993 meeting of the Working Group on the Baltic Marine Environment (WGBME).

This Baseline Study is being conducted by ICES for the Baltic Marine Environment Protection Commission (Helsinki Commission). The study has the objectives of describing the distribution of contaminants in Baltic Sea sediments and producing baseline data as a reference for future temporal trend monitoring.

The ACME noted that previous comments and recommendations made by the ACMP and WGMS have been taken into account by the Steering Group in the final planning stage.

Sediment samples for the Baseline Study are to be taken on board the Finnish research vessel "Aranda" during a cruise starting on 13 June 1993 in Copenhagen and ending on 9 July in Helsinki. Surface and core samples are to be taken from more than twenty sediment deposition areas in the Baltic Sea.

The sediment samples (totalling 3000-3500, including parallel samples and core slices) will be freeze-dried after the cruise, and distributed thereafter to the participating laboratories. To the extent possible, it has been intended that only one analytical laboratory should analyse all samples for any given determinand. For several groups of determinands, however, the large number of samples has resulted in the necessity to have more than one laboratory share the analytical work. The ACME also noted that because of difficulties in financing, particularly for the analysis of organic contaminants, the deadline for the completion of the analyses has been set at 31 December 1995. The deadline for the completion of a joint report on the results has been set at 31 December 1996. ICES will serve as the data centre for the project.

8.2 Coastal Zone/Open Sea Flux Studies in the Baltic Sea

The ACME noted that for the past several years the Working Group on the Baltic Marine Environment (WGBME) has been designing and planning an integrated Baltic Sea regional programme of flux studies with particular focus on net riverine influxes to the Baltic Sea. As an initial step in this programme, the WGBME prepared tentative plans for a joint study on

coastal zone/open sea fluxes to be carried out in the Gulf of Finland, concentrating on vertical/horizontal hydrographic and biological fluxes, with the overall aim of obtaining a detailed ecological model for the main nutrients and the biological production in the area. There seems to be a general interest in this type of study in the three countries bordering the Gulf of Finland (Estonia, Finland, and Russia). A tentative schedule has been agreed, with the field year in 1995.

The ACME noted that similar international studies are also being initiated and coordinated by other bodies. These include a German-Polish project in the Pomeranian Bay, a tentative project for a flux study in the Gotland Deep area coordinated by ECOPS (European Committee for Ocean and Polar Sciences), the BALTEX project (Baltic Sea Experiment in the framework of the World Climate Research Programme as a contribution to the Global Energy and Water Cycle Experiment), the Gulf of Riga Project supported by the Nordic Council of Ministers, as well as the international LOICZ programme (Land/Ocean Interaction in the Coastal Zone), and the IOC GOOS (Global Ocean Observing System initiated by the Intergovernmental Oceanographic Commission (IOC)).

Taking into account such a wide and complex picture of international and national activities, the ACME supported the WGBME intention to cooperate with other relevant international projects and organizations on the conduct of a Flux Study in the Gulf of Finland.

At the same time, the ACME believed that, from the point of view of ICES strategy and the WGBME future activity in the Baltic Sea area, it would be appropriate for the WGBME to focus its efforts on:

- developing suitable approaches and methodologies for planning and conducting marine flux studies which could be acceptable as a framework for similar studies in different marine areas; and
- drafting proposals and a programme for an international symposium with the tentative title "Theory, practice and prospects of coastal zone/open sea flux studies in the Baltic Sea". This symposium could provide a good opportunity to enhance and consolidate international efforts in relation to this fundamental ecological problem.

8.3 Action Plan to Study Major Inflows to the Baltic Sea

Some years ago, BALTEP (the Baltic BATHY/TESAC Project) was introduced as a joint project of ICES and

the IOC/WMO IGOSS (Integrated Global Ocean Services System). This project is designed to provide for the rapid distribution, through the Global Telecommunications System (GTS), of research vessel data on salinity, temperature and dissolved oxygen, with the aim of obtaining information on the occurrence of salt water inflows to the Baltic Sea. In addition to this, the Swedish Meteorological and Hydrological Institute has maintained an automatic station at the Drogden Sill in the Sound since the beginning of the 1980s. As the station transmits data in real time, it is useful for the detection of inflows.

Through concerted action by Swedish authorities and the Norwegian company Oceanor, two buoys have been moored in the southern Kattegat (in the approaches to the Baltic Sea) and the Arkona Sea (southwestern Baltic). These buoys are links in SeaWatch Europe and transmit, via the Argos satellite system, data on meteorological parameters as well as current speed, temperature, salinity, dissolved oxygen and light attenuation at a selected depth in the deep water. Through these measurements, and those from buoys moored in the Great Belt, it will be possible for Danish, German and Swedish scientists, in particular, to investigate and report on possible new inflows to the Baltic Sea.

Plans to investigate the effects of the inflow of January-February 1993 are being incorporated into the operational plans of institutes and authorities in countries around the Baltic Sea. In addition, plans to investigate effects of possible future inflows and relevant practical arrangements will be discussed on the Baltic Hot Line Network, that is being established by the Working Group on the Baltic Marine Environment (WGBME), and at future meetings of WGBME.

In reviewing the above information, the ACME noted that the Steering Group on Fisheries/Environmental Management Objectives and Supporting Research Programmes in the Baltic Sea considered that the development of research programmes on marine water inflows to the Baltic Sea should have a high priority in view of, among others, the great influence that the renewal of bottom water in the Baltic Sea (or the lack thereof) has on bottom-living organisms and demersal fish.

The WGBME has pointed out that it still takes a very long time to obtain permission for research vessels from one country to enter the national waters of another country in the Baltic Sea. For this reason, the WGBME recommends that ICES again draw the attention of HELCOM to the need to obtain a more flexible application of the existing HELCOM Resolution concerning the access of research vessels to conduct research work in the waters of Baltic Sea countries, at least in urgent cases such as those related to major water inflows and unusual algal blooms, but also for marine research in general.

The ACME took note of this information and expressed great concern over the continuing difficulties in obtaining permission to conduct research in the Exclusive Economic Zones of Baltic Sea countries. The ACME decided that ICES should again raise this matter with its own member countries and also with the Helsinki Commission.

9 FISH DISEASES AND RELATED ISSUES

At its May 1993 meeting, the ICES Advisory Committee on Fishery Management (ACFM) considered that there were two issues of potentially great importance for the affected fish stocks for which further information was required:

- 1) the occurrence of an unknown mortality factor (M-74) in salmon hatcheries in the northern Baltic Sea; and
- 2) the occurrence of *Ichthyophonus* in herring.

As the ACFM felt that it did not have the relevant expertise for an in-depth consideration of these topics, it requested the ACME to review the available information on these topics and propose means by which further information could be obtained that would permit a realistic estimation to be made of the effects of these causes of mortality on the affected stocks.

Accordingly, the ACME reviewed information on the M-74 mortality in Baltic salmon, as provided by the Baltic Salmon and Trout Working Group, and prepared a summary of its findings and an outline of a research programme into potential causes of this mortality. This is contained in Section 9.1, below.

Similarly, the ACME reviewed information on the occurrence of *Ichthyophonus* in herring, primarily on the basis of the report of the Herring Assessment Working Group for the Area South of 62°N, and prepared a summary of its findings. This is contained in Section 9.2, below.

Information on other fish disease issues is contained in Sections 9.3 and 9.4, below.

9.1 Occurrence of an Unknown Mortality Factor (M-74) in Salmon Hatcheries in the Northern Baltic Sea

In Swedish hatcheries in 1974, it was observed that the offspring of some sea-run females died during resorption of the yolk-sac. The unidentified mortality was named M-74. Although no statistical correlation between the occurrence of M-74 and exposure to organochlorine contaminants or metals has been found, there is a suspicion that M-74 may be related to environmental conditions. The number of females affected in the period between 1974 and 1991 was fairly low and losses were compensated by stripping larger numbers of eggs. In 1992, the number of females affected by M-74 was very high, resulting in total mortalities from spawning to feeding larvae of 60-95%, compared with the previous level of 10-30%. Apart from this, salmon kept

in basins before stripping lost balance, some resting laterally on the bottom. This was observed for the first time in 1991 and occurred even more frequently in 1992.

The problem is also known to occur in Finland, but has not been observed in Estonia or Latvia. Unexplained mortalities of yolk sac larvae are frequently reported to occur in European salmon and trout hatcheries. There is information on high levels of mortality of salmon in France, which is considered to be related to a disturbance in the acid-base balance of peripheral blood. The acid-base balance is regulated by the enzyme carbonic anhydrase (CA). Deficiency of CA can cause severe acid-base imbalance by increasing the CO₂ pressure in the blood and the entire organism, which can result in lowering the intra- and extra-cellular pH. Acidification affects most metabolic functions, including those involved in the reproductive process. Possible causes for deficiencies in CA are:

- 1) The presence of a wide range of chemicals, including contaminants.
- 2) Selection in hatcheries can result in strains of fish deficient in certain genes. CA is known to be very susceptible to genetic variation.
- 3) Sulphonamides are often used in hatcheries to prevent the outbreak of diseases, and sulphonamides with an unmodified amide group, especially the heterocyclic aromatic sulphonamides, may be effective inhibitors of CA.

For a number of estuarine and marine fish species in the North Sea and the waters off the coast of the USA (e.g., *Platichthys flesus*, *Merlangius merlangus*, *Pseudopleuronectes americanus*), a negative correlation has been found between organochlorine contamination of the gonads and hatching success. The literature discusses whether the contamination is causally linked to the reduction in hatching success.

To obtain information on the possible causes of the problem, the following recommended approach was supported by ACME:

- 1) A baseline study should be conducted to measure the concentrations of contaminants in the female gonads of each species affected.
- 2) The resulting contaminant levels should be compared with those demonstrated to correlate with lowered hatching success of free-living marine fish species, as described in the literature.

- 3) If contaminant levels found during the baseline studies are comparable to those found to affect hatching success, it is recommended that similar hatching success experiments be carried out at salmon hatcheries in Sweden and Finland. Those experiments should quantify the hatching success of embryos of the respective gonads relative to the concentrations of contaminants. This will allow the calculation of correlations between the contamination of parental fish and the quality of their offspring. The methodology recommended is published, *inter alia*, in Westernhagen *et al.*, 1989.
- 4) Enzyme levels (carbonic anhydrase, CA) could be analysed to provide information on possible deviations, although they may possibly react to factors other than contaminants.

The ACME agreed that the EIFAC (European Inland Fisheries Advisory Commission of FAO) Sub-commission III (Fish and Polluted Water), which has collected information on the levels of various contaminants in aquaculture organisms including fish, should be contacted for information and/or cooperation.

Westernhagen, H. von, Cameron, P., Dethlefsen, V., and Janssen, D. 1989. Chlorinated hydrocarbons in North Sea whiting (*Merlangius merlangus* L.) and effects on reproduction. 1. Tissue burden and hatching success. *Helgolander Meeresunters.*, **43**: 45-60.

9.2 The Occurrence of *Ichthyophonus* in Herring

The fungal disease *Ichthyophonus* was first identified in herring from European waters in the North Sea and the Kattegat in 1991, however, it is known to have repeatedly caused mortalities in stocks off the east coast of the United States in the Twentieth Century. Due to the high mortality that occurred in some herring stocks affected, two special scientific meetings on this parasite were held under the auspices of ICES, with the attendance of fish pathologists and parasitologists, and specialists on herring stock assessment. Results from laboratory experiments on juvenile herring in the USA showed two different mortality rates: acute mortality, within 15-30 days, and chronic mortality, which spreads over six months.

New information on the prevalence and distribution of infected herring shows that the disease has not spread to stocks other than those infected in 1991. The disease is present in the northern North Sea east of the Shetlands up to 64°N, in inshore areas along the Norwegian coast, in the Skagerrak/Kattegat area, and in the southwestern Baltic Sea. Currently, the following seriously infected groups of herring have been identified: (1) Norwegian spring spawners; (2) part of the northern North Sea stock; and (3) the southwestern Baltic Sea

stock. Other stocks, e.g., in the southern North Sea and southwest of Iceland, are known to harbour the infection at lower levels.

Preliminary attempts were made to calculate the mortality in several herring populations using epidemiological models. The very tentative results of the calculations indicate that the annual mortality rate could be about 16% in the case of North Sea herring. It was concluded that although the disease-induced mortality (MI) cannot simply be added to the fisheries-induced mortality (M), both were at similar levels and therefore the disease-induced mortality can have a significant impact on stock size.

Based on the limited material available, there is no currently known risk to humans from this fungal disease.

Although the mortality rate following infection is known to be high in some areas, at present there is no evidence from the catch data that herring stocks in the North Sea were seriously affected by *Ichthyophonus* infection.

The ACME noted and supported a recommendation of the Herring Assessment Working Group for the Area South of 62°N that sampling to obtain data on infection rates in fish and other vertebrate species be intensified and that the analysis of commercial catches be extended. Available data on the distribution and prevalence of *Ichthyophonus* should be summarized, preferably by season, and disaggregated by age group. Furthermore, experimental work should be carried out on the pathogenicity of *Ichthyophonus*.

9.3 Studies of Fish Diseases in the Baltic Sea

The ACME reviewed the description of fish disease studies being conducted in the Baltic Sea, as reported by the Working Group on Pathology and Diseases of Marine Organisms (WGPDMO) but mainly coordinated by the Baltic Marine Biologists (BMB) Working Group on Fish Diseases.

It was noted that the results of the BMB sea-going workshop in October 1991 on methodological aspects of fish disease studies in the Baltic Sea are ready for publication. A follow-up joint BMB/ICES workshop is planned to be held on the German research vessel "Walther Herwig" (Conveners: Dr T. Lang and Dr J. Thulin) in November 1994 that will focus on fish diseases and parasites in the eastern and northern parts of the Baltic Sea.

The main topics of present concern in the context of fish diseases in the Baltic Sea are:

- liver tumours in Baltic flounder which appear to occur at high prevalences in Finnish waters, but at low prevalences in Estonian and western Baltic waters;
- the microscopic identification of *Ichthyophonus* spores, which were found in different fish species in Estonian waters without causing clinical signs of the disease; and
- the M-74 syndrome, an unexplained syndrome first detected in 1974, which causes high mortality rates of yolk-sac fry in salmon hatcheries using wild broodfish.

The ACME agreed with the WGPDMO recommendation that better communication should be established with the BMB Working Group on Fish Diseases, to coordinate activities and exchange information. Baltic Sea countries were encouraged to submit fish disease data collected according to the standard methodology to the ICES Data Centre.

9.4 Assessment of Fish Disease Prevalence Data

The ACME reviewed the results of an analysis of fish disease prevalence data that had been prepared by a subgroup of the Working Group on Pathology and Diseases of Marine Organisms (WGPDMO).

With regard to the ICES Fish Disease Database, it was noted that most of the data on fish disease prevalence submitted to ICES have been computerized. However, all countries still have to validate the ICES files against their original data.

A new format for reporting fish disease data to ICES has been prepared by the ICES Data Centre, which now makes it possible to submit information on individual fish. This new format should be used for future reporting of data, and previously submitted data on fish diseases should be resubmitted using the new format during 1994.

Concerning the data analysis, it was noted that logistic models defined by the GLIM software package were used. In a general model for disease prevalence, fish length, sex, season, year and ICES statistical rectangle were incorporated as explanatory factors. The disease-odds ratios estimated by GLIM give a relative probability of a fish being affected that can be compared between ICES statistical rectangles. Due to the incom-

plete and unvalidated nature of the data held at ICES at the time this analysis was conducted, however, only a subset of the information could be included in the resulting maps.

Attempts were made by the WGPDMO subgroup to compare maps, provided by ICES, of the concentrations of various contaminants in marine sediments, with the preliminary maps on fish diseases. These two types of maps were not appropriate to establish correlations, however, owing to temporal and spatial differences in the samples taken to obtain the fish disease data. In addition, the high variability in the measurements of some contaminants in sediments was considered to present problems. Future close cooperation between the relevant working groups will be necessary to study possible relationships between sediment contamination levels and the prevalence of diseases in demersal fish.

The ACME stressed the importance of continuing studies on the occurrence and spatial distribution of diseases in wild fish for the following reasons:

- 1) There is a continuous public concern about diseases in marine fish;
- 2) The presence of high levels of externally visible fish diseases and parasites often has economic repercussions. It is therefore necessary to have recent information on these phenomena available for advisory purposes; and
- 3) Cause-effect links between marine contaminants and fish diseases have not been proven, perhaps because of the complexity of the interactions between pathogens, contaminants, and a variety of predisposing *in situ* factors. These interactions require continuing study. An example of the value of collecting new information is the observation that dab (*Limanda limanda*) from Icelandic waters show a similar prevalence of lymphocystis and skin ulceration to that of dab from the North Sea.

The ACME recommended the continuation of fish disease studies to obtain long-term information on the fluctuations of disease prevalences. These studies should include not only the analysis of contaminants in sediments and biota but, equally important, collection of information on a number of biological factors, such as the age of the fish, food availability, condition factor of the fish, and environmental conditions, such as sediment structure, salinity, oxygen concentration, etc.

10 PROGRAMME FOR INVESTIGATING THE DYNAMICS OF ALGAL BLOOMS

The ACME noted that the Study Group on the Dynamics of Algal Blooms (SGDAB) was established in 1991 to plan and propose a programme for investigating the dynamics of algal blooms in coastal oceans. IOC is a co-sponsor of this Study Group.

The Study Group has proposed the conduct of field studies in order to understand and predict the occurrence of algal blooms in terms of location, intensity, and detrimental effects. Three regions have been chosen for study which are subject to the recurrent occurrence of harmful phytoplankton and where a background knowledge of hydrography and phytoplankton ecology already exists. These regions are the Gulf of Maine, the Skagerrak/Kattegat area, and off the coast of Iberia.

The Study Group has accepted a population dynamics approach as the best way to improve the understanding of and predictive capabilities with regard to harmful algal blooms. There is a need to establish links between the ecological problems and the physical oceanographic background on a site-specific basis. To assist with these tasks, an interdisciplinary approach in collaboration with physical oceanographers has been accepted, with the expertise in physical oceanography supplied by the Working Group on Shelf Seas Oceanography (WGSSO).

Following a joint meeting between the SGDAB and the WGSSO in 1993, these groups produced a detailed review document on the importance of resting cysts in the bloom dynamics of harmful algae. This review notes that many phytoplankton species, including some harmful species, have dormant stages in their life histories. The alternation between dormant and benthic stages and a motile, vegetative existence is a complex process that must be considered to understand the dynamics of harmful blooms.

The joint meeting noted that marine biology is a complex field and adding physical aspects will enhance this complexity. Although marine biology depends on physical processes, such as advection, diffusion, and upwelling, physical oceanography is practically independent of biological processes. Physical oceanographic processes are more readily quantifiable than those of marine biology. One advantage of physical oceanography is that the dynamic relations are governed by the laws of conservation, e.g., energy, momentum, and mass, which can be expressed in terms of differential equations.

The joint meeting also noted that theories of blooms are well developed and models have been produced, but they do not work very well at present for toxic blooms. The problem of prediction of toxic blooms is similar to

the problem of predicting weather and climate. There is the problem of predicting blooms in the short term of days and weeks and on longer time scales of years and longer. Long-term changes in major nutrients can be linked to climate change and it is necessary to know what effects this will have on the species composition of the phytoplankton population and on the frequency and intensity of toxic blooms.

There are at least three main types of toxic algae:

- 1) benthic types, both macro- and microalgae (e.g., those responsible for Ciguatera toxins);
- 2) types from the mixed pelagic environment (e.g., diatoms);
- 3) types from the stratified pelagic environment (e.g., flagellates).

Buoyant forms such as *Trichodesmium* and *Noctiluca* are also important in certain regions. In fresh water, neurotoxin- and hepatotoxin-producing cyanobacteria are important; certain areas of China have high incidences of liver cancer as a result of microcystin-producing organisms.

At least four fundamental ecosystem types can be recognized:

- 1) the open coastal type of ecosystem;
- 2) the semi-enclosed type of ecosystem, which may be eutrophic; in this type it is also possible to distinguish deep (fjords) and shallow areas;
- 3) major estuarine fronts;
- 4) the open ocean, where species such as *Gymnodinium breve*, *G. catenatum*, *Gyrodinium aureolum* and *Trichodesmium* (now thought to be a neurotoxin producer) occur.

Within systems one can distinguish low and high nutrient types, with high concentrations of nutrients occurring either naturally (e.g., by upwelling) or anthropogenically (by eutrophication). Blooms have a characteristic seasonality, often occurring within short 'windows' of time and often involving cysts or spores. Toxic blooms are ultimately site specific. Sometimes indices can be used for their prediction, e.g., temperature can be used to predict *Chattonella* blooms in the Sea of Japan. Some of the complications in dealing with toxic blooms are the occurrences of both toxic and non-toxic forms in the same species, behavioural complications

such as swimming, allelopathy ('chemical warfare') and its effect on grazing and the food web, and selective grazing, e.g., of non-toxic forms.

The Strait of Georgia (British Columbia, Canada) is a good example of a large, semi-enclosed, deep estuarine ecosystem (case 2), where regular blooms of *Heterosigma* cause serious damage to the salmon cage culture industry. The blooms do not appear until the temperature reaches 15°C, but the salinity must also decrease to 15. The duration of the bloom depends on strong stratification (this lasted four months in 1989) and the termination of the bloom depends on the breakdown of the stratification. These events are preceded by a typical spring bloom followed by an interval and then the big freshwater runoff from the Fraser River, following which stratification occurs and *Heterosigma* appears. This organism is allelopathic; it blooms during a time of low surface major nutrients and migrates vertically for nutrients and light if the stratification is less than 10 m (it is usually 5-8 m). Autumn wind events lead to the breakdown of this system. The *Heterosigma* populations are horizontally advected; the growing population remains about the same at the mouth of the Fraser River, while large quantities are exported down the Strait of Georgia where they encounter fish farms. Years of low snowfall, such as the winter of 1991/1992, result in high salinity and low micronutrient levels (as in 1992) and, consequently, no bloom occurs.

Long-term records for the occurrence of *Heterosigma* in the area are qualitative. In Japan, the situation is similar but there are also anoxic bottom waters. The *Heterosigma* situation in Narragansett Bay (Rhode Island,

USA) is different again. An intercomparison study of *Heterosigma* blooms in the three localities (Strait of Georgia, Sea of Japan, and Narragansett Bay) would be instructive.

Theory and modelling are required in physical oceanographic research to understand observations and to address new questions. In biology it is often necessary to describe rate processes. For biologists and physicists to interact and to harmonize their efforts, it is necessary to introduce theory and modelling at an early stage in the programme to help determine which processes can be ignored and which need to be studied or measured. It is at the point of theory that physicists and biologists can meet, and it is important to isolate the most crucial relationships which determine the processes to be considered.

The potential contribution of mesocosm experiments to the understanding of the dynamics of algal blooms was also reviewed. However, this use of such types of experiments was not widely accepted, because it was felt that many factors controlling algal populations in nature are eliminated when isolated by these devices. However, there was agreement that such experiments might provide some information on the range of variation of critical parameters.

The ACME welcomed the initiatives taken at the joint session between the SGDAB and the WGSSO to establish a dialogue and cooperation between the physical and biological oceanography communities for the study of the dynamics of algal blooms.

11 ISSUES REGARDING MARINE MAMMALS

11.1 Seals and Small Cetaceans in European Seas

The ACME reviewed the report of the 1993 meeting of the Study Group on Seals and Small Cetaceans in European Seas.

Abundance of seals and small cetaceans

The Study Group reviewed the most recent information on the sizes of marine mammal populations within its geographical area of interest and attempted to place them in a historical context. The Study Group recognized the need for a single table which summarized the best available estimates for all marine mammal populations in its area, and which would provide an indication of the estimation method, the year(s) to which the estimate applied, and the confidence limits, where available. The ACME endorsed this task as a priority action for the 1994 meeting of the Study Group.

The Study Group noted that, for many species, there are no well-defined biological stocks and only point estimates of abundance are available. In its report, the Study Group provided estimates of populations of harbour seals (*Phoca vitulina*) in fourteen general areas, from the Baltic Sea in the east to the west coast of Ireland, and from the northern coast of France to the northern coast of Norway. On a less detailed basis, population estimates were provided for grey seals (*Halichoerus grypus*) from roughly the same overall geographical areas. Finally, for ringed seals (*Phoca hispida*), information was provided on populations in the Baltic Sea, the only area in which this species is found in Northern Europe.

Information on the abundance of small cetaceans is poor because there have been few surveys specifically dedicated to estimate their abundance in the area covered by the Study Group. Some estimates were given, however, for populations of harbour porpoises (*Phocoena phocoena*) and common dolphins (*Delphinus delphis*).

The ACME noted that a common methodology for conducting shipboard surveys of small cetaceans has been developed over the last few years. The method is built on a basic line transect approach, with the distance and angle of animals from the trackline being recorded. This means that a well-established and well-documented standardized protocol for conducting surveys of small cetaceans is in existence and available for use.

Information from other sources, including aerial surveys using a strip transect methodology and acoustic cues, have proved to be valuable in providing information on the spatial and temporal distribution of small cetaceans.

Although grey, harbour and ringed seal populations in the Baltic Sea now appear to be stable, it is too early to determine whether this is a sustainable trend, and current management measures banning hunting should therefore be maintained. The monitoring of seal populations for pathological and contaminant effects should continue.

By-catches of marine mammals

The Study Group reviewed information on the by-catch of small cetaceans in specific fisheries, as collected by various ICES member countries. The Study Group concluded that it is possible to obtain detailed and reliable information on by-catches using an observer scheme. Other schemes, such as postal surveys, voluntary reporting schemes, and reporting by untrained observers, are useful for identifying fisheries where there may be a problem with by-catch, but they are unlikely to provide good quantitative information.

Surveys of by-catches can have two purposes: (1) to estimate the scale of the by-catch in a particular fishery; or (2) to determine how by-catches might be reduced. It is generally necessary to use some kind of sampling programme to estimate by-catch. Total by-catch is then estimated by scaling-up the results of the sampling programme. Some measure of fishing effort is required for this scaling-up process. The Study Group recommended that one of the official effort statistics (e.g., number of hours at sea) which skippers normally report to fisheries officers should be used for scaling-up the survey results. Data forms for reporting information on by-catches should be easy to fill in; simple multiple choice questions are recommended for recording identification characters of the marine mammals in the by-catch.

The ACME supported the Study Group recommendation that the use of observer schemes to document by-catches should be continued and similar methods should be used to document the by-catch in specific fisheries using actively-fished gear.

In terms of reducing or avoiding by-catch, the basic problem is to reduce the probability that marine mammals will come into direct contact with fishing nets. This can be achieved by modifying the gear so that it is more easily detected by marine mammals, or by modifying the way that gear is deployed so that it is not used at times or in localities where the risk of by-catches is high.

The problem posed by by-catches is such that the ACME recommended that work on remedial measures be pursued by both scientists and administrators.

11.2 Distribution and Sources of Pathogens in Marine Mammals

The ACME reviewed the results of the ICES Workshop on the Distribution and Sources of Pathogens in Marine Mammals (Cambridge, UK, 23-26 March 1993). The Workshop reviewed the known pathogens of marine mammals under two headings:

- 1) Microparasites. This includes all viruses, mycoplasmas, bacteria, protozoa and fungi. The toxins produced by certain algae were also included in this category.
- 2) Macroparasites. This includes all metazoan parasites, such as digeneans, nematodes and arthropods.

Pathogens of Marine Mammals

Certain viruses are known to cause large-scale mortality in marine mammals; they include the phocid distemper virus, that caused wide-scale mortality in seals in north-western Europe in 1988. A wide range of bacteria can be cultured from seals. In European seals, *Streptococcus* spp. are generally the most common organisms found.

While macroparasites in general are not fatal, for a number of species there is direct or indirect evidence that they may be a significant component of natural mortality.

Marine mammals are most likely to come into contact with anthropogenically derived pathogens from the discharge of untreated human sewage or effluent from facilities which contain domestic animals. The Workshop concluded that the greatest threat to marine mammal populations from pathogens is likely to come from the introduction of a novel pathogen into a naive population (i.e., a population not previously exposed to that pathogen).

In view of the claims that additional contributory factors may have led to higher mortality or triggered the disease outbreak, the Workshop reviewed information on the potential role of the following factors:

- Contaminants, such as organochlorine compounds and certain heavy metals, that may have an immunosuppressive effect;
- Microparasites, particularly morbilliviruses;

- Macroparasites;
- Body condition and food availability;
- Genetics; and
- Climate change, for example, influencing the amount of ice cover for seal haul outs.

Risk of future outbreaks of infectious disease

The Workshop considered that the greatest risk of epizootic disease outbreaks in marine mammal populations was likely to come from viruses. The agents most likely to cause mass mortality are the morbilliviruses and influenza viruses.

The most vulnerable populations are those which might be exposed to novel pathogens or to pathogens which remained endemic within populations and caused episodic outbreaks when the number of susceptible animals rose above some critical level.

Although theoretically the number of infective individuals should fall to very low levels in the post-epidemic period, there is evidence that some pathogens may persist in small populations of marine mammals.

However, in terms of the consequences of recent mass mortalities, it was noted that, although harbour seal populations in the Wadden Sea and the Kattegat/Skagerrak area suffered a mortality of around 60% in 1988, they are predicted to return to pre-epidemic levels by 1995 to 1997.

Proposals from the Workshop

The Workshop recognized the need for a well-defined approach to future mass mortalities of marine mammals to ensure that the maximum amount of scientific information was obtained and that public concerns were addressed as rapidly as possible. One of the major problems identified was the need to establish contacts with collaborators with the appropriate expertise as rapidly as possible. The Workshop did not believe that a single protocol could be developed to address all relevant issues. Rather, the Workshop recommended that four working groups be established to develop standard protocols and methods for the following topics: (1) pathology and medicine, (2) infectious diseases, (3) toxicology, and (4) ecology.

A more detailed summary of the Workshop report is contained in Annex 3.

12 ISSUES REGARDING INTRODUCTIONS AND TRANSFERS OF MARINE ORGANISMS

12.1 1993 Code of Practice to Reduce the Risk of Adverse Effects Arising from Introductions and Transfers of Marine Species

The ACME reviewed the section of the report of the Working Group on Introductions and Transfers of Marine Organisms dealing with the revised 1993 Code of Practice to Reduce the Risk of Adverse Effects Arising from Introductions and Transfers of Marine Species, Including the Release of Genetically Modified Organisms. The Code of Practice comprises recommendations for:

- 1) reaching a decision regarding proposed new introductions of non-indigenous aquatic organisms;
- 2) quarantine procedures for the broodstock, once the principle of an introduction has been accepted;
- 3) recommended procedures for introduced or transferred species which are part of current commercial practice; and
- 4) recommended procedures concerning the release of genetically modified organisms.

Item (4) represents the main revision over previous versions of the Code of Practice. The Working Group has requested that this Code of Practice be formally adopted by ICES.

The ACME noted, however, that a recent incident suggests that there should be a modification to Section IV of the Code of Practice. This incident, noted in Section 12.3, below, concerns the recent introduction into one European Economic Community (EEC) country of exotic species following the transfer of half-grown Pacific oysters (*Crassostrea gigas*) from another EEC country. Samples from consignments arriving in the receiving country, although certified as *Bonamia* and *Marteilia* free, revealed the presence of the parasitic copepod *Mytilicola orientalis*, the flat oyster *Ostrea edulis* (a vector of *Bonamia*), and the slipper-shell limpet *Crepidula fornicata*. Other organisms included shell epifauna and dinoflagellate cysts. These findings are causing considerable concern to some scientists and oyster growers.

On the basis of this concern, the ACME recommended that Section IV of the Code of Practice, presently reading "periodic inspection (including microscopic examination) of material prior to exportation to confirm freedom from introducible pests and diseases", should be amended to read "confirm freedom from introducible pests and diseases and any other non-indigenous or harmful organisms".

There was considerable discussion in ACME about the potential ecological effects of introductions, and whether precautions concerning ecological impact receive sufficient weight in the Code of Practice compared to the problem of disease. The ACME requested the WGITMO to take note of this point in drafting the proposed ICES Cooperative Research Report, 'Guidelines and Manual of Procedures'. To provide further reassurance, the ACME requested an addition to the Code of Practice in the form of the following preamble: "The introduction or transfer of marine species carries the risk of introducing pests and disease, establishing undesirable ecological effects in relation to existing species in the new environment, and, where the introduction is a genetically modified organism, of affecting existing genotypes. This Code of Practice provides recommendations dealing with these issues for new introductions, and also recommends procedures for species which are part of existing commercial practice." Subject to these amendments and the addendum, the ACME recommended that the Council adopt the Revised 1993 Code of Practice.¹

The ACME stressed that, while the Code of Practice represents a worthwhile step forward (the ACME commends the Working Group for its work on this), it is not a regulation or statute, and existing laws may to some extent work against it. Thus, the movement of Pacific oysters, certified disease-free, from one EEC country to another EEC country is completely legal under EEC Directive 91/67. Provisions to adopt movement controls previously available nationally in some ICES member countries are no longer valid for EEC countries under this Directive, and shellfish growers in some receiving countries are now concerned about the practical effect of the Directive. In the above-mentioned case, either screening did not take place or, if it did, the process failed to detect *Ostrea edulis*, thus raising

¹ After the ACME meeting, the Working Group on Introductions and Transfers of Marine Organisms withdrew the revised 1993 Code of Practice from the review process in order to handle the ACME amendments at its 1994 meeting.

questions about either the screening sample size or the basic competence of the screening at the exportation site. The Working Group has therefore recommended that ICES establish a dialogue with relevant international agencies, such as the Commission of the European Communities (CEC), concerning the increasing shipments of live aquatic organisms, to ensure that potential ecological and genetic impacts of such transfers are taken into consideration, and not only the prevention of disease agents. The ACME expressed concern about the environmental and commercial implications of this incident, and fully endorsed the proposed establishment of a dialogue with the CEC. However, the ACME noted with concern that, given the amount of time it will take to establish the dialogue and, particularly, to resolve the issues, accidental introductions of harmful species could occur in association with international shipments of live marine organisms.

12.2 Guidelines for Research to Evaluate the Ecological Effects of the Release of Genetically Modified Organisms to the Marine Environment

The ACME noted that, in connection with the preparation of the revised 1993 Code of Practice to Reduce the Risks of Adverse Effects Arising from Introductions and Transfers of Marine Species, including the Release of Genetically Modified Organisms, the Working Group on Introductions and Transfers of Marine Organisms (WGITMO) considered guidelines for research to evaluate the effects of the release of genetically modified organisms to the marine environment.

At its 1992 meeting, the WGITMO adopted the definition of genetically modified organisms (GMO) given in Article 2(2) of European Economic Community (EEC) Directive 90/220: 'Genetically modified organism (GMO)' means an organism in which the genetic material has been altered in a way that does not occur naturally by mating and/or natural recombination.¹

Aspects that have to be considered in a code of practice covering the release of genetically modified organisms include the potential for the transfer of genetic material from the GMO to other organisms, the phenotypic and genotypic stability of the GMO, the GMO's potential to survive and spread, and its potential negative impacts on other organisms. Assessments have to be made of the GMO's biological and environmental requirements, and

any behavioural changes compared to the unaltered organism.

Rapid advances in the field of biotechnology may soon lead to a request for the release of a GMO into the marine environment. For this reason, a new section on the release of GMOs has been proposed for addition to the ICES Code of Practice on introductions and transfers.

The WGITMO considered that guidelines for research on the release of GMOs into the marine environment should include the following:

1. Assess whether the GMO could hybridize with the unmodified organism or other species. Using triploids, wherever possible, might be considered.
2. Assess whether there are changes in the biological and ecological requirements of the GMO compared to the unmodified organism. This might include studies of food preference, food requirements, temperature range, salinity range, oxygen utilization, the reproductive cycle, life span and disease susceptibility. These studies should be carried out from small laboratory-scale experiments through to field trials, in containment at all stages. If adverse changes are detected, then the trial should be abandoned or modifications made to earlier steps of the procedure.
3. Assess the benefits/risks to human health, the economy, social structure, and recreation, and quantify the human perception of the release of the GMO.
4. Characterize the environmental conditions of the release site as far as is practical (for example, measurements of biodiversity and physicochemical factors). Monitoring should continue after the introduction of the GMO has taken place.
5. Assess and validate methods for controlling/eradicating the GMO prior to its release.

This is a relatively new technique within biotechnology. The ACME stressed the potential importance of this area for mariculture and the ecological impact of GMOs. More knowledge on this area is desirable.

¹ European Economic Community "Council Directive of 23 April 1990 on the Deliberate Release into the Environment of Genetically Modified Organisms (90/220/EEC)", Official Journal of the European Communities, No. L., 117: 15-27 (1990).

In this connection, the ACME noted that the OECD Group of National Experts on Safety in Biotechnology sponsored a Workshop on the Impacts on the Aquatic Environment arising from the Introduction or Escape of Aquatic Organisms which have been Derived from Modern Technology, in Trondheim, Norway, in June 1993. The objectives of the Workshop were to:

- 1) Review current knowledge on the use of modern biotechnology as applied to aquatic organisms;
- 2) Describe the scientific experience derived through the analysis of selected case studies, as well as predictive models, involving the release (introduction or escape) of aquatic organisms;
- 3) Identify possible environmental implications of such releases;
- 4) Identify the gaps in our knowledge that need to be filled to address these environmental implications; and
- 5) Define information and research needs to enhance the safe use of aquatic organisms in sustainable aquaculture.

The types of aquatic organisms covered include finfish, shellfish, plants and microorganisms.

12.3 Accidental Transfers of Aquatic Organisms

In view of the rapidly growing international concerns over the continued spread of non-indigenous aquatic organisms by ships' ballast water, the WGITMO reviewed the status of ballast water regulations and procedures in ICES member countries. In particular, Canada and the United States have been very active in the area of ballast water management. Internationally, guidelines have been prepared by the International Maritime Organization, and the WGITMO noted that the implementation of these guidelines varied greatly between countries.

The ACME noted with great concern the introduction of the American comb jelly *Mnemiopsis leidy* to the Azov, Black, and Mediterranean Seas by ballast water in the 1980s, which may have been a contributing factor to the devastation of the Azov Sea anchovy fishery. The potential for the spread of this species by ballast water around Europe has been noted by the UN Food and Agriculture Organization (FAO) and other organizations.

The WGITMO also noted that a number of non-native species, including parasitic copepods, molluscs, worms, and dinoflagellates, were released into the waters of one EEC country via shipments from another EEC country of half-grown Pacific oysters. Such shipments of live fish and shellfish are now permitted under EC Council Directive 91/67/EEC. The ACME voiced concern over the implications of an increase in free trade of live aquatic organisms, in terms of the co-introduction of non-target species. The ACME, therefore, recommended that ICES establish a dialogue with international agencies, such as the Commission of the European Communities, concerning the increasing international shipments of aquatic organisms based on new trade agreements, to ensure that the potential ecological and genetic impacts of such movements are taken into consideration, and not only the prevention of the introduction of disease agents.

The problems related to the accidental transfer of organisms, either through ballast water or any other vector for spreading non-indigenous species, can be very serious in relation to aquatic ecosystems. For this reason, the ACME recommended that action plans against accidental transfers be considered by relevant bodies within the ICES area.

13 GUIDELINES FOR ENVIRONMENTAL IMPACT ASSESSMENTS OF MARINE AGGREGATES DREDGING

The ACME considered the report of the Working Group on the Effects of Extraction of Marine Sediments on Fisheries and noted with particular interest the work done in relation to the development of guidelines for the environmental impact assessment of marine aggregates dredging proposals. The guidelines are still at the draft stage as further experience is still required in the practical application of environmental impact assessment procedures to proposals for marine aggregates dredging. The Working Group considered that particular attention should be given to the degree of detail to be included in the guidelines for environmental impact assessments and the requirements of relevant European Community Directives.

The draft guidelines include the following requirements:

1. Information requirements

- Nature of the deposit (e.g., location, geological history, total quantity of material);
- Physical environment (e.g., local hydrographic conditions, bedload sediment transport, turbidity, potential for release of chemical contaminants);
- Biological environment (e.g., benthic community structure, fish and shellfish resources, estimated recolonization times);

- Interference with other legitimate uses of the sea (e.g., potential interference with fishing activities, navigation, recreation, conservation).

2. Preparation of the assessment and statement

This includes identification and quantification of significant effects of the proposed dredging; possibilities to mitigate the effects of extraction activities; results of the assessment in the form of an impact hypothesis.

3. Monitoring

This includes the objectives of the monitoring programme, the measurements that should be made to meet those objectives, and plans for the regular review of the monitoring results in relation to the objectives.

The ACME appreciated the outline of the guidelines and requested the Working Group to develop them further at their next meeting in order to present the final guidelines at the 1994 ACME meeting.

ICES has a long tradition for providing scientific advice related to fisheries and environmental matters on a regional scale. This tradition is partly based on the efforts of ICES to promote and support the necessary scientific collaboration between its member countries in order to address questions at this scale. An important aspect of this collaboration has been the compilation and publication of scientific data. Over recent decades, this has evolved into the scientific management of data banks containing data on fish catches, fisheries biological data, oceanographic data, and data on marine contaminants.

The fisheries data bank contains official data on total catches supplied by the national statistical offices of ICES member countries, as well as data supplied by members of ICES assessment working groups. The latter data include information supplementing the official data on total catches as well as biological information on the age composition of the catches and estimates of the level of fishing effort. These data are updated annually during assessment working group meetings. In order to access these data, ICES has recently implemented a set of computer programmes (IFAP) that are used for data handling and documentation. In addition to catch data, ICES also serves as a data centre for the results from surveys such as the International Bottom Trawl Survey in the North Sea, Kattegat and Skagerrak. This survey started in 1972 as an annual survey, but was extended into quarterly surveys in 1991.

The oceanographic data bank contains a number of time series of hydrographic parameters. The most comprehensive of these consists of the hydrographic station data from the North Atlantic and adjacent seas which extends back to 1902. ICES now acquires about 20,000 stations annually, which are added to the 400,000 stations currently in the bank. In addition to these data, ICES holds a number of hydrographic data sets obtained from collaborative research programmes, such as PEX '86, SKAGEX, GSP, etc.

The environmental data bank contains data on contaminants, mainly in coastal areas, and extends back to 1978. In 1983, the data were extended to encompass the needs of the Joint Monitoring Programme (JMP) of the Oslo and Paris Commissions (OSPARCOM) and since 1988 the data bank has also served the needs of the North Sea Task Force. Until 1990 the data related only to concentrations of contaminants in fish and shellfish, sea water, and sediments. Recently, a number of additional parameters relevant for the monitoring of biological effects of contaminants and fish diseases have been included. The data bank is utilized by several ICES working groups who have developed appropriate

statistical models to analyse temporal trends in the data, particularly for contaminant levels in fish and shellfish.

In addition to the data held at ICES Headquarters, a number of data sets are in the custody of individual laboratories, working groups, and study groups. Among these are the data from collaborative programmes such as the ICES Stomach Sampling Programme, containing information on the diet of a number of fish species in the North Sea, and the 1986 ICES North Sea Benthos Survey.

There are no general rules for gaining access to the data bases. Most of the data are freely available to qualified experts upon request to the relevant ICES official and the data originator.

The ACME noted that the multidisciplinary/interdisciplinary nature of its work calls for a close cooperation among and integration of the marine disciplines in order to ensure that quantitative assessments can be made. For example, it is expected that the demand for future quality status reports (QSRs) for regional seas within the ICES area will increase. Quantitative assessments of the quality of the marine environment will necessitate the collection and analysis of data reflecting all aspects of environmental quality from marine chemistry to fisheries. They will also require studies of likely effects across disciplines, e.g., the effects of fisheries on the marine environment and *vice versa*.

Such studies require easy access to and enhanced possibilities for combining environmental, oceanographic, and fisheries data. This is necessary in order to enable working groups and advisory committees to highlight relationships between environmental parameters stored in different data sets. The ACME realized that this can only be done if the interrelationships between databases are clearly defined.

In addition, the assessments will require that additional data, e.g., on benthos, marine mammals and seabirds, are made available and that the necessary procedures are developed to ensure the quality of these data. Given that the data will be utilized by working groups that may not have participated in the collection of the data themselves, it is important that detailed descriptions of the procedures involved in collecting, analysing and quality assurance are provided.

The ACME noted that the development of the ICES databases and interrelationships between them is an ongoing task, and offered to provide guidance for these developments when required.

ANNEX 1

GUIDELINES FOR THE USE OF SEDIMENTS IN MARINE MONITORING IN THE CONTEXT OF OSLO AND PARIS COMMISSIONS PROGRAMMES

1 INTRODUCTION

- 1.1 These guidelines provide advice on the use of marine sediments in environmental monitoring, with the aim of ensuring comparable results between monitoring programmes.
- 1.2 They also give general guidance on the sampling and analysis of sediments and the interpretation of data.
- 1.3 They include four technical annexes which give detailed guidance on the sampling and analysis of sediments, the normalization of results, the statistical aspects of survey design and quality assurance of data. These annexes cannot be used as laboratory handbooks, but references to source literature are given.
- 1.4 The content of the technical annexes will develop in line with progress in scientific knowledge.
- 1.5 It must be emphasized that these guidelines are not sufficiently detailed to be used, without addition, as full and adequate instructions for cooperative monitoring programmes. It is strongly advised that the details of survey design, sampling, analysis, etc., should be referred to a Steering Group prior to the commencement of a field programme to ensure that detailed specifications are drawn up for all subjects discussed in this document and its annexes in order to meet the precise objectives of the programme. Only in this way can homogeneous and comparable data sets be obtained, and the maximum benefit be derived from their interpretation.

2 MONITORING

It is necessary to review the role of sediments in the monitoring programmes of the Oslo and Paris Commissions (OSPARCOM) so that guidelines for the use of sediments will be relevant to the needs of these organizations. In 1988, the ICES Advisory Committee on Marine Pollution (ACMP) adopted the following definition of monitoring (ICES, 1989): "In the context of assessing and regulating environmental and human health impacts of anthropogenic activities, specifically the

introduction of wastes, monitoring is the repeated measurement of an activity or of a contaminant or of its effects, whether direct or indirect, in the marine environment." ACMP saw the ultimate purpose of monitoring as the control of the exposure of critical organisms to activities or contaminants affecting them. Monitoring activities, in practice, could be classified into three groups:

- a) monitoring for compliance purposes;
- b) monitoring patterns and trends;
- c) monitoring for research purposes.

In further discussion, ACMP recognized research monitoring as the investigative stage required to establish efficient and targeted monitoring for trends and patterns, and clearly linked the first two types of monitoring to assessment, through defined targets or quality standards, and on to possible regulatory action.

The Joint Monitoring Group (JMG) of OSPARCOM has defined two purposes, of immediate relevance to sediments, for its monitoring programmes:

- Purpose c) assessment of the existing level of marine pollution (spatial distribution);
- Purpose d) assessment of the effectiveness of measures taken for the reduction of marine pollution in the framework of the Conventions (temporal trend assessment).

Many contaminants have high affinity for particles, and bottom sediments therefore are the repository for a large proportion of the contaminants introduced to the sea. The concentrations of contaminants in sediments have been shown, in many areas, to reflect waste disposal practices and other forms of input and so can be an important element in programmes to describe the distribution of contaminants. The temporal trend component (Purpose d) has clear parallels in the ICES strategy, while the spatial distribution component (Purpose c) can be seen as linked to the ICES monitoring of patterns, or perhaps research monitoring to explore the need for further monitoring of patterns or trends. There is a strong emphasis on assessment, i.e., the interpretation of data leading into management decisions.

The North Sea Task Force (NSTF) has stated that the objective of work under its Monitoring Master Plan (MMP) is "to develop an adequate depth of coverage of data which will provide all the necessary information that is required to measure the condition of the North Sea, including trends in physical, chemical and biological parameters." This objective therefore has, as a primary component, a description of the North Sea, a task which might be accomplished in a single comprehensive programme. The role of repeated measurements might therefore be limited to the establishment of the degree of short-term temporal variability. Temporal trends are not specifically mentioned, but are grouped together with spatial trends under a single heading. The link between monitoring and regulatory action is not as explicit in the NSTF objectives as in the JMG purposes, or in ICES discussions, nor is assessment in relation to targets or standards emphasized as much as in the ICES document.

Within both the OSPARCOM and NSTF programmes, which may be seen as to some extent complementary, are requirements for the description of the marine environment, and the assessment of current environmental quality in terms of condition (NSTF) or level of pollution (JMG). OSPARCOM and NSTF both identify the need to obtain information on changes in the quality of the marine environment in response to anthropogenic influences, whether through continuing waste inputs, or through the effects of regulatory activities (e.g., through the Commissions, or through national action arising from the North Sea Conferences system). The monitoring of sediments can provide information of direct relevance to these objectives, in ways that can be broadly categorized as follows:

- a) Assessment of the spatial distributions of physical and chemical components of surface marine sediments at one time.
- b) Assessment of the temporal changes in the chemical composition and physical properties of surface sediment at one place through repeated sampling at that place.
- c) Retrospective assessment of temporal changes in the chemical and physical properties of sediment at one place through the examination of surface and sub-surface sediment.
- d) More specialized programmes for particular purposes, for example, in support of studies of the effects of contaminants on organisms.

Category (a) monitoring can identify areas of enhanced concentrations of contaminants, and allow interpretation in terms of relative degrees of contamination and location of sources. Category (b) monitoring seeks to detect short-term changes in sediment quality, while category

(c) studies normally include identification of 'background' or 'pre-industrial' conditions preserved within the sedimentary column to provide a framework within which to view current conditions. Studies of sediments can therefore make a considerable contribution towards the objectives of the OSPARCOM and NSTF monitoring programmes. However, the sampling, analytical, and other approaches that need to be adopted vary with the category of sediment monitoring being considered.

3 SAMPLING AND ANALYSIS

The strategy of sampling and analysis will depend on the purpose of the monitoring programme. Aspects that are involved are:

- i) choice of area;
- ii) choice of sampling device;

A wide range of sampling devices are in use for sampling sediments in the marine environment. The choice of equipment should be made depending on the local conditions at the site of sampling (water depth, type of sediment, etc.), bearing in mind the objectives of the sediment sampling.

- iii) choice of analytical method;
- iv) choice of density and design of sampling grids;
- v) choice of frequency of sampling.

- 3.1 As a general principle, the sampling procedure should not unduly alter the properties of the sediment (e.g., by contaminating or disturbing the sample or losing the surface layer).
- 3.2 Spatial or temporal assessment can be accomplished using surface samples of defined thickness obtained using appropriate equipment.
- 3.3 Retrospective assessment of temporal changes requires core samples.
- 3.4 Samples should be collected throughout the area of interest, taking account of the advice on statistical considerations (Technical Annex 3) and considering the variability in the contaminant content of the sediment and the bottom topography. For example, denser sampling grids are required nearer to point sources than in areas of diffuse contamination, and also in areas of uneven bottom topography compared to more uniform areas.

4 ANALYSIS

Analytical procedures should be carefully considered to allow comparisons to be made between laboratories and programmes. Depending upon the objectives of the monitoring programme, the determinands in question should be analysed either in the total unfractionated (bulk) sediment, or else in a separated grain size fraction, as indicated below:

- a) Monitoring for the assessment of spatial distributions. Analysis of the whole (<2 mm) unfractionated sediment is recommended.
- b) Monitoring for the assessment of temporal trends through repeated sampling. Experience suggests that analysis of a fine-grained fraction of the sediment (e.g., <63 μm or <20 μm) should be recommended, as this can provide a more sensitive indicator of change. There may also be a requirement, arising out of previous assessments of spatial distributions, to analyse the whole unfractionated sediment.
- c) Monitoring for retrospective assessment of temporal trends. The analytical approach to core samples is dependent upon the precise purpose of the programme, and the comparisons to be made between the core data and other data sets.
- d) Monitoring in more specialized programmes. It is difficult to give firm guidance on the approach to be taken in these studies, although it seems likely that analysis of a fine fraction may usually be appropriate.

At present, the certified values of contaminant concentrations in reference materials are always based upon total concentrations, rather than some less complete extractable fraction. For the security of analytical quality assurance, it is therefore necessary to use methods that determine the total amount of the analyte in the sample. For example, for trace metal determination, this will require a total digestion or another, non-destructive total method. Even in cases where, for special purposes, a partial extraction is required, the total contents should also be determined. In some cases, it may be possible to demonstrate equivalence between total digestion and some less rigorous extraction for some elements, but the use of such methods requires particular attention to quality assurance, and may not provide data that can reliably be compared with data from other studies.

5 DATA INTERPRETATION

Initial approaches to the interpretation of analytical data are given in Technical Annex 2 on the normalization of data.

ICES, 1989. Report of the ICES Advisory Committee on Marine Pollution, 1988. ICES Cooperative Research Report No. 160, p. 18.

TECHNICAL ANNEX 1

SAMPLING AND ANALYSIS

A1 Sampling Strategy

A1.1 Categories of investigation

Two approaches to sampling and analysis are suggested, appropriate to different monitoring objectives. The first is relatively inexpensive, and can provide information on spatial distributions and temporal trends of contaminants in surface sediments. The second is more demanding, and is necessary for retrospective temporal trend studies; it provides a more complete assessment of contaminant levels, information on sediment accumulation rates and contaminant fluxes, and can be applied to contaminant budget studies.

A1.1.1 Surface sediment studies (spatial and temporal trends)

Box corers are recommended for these programmes. They can provide excellent, undisturbed samples and are relatively free from 'edge effects'.

Grab samplers can only be used provided that they do not disturb the sediment. Therefore, large box corers are preferred. Tightly closing grab samplers are usually adequate for studies of the most recently deposited layer, provided that they are well designed and handled. Normally, only the uppermost layer is used for the studies. However, an important reason to prefer the box corer is that a sample can be taken of a specific thickness of the surficial layer with greater accuracy. The thickness of the surficial layer to be sampled should be defined for each monitoring survey. The layer should be thick enough to result in a sufficient amount of material for all analyses.

In the case of strong biological perturbation of the sediments, the contamination signal of the surficial layer may be significantly damped.

Since deposition rates cannot be determined from grab samples, this approach does not allow an estimate of the retrospective time trend of contamination at the site, or the establishment of a pre-industrial baseline.

The choice of sampling area will be governed by the area of interest and the aim of the monitoring programme. In spatial surveys, samples should be distributed throughout the area of interest, including areas of sediment accumulation and more dispersive areas, all

depths of water, and taking account of the known distribution of contaminant inputs. It is normally valuable to obtain information on the variability of the sediment at a few sites by replicate sampling and analysis. In reporting the results of replicate samples, it is important to describe fully the replication procedure, and to indicate the degree to which analyses of normalizing variables also have to be replicated.

A1.1.2 Retrospective temporal trend studies

This category of monitoring programme necessarily involves the collection of samples by corer at selected sites, using a box corer or large-diameter gravity corer, or equivalent device. Measurements of the sediment accumulation rate, by radiochemical or other techniques, are required.

The radionuclides most commonly used for determining the rate of sediment deposition are the naturally occurring radionuclides ^{210}Pb and ^{234}Th and the man-made radionuclides $^{239}, ^{240}\text{Pu}$.

A topographic map of the sampling area should be obtained by surveying with an echo-sounder or, even better, with a high-frequency seismic reflection profiler and side-scan sonar. Sampling should be performed exclusively in non-erosion areas, normally at the deepest parts of the locality. If a point source of pollution is present, the positioning of the stations should aim at obtaining gradients. To test the representativity of a single sediment sample at a locality, several cores should be taken at one or two stations.

Sediments which are physically disturbed by man's activities (e.g., trawling) are generally not suitable for retrospective trend monitoring purposes.

A1.2 Analysis

A1.2.1 Visual description of the sediment

A log book should be used during sampling where a visual description of the samples is recorded. The description should contain the following points:

- i) colours (e.g., Munsell colour chart);
- ii) homogeneity (presence or absence of stratification);

iii) the presence or absence of animals (as an indication of bioturbation);

iv) textural description.

If possible, the sediment core should be x-rayed before analysis to confirm textural changes and biological mixing.

A1.2.2 Sub-sampling and storage at sea

The sub-sampling of sediments should preferably be performed immediately after sampling. Care should be taken to avoid smearing the sides of the extruded core. Sub-samples for physical purposes (i.e., grain size analysis) should be stored frozen.

A1.2.3 Treatment of sediments prior to chemical analysis

A1.2.3.1 Storage

Sub-samples for the analysis of inorganic contaminants, total organic carbon, nitrogen, or phosphorus should be stored either frozen or freeze-dried.

In terms of the possible use of older, archived dried sediment samples for the analysis of total metals, there is no evidence, except for mercury, that storage conditions are critical as long as the sample is kept under non-contaminating conditions. For mercury, samples must be stored in glass or quartz containers, as mercury can move through the walls of plastic containers.

Samples taken for the analysis of trace organic contaminants must be stored frozen, in proper non-contaminating containers, e.g., glass, teflon. For longer-term storage, temperatures of -20°C or lower are preferred.

A1.2.3.2 Grain size fractionation prior to chemical analysis

If the monitoring programme requires analysis of the fine sediment fraction, the sample should be split using appropriate sieving techniques.

A1.2.3.3 Drying

Samples should be freeze dried. Alternatively, for analyses of inorganic constituents (metals), except volatile substances (i.e., mercury), the sediments may be dried at 105°C or 60–80°C.

A1.2.3.4 Sub-sampling for trace organic analyses

For trace organic constituents, the analysis of wet sediments is recommended. The water content should be

determined on a parallel sub-sample to allow calculation of the concentration on a dry weight basis. Alternatively, freeze-dried sediments may be used following careful checks for the loss of volatile substances and possible contamination (e.g., by vacuum pump oil).

A1.2.4 Determination of variables other than contaminants

A1.2.4.1 Grain-size distribution

Standard methods exist for grain-size fractionation. The fine fraction under 63 µm is obtained by wet sieving, and the distribution pattern can be determined by a range of methods. The fraction above 63 µm can be fractionated by wet sieving, or dry sieving, after removal of the fine fraction. The minimum requirement for normalization is the determination of the fraction <63 µm. More detailed analyses may be required for more particular purposes.

A1.2.4.2 Organic carbon

Organic carbon should be determined using specific instruments that measure carbon, after pre-treatment with sulphurous acid to remove carbonates. Diluted hydrochloric acid may also be appropriate.

A1.2.4.3 Carbonate

Total carbon should be determined before and after acid treatment, and the carbonate content calculated from the difference.

A1.2.5 Trace metal analysis

The analytical methods used must have sufficiently low detection limits to provide quantified data for most samples.

The total dissolution of the sediment by HF plus aqua regia is the most effective procedure for removing metals from sediments. It should be used as a standard method if the total contents of trace metals are to be determined. Evaporation of acids (except for Hg) or boric acid addition should be performed before the metal determinations. Atomic absorption spectrometry (cold vapour, flame and/or graphite furnace) or plasma emission are suitable methods for metal determination. Instrumental methods, e.g., x-ray fluorescence analysis and neutron activation analysis, can also be used for total metal determination.

The use of certified reference materials of suitable matrices is absolutely necessary to ensure the accuracy of the results.

A.1.3 Reporting the results

Results should be submitted using the ICES Reporting Format on Contaminants in Sediments to the ICES data centre not later than 1 August of the calendar year following collection of the samples.

In addition to reporting the data, appropriate comments should be supplied to the data centre and to the coordinating organization.

TECHNICAL ANNEX 2

NORMALIZATION TECHNIQUES FOR STUDIES ON THE SPATIAL DISTRIBUTION OF CONTAMINANTS

A2.1 Introduction

Normalization is defined, for the purpose of these guidelines, as a procedure to compensate for the influence of natural processes on the measured variability in the concentrations of contaminants in sediments. Most contaminants (metals, pesticides, hydrocarbons) show high affinity to particulate matter and are, consequently, enriched in bottom sediments of estuaries and coastal areas. In practice, natural and anthropogenic substances entering the marine system are subjected to a variety of biogeochemical processes. As a result, they become associated with fine-grained suspended solids and colloidal organic and inorganic particles. The ultimate fate of these substances is determined, to a large extent, by particulate dynamics. They therefore tend to accumulate in areas of low hydrodynamic energy, where fine material is preferentially deposited. In areas of higher energy, these substances are 'diluted' by coarser sediments of largely natural origin and low contaminant content.

It is obvious that grain size is one of the most important factors controlling the distribution of natural and anthropogenic components in the sediments. It is, therefore, essential to normalize for the effects of grain size in order to provide a basis for meaningful comparisons of the occurrence of substances in sediments of various granulometry and texture within individual areas or among areas. Excess levels, above normalized 'background' or 'pre-industrial' values, could then be used to establish sediment quality.

Normalization is therefore very necessary for analyses of whole sediment, but may be less so for analyses of a separated fine-grained fraction. Sieving is itself a form of normalization.

For any study of sediments, a basic amount of information on their physical and chemical characteristics is required before an assessment can be made on the presence or absence of anomalous contaminant concentrations. The concentration at which contamination can be detected depends on the sampling strategy and the number of physical and chemical variables that are determined in individual samples.

The various granulometric and geochemical approaches used for the normalization of trace element data, as well

as in the identification of contaminated sediments in estuarine and coastal sediments, have been extensively reviewed by Loring (1991). Two normalization approaches widely used in oceanography and in atmospheric sciences have been selected here. The first is purely physical and consists of characterizing the sediment by measuring its content of fine material. The second approach is chemical in nature and is based on the fact that the small size fraction is usually rich in clay minerals, iron and manganese oxi-hydroxides, and organic matter. Furthermore, these components often exhibit a high affinity for organic and inorganic contaminants and are responsible for their enrichment in the fine fraction. Chemical parameters (e.g., Al, Sc, Li) representative of these components may thus be used to characterize the small size fraction under natural conditions.

It is strongly suggested that several parameters be used in the evaluation of the quality of sediments. The types of information that can be obtained by the utilization of these various parameters are often complementary and extremely useful, considering the complexity and diversity of situations encountered in the sedimentary environment. Furthermore, measurements of the parameters selected here are rather simple and inexpensive.

This technical annex presents general guidelines for the interpretation of physical and chemical parameters used for the normalization of geochemical data in the OSPARCOM area. Its purpose is to demonstrate how to collect sufficient data to normalize for the grain-size effect and to allow detection, at various levels, of anomalous concentrations of contaminants.

A2.2 Normalization procedures

A2.2.1 Granulometric normalization

Since contaminants tend to concentrate in the fine fraction of sediments, correlations between total concentrations of contaminants and the weight percent of the fine fraction, determined separately on a sub-sample of the sediment by sieving or gravity settling, constitute a simple but powerful method of normalization. Linear relationships between the concentration and the weight percentage of the fine fraction are often found and it is then possible to extrapolate the relationships to 100% of

the fraction studied, or to characterize the size dependence by the slope of the regression line.

A2.2.2 Geochemical normalization

Granulometric normalization alone is inadequate to explain all the natural trace variability in the sediments. In order to interpret better the compositional variability of sediments, it is also necessary to attempt to distinguish the sedimentary components with which the contaminants are associated throughout the grain-size spectrum. Since effective separation and analysis of individual components of sediments is extremely difficult, such associations must rest on indirect evidence of these relationships.

Because contaminants are mainly associated with the clay minerals, iron and manganese oxi-hydroxides, and organic matter, which are abundant in the fine fraction of the sediments, more information can be obtained by measuring the concentrations of elements representative of these components in the samples.

An inert element such as aluminium, a major constituent of clay minerals, may be selected as an indicator of that fraction. Normalized concentrations of trace elements with respect to aluminium are commonly used to characterize various sedimentary particulate materials. It may be considered as a conservative major element, that is not affected significantly by, for instance, early diagenetic processes and strong redox effects observed in sediments.

In the case of sediments derived from the glacial erosion of igneous rocks, it has been found that contaminant/Al ratios are not suitable for normalizing for granular variability (Loring, 1991). Lithium, however, has been shown to be an ideal element to normalize for the grain-size effect in this case, and may also be applicable in the North Sea, which contains large areas with sediments of low aluminium content.

In addition to the clay minerals, Mn and Fe compounds are often present in the fine fraction, where they exhibit adsorption properties strongly favouring the incorporation of various contaminants. Mn and Fe are easily analysed by flame atomic absorption spectrometry and their measurement may provide insight into the behaviour of contaminants.

Organic matter also plays an important role as a scavenger of contaminants and controls, to a major degree, the redox characteristics of the sedimentary environment.

Finally, the carbonate content of sediments is easy to determine and provides additional information on the origin and the geochemical characteristics of the sediments. Carbonates usually contain insignificant amounts

of trace metals and act mainly as a diluent. Under certain circumstances, however, carbonates can fix contaminants such as cadmium and copper. A summary of the normalization factors is given in Table 1.

A.2.3 Interpretation of the data

The simplest approach to the geochemical normalization of substances in sediments is to express the ratio of the concentration of a given substance to the concentration of the normalizing factor.

Normalization of the concentration of trace elements with respect to aluminium (or lithium) has been used widely and reference values on a global scale have been established for trace elements in various compartments: crustal rocks, soils, atmospheric particles, river-borne material, marine clays and marine suspended matter (cf., e.g., Martin and Whitfield, 1983; Buat-Menard and Chesselet, 1979)

The normalization also allows the definition of an enrichment factor for a given element with respect to a given compartment. The most commonly used reference level is the 'background' or 'pre-industrial' concentration. The enrichment factor EF is given by:

$$EF_{\text{background}} = (X/Al)_{\text{sed}} / (X/Al)_{\text{background}}$$

where X/Al refers to the ratio of the concentration of element X to that of Al in the given compartment.

Natural 'background' or 'pre-industrial' levels can be evaluated on a local scale by examining the vertical distribution of the components of interest in the sedimentary column. This approach requires, however, that several favourable conditions are met: steady composition of the natural uncontaminated sediments; knowledge of the physical and biological mixing processes within the sediments; absence of diagenetic processes affecting the vertical distribution of the component of interest. In such cases, grain-size and geochemical normalization permit compensation for the local and temporal variability of the sedimentation processes (cf., retrospective temporal trend monitoring).

These values can be compared to the normalized values obtained for the sediments of a given area. Large departures from these mean values indicate either contamination of the sediment or local mineralization anomalies.

A linear relationship between the concentration of trace constituents and that of the normalization factor has often been observed (Windom *et al.*, 1989). In this case and if the natural geochemical population of a given element in relation to the normalizing factor can be defined, samples with anomalous normalized concentrations are easily detected and may indicate anthropogenic

inputs. According to this method, the slope of the linear regression equation can be used to distinguish the degree of contamination of the sediments in a given area.

When other variables (Fe, Mn, organic matter and carbonates) are used to characterize the sediment, regression analysis of the contaminant concentrations with these variables often yields useful information on the source of contamination and on the mineralogical phase associated with the contaminant.

Compensation for grain size effects on organic contaminants can be achieved by normalization against organic carbon.

A2.4 Measurements required for normalization of whole sediment analyses

For the normalization of contaminant concentrations in whole sediments, it is therefore necessary to measure the following:

Grain size fraction $< 63 \mu\text{m}$
Organic carbon content
Aluminium (Al) content
Iron (Fe) content
Lithium (Li) content
Carbonate content

Table 2 shows a scheme for sediment analysis.

A2.5 Conclusions

The use of granulometric measurements and of component/reference element ratios are practical approaches towards complete normalization of granular and mineral-

ogical variations, and identification of anomalous concentrations of contaminants in sediments. Their use requires that a large amount of good analytical data be collected and specific geochemical conditions be met before all the natural variability is accounted for, and the anomalous contaminant levels can be detected. Anomalous metal levels, however, may not always be attributable to contamination, but rather could easily be a reflection of differences in sediment provenance.

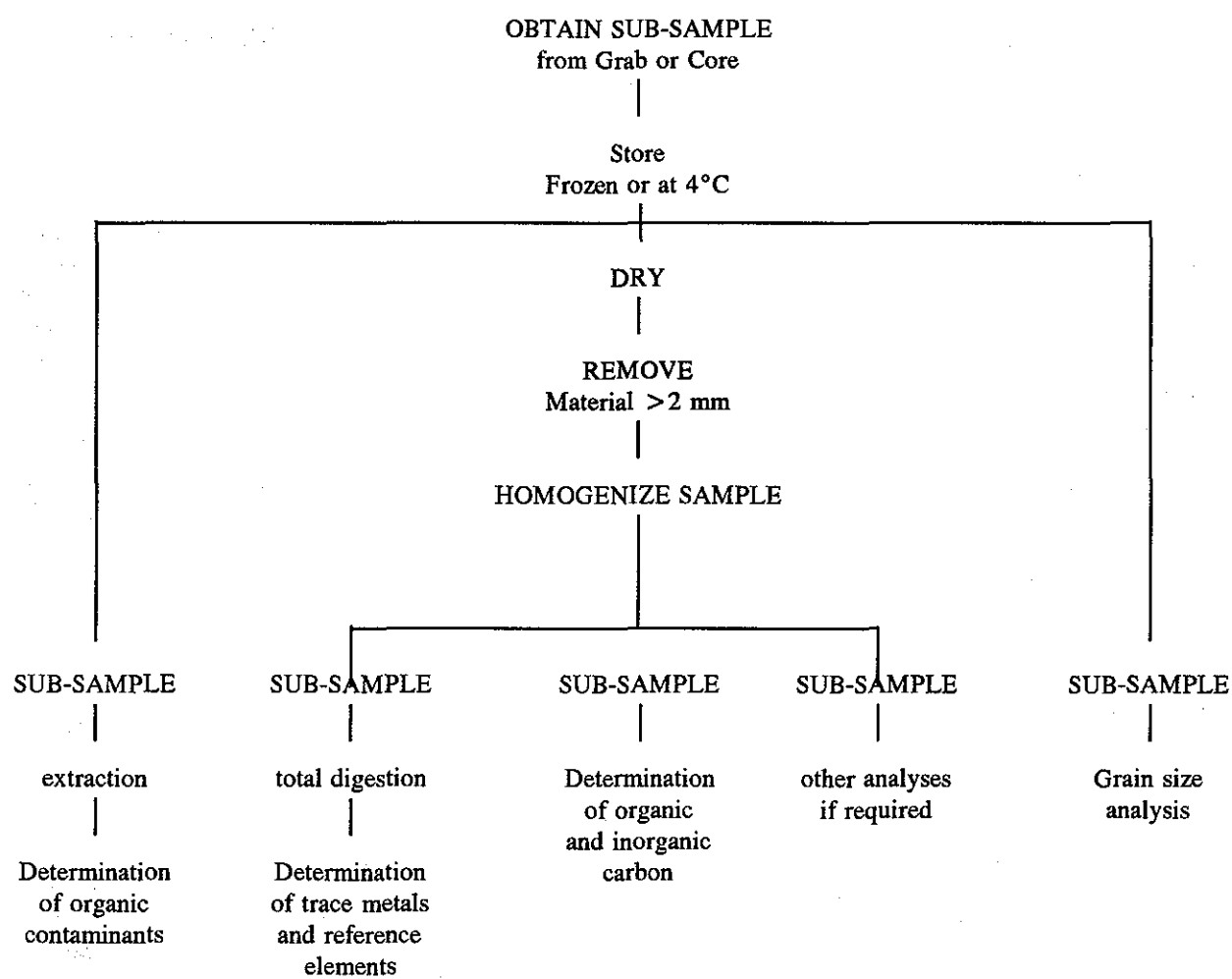
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Table 1 Summary of normalization factors.

Normalization factor	Size (μm)	Indicator	Role
<u>Textural</u>			Determines physical sorting and depositional pattern of metals
Sand	2000-63	Coarse-grained metal-poor minerals/compounds	Usually diluent of trace metal concentrations
Mud	<63	Silt and clay size metal-bearing minerals/compounds	Usually overall concentrator of trace metals
Clay	<2	Metal-rich clay minerals	Usually fine-grained accumulator of trace metals
<u>Chemical</u>			
Si		Amount and distribution of metal-poor quartz	Coarse-grained diluent of contaminants
Al		Al silicates, but used to account for granular variations of metal-rich fine silt and clay size Al-silicates	Chemical tracer of Al-silicates, particularly the clay minerals
Li, Sc		Structurally combined in clay minerals and micas	Tracer of clay minerals, particularly in sediments containing Al-silicates in all size fractions
Organic carbon		Fine-grained organic matter	Tracer of organic contaminants. Sometimes accumulator of trace metals like Hg and Cd
Fe, Mn		Metal-rich silt and clay size Fe-bearing clay minerals, Fe-rich heavy minerals and hydrous Fe and Mn oxides	Chemical tracer for Fe-rich clay fraction. High adsorption capacity of organic and inorganic contaminants
Carbonates		Biogenic marine sediments	Diluent of contaminants. Sometimes accumulate trace metals like Cd and Cu

Table 2 A typical approach for determinations of physical and chemical parameters in marine sediments.



ANNEX 1 (continued)

TECHNICAL ANNEX 3

STATISTICAL ASPECTS OF THE PLANNING OF SEDIMENT MONITORING SURVEYS AND THE INTERPRETATION OF THE RESULTS

A.3.1 Planning

Before undertaking a sediment survey, all participants must agree on the programme to be followed and a planning document must be produced which includes the following information:

- 1) A description of the objectives of the study and the questions that it should answer.
- 2) A description of the sedimentary environment and the population which would ideally be sampled (e.g., surface samples from all sediment types in the North Sea, all collected at one time).
- 3) A description of the population which will actually be sampled bearing in mind the practical constraints on sampling (e.g., surface sediment samples from sands, muddy sands and muds in the North Sea at various times over a two-year period).
- 4) If possible, information about the statistical distribution of variables of interest (e.g., concentrations of contaminant x are Normally distributed with parameters y and z) and the sources of their variance (e.g., factors in the field which vary in time and/or space, the rate of change of any input terms and the sedimentation rate). It must be noted that in many cases detailed information may not be available, but as much information as possible must be used to provide a basis for survey design.
- 5) A description of the sampling unit and sampling device (e.g., surface 0–1 cm of 0.1 m² Day grab sample).
- 6) The analytical method to be used, including its variance (e.g., total digestion of whole sediments).
- 7) The normalization method to be used (e.g., chlorobiphenyl/carbon ratios, metal/aluminium ratios).
- 8) The desired final product (e.g., contour maps, 'bubble plots').

A.3.2 Background references

The following list of references gives information which may be of help in terms of the statistical aspects of designing a monitoring programme.

The particular topics covered are:

- a) A model describing the influence of the input flux, the sedimentation rate, mixing depth, and mixing coefficient on the concentration at a specific depth in the sediment, and on the statistical 'detection limit' for a trend (Kelly *et al.*, 1992; Larsen and Jensen, 1989).
- b) The number of samples needed per location to be able to distinguish between locations, depending on 'field' and analytical variance, and the pooling of samples (Krumgalz *et al.*, 1989).
- c) Trend detection – the chance of detecting a trend in a certain period at a certain (statistical) reliability, as a function of the frequency and variance (Lettermaier, 1976, 1978).

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TECHNICAL ANNEX 4

**ANALYTICAL QUALITY ASSURANCE IN THE PLANNING STAGE OF
SEDIMENT MONITORING PROGRAMMES AND ASSESSMENT**

It is vitally important for the success of any coordinated monitoring or assessment programme that the analytical performance of the participating laboratories matches the needs of the programme. For some contaminants and supporting variables, routine analytical methods are sufficiently established so as to be widely available and capable of providing data to a high standard. In other cases, methods are less firmly established; they may show greater differences in performance characteristics between laboratories, and may only be available in a limited number of laboratories. In both cases, but particularly the latter, it is necessary to ensure that laboratories participating in a coordinated monitoring programme know what is expected of them in terms of analytical performance, and are able to demonstrate their ability to achieve this level of performance.

To address this requirement, a system of actions and exchanges is required between the planning (management) level of a programme, the technical level, and the individual laboratories executing that programme. The planning and technical levels of the process are within the structures of the coordinating body (e.g., the Joint Monitoring Group of the Oslo and Paris Commissions), while the executing laboratories are necessarily outside it, but may be represented within it.

It has been clearly established that a substantial preparatory period is required between the initial formulation of the need for a programme and its execution. At an early stage, the objectives, design, and outputs of the programme should be clearly defined by the planning group (although the details of design will require some exchanges with the technical group). These statements should cover, among other matters, the location of the programme, a range of time-related factors (dates of execution, rates of change of critical environmental variables, training periods, etc.), the analyses required, and the sources of the funding required for both the planning and technical development stages, and the execution, evaluation, and reporting stages.

These specifications should then be passed to a technical advisory body within the coordinating system. This body will undertake a desk technical feasibility assessment. In particular, this body will define the minimum performance characteristics of the analytical methods necessary for the execution of the programme and the achievement of its objectives. The performance characteristics may be

defined in various ways, probably including all or some of such criteria as the accuracy, precision, and limit of detection or quantitation of the methods. If the technical body considers that it is not feasible to achieve the required performance, it should report back to the planning group, with a view to a redefinition of the programme or its objectives.

Once performance criteria have been established, it should be a matter of policy that laboratories will not be permitted to participate in the programme unless they have demonstrated to the satisfaction of the technical group that they can achieve these performance standards. This group should consider and define the types of evidence of the standard of performance that it would consider acceptable. Criteria might include participation in previous intercomparison exercises, evidence from laboratory control charts of analyses of reference materials, or intercomparisons with one or more recognized expert laboratories. In some cases, it may be necessary for the technical group to organize (or request another recognized body to organize) an intercomparison exercise for laboratories wishing to participate in the programme, but which cannot provide satisfactory evidence from other sources.

Once an appropriate time interval has passed, the technical group should review the evidence presented to it, and prepare a list of those laboratories which have presented acceptable evidence of analytical performance. Data from other laboratories which have not been so listed should not be accepted as contributing to the monitoring programme. However, it would be helpful to these laboratories if the technical group could make available to them information on satisfactory current analytical practice, as employed in the laboratories which were assessed as acceptable, or provide other appropriate reliable technical advice. In this way, the unsuccessful laboratories might be able to review their procedures and subsequently improve their performance to a level that would permit their re-application for acceptance as participants in the programme.

The above assessment of laboratory performance prior to the commencement of the sampling programme does not detract in any way from the need to adopt appropriate rigorous quality assurance procedures during the execution of the programme.

ANNEX 2

PROPOSED COORDINATED MEASUREMENTS OF BIOLOGICAL EFFECTS AND ASSOCIATED SEDIMENTOLOGICAL PARAMETERS

Background information relevant to coordinated measurements of chemical contaminants and biological effects in marine sediments is contained in a detailed report on the characteristics of sediments which influence contaminant exposure to marine organisms, and methods for their quantification (Anon., 1992). This report was prepared by the Study Group on the Biological Significance of Contaminants in Marine Sediments at its 1992 meeting. The report contains detailed appendices which identify and describe the factors controlling the bioavailability of heavy metals and organic contaminants in sediments.

The report provides valuable overviews of a general nature on the characteristics of sediments that should be considered in the interpretation of biological effects data related to sediment quality. This report should be taken, therefore, as the basis for more detailed considerations of the linkages that should be established between specific biological effects measurements and sedimentological data.

The following biological effects techniques have been identified by the Working Group on the Biological Effects of Contaminants (WGBEC) as currently ready for application in contaminant monitoring programmes:

- Benthic community analysis,
- EROD activity in dab liver,
- Oyster embryo bioassay, and
- Scope-for-growth in mussels.

However, only two of these techniques have the potential for application to sediment assays.

Other techniques which may be valuable in the future are:

- Metallothionein analysis,
- Acetylcholinesterase inhibition, and
- Fish liver pathology, especially the incidence of liver tumours.

Of the techniques mentioned, the oyster embryo bioassay (a water column bioassay) and scope-for-growth are not applicable to the measurement of effects in sediments. Whole sediment bioassays should also be considered as these are likely to replace the sediment elutriate test.

The chemical analysis of sediments is necessary to accompany each biological effects measurement technique listed below. In the case of fish as the target organism, chemical analysis of the sediment should be conducted only in the top 2 cm on a whole sediment basis.

A number of research requirements are also identified which reflect the interactions of organisms and sediment leading to observed biological effects. The primary need is for additional controlled experimental work rather than further field surveys.

1 EROD activity in flatfish liver

EROD (ethoxyresorufin-O-deethylase) in fish liver represents an environmentally inducible monooxygenase enzyme system which plays a major role in the metabolism of many organic xenobiotics. EROD induction is a sensitive adaptive response by the fish which has been shown to precede more deleterious pathological responses. The measurement is selective for aromatic compounds with a planar configuration. The presence of high concentrations of contaminants, however, may result in an inhibition of EROD activity. In terms of whether chemical analytical measurements are more appropriately carried out in the fish (liver) or in the sediment, it is indicated that for those contaminants not readily metabolized, measurement in liver is more appropriate.

Analytical requirements in fish liver or sediments:

Aromatic hydrocarbons, especially polyaromatics and halogenated benzenes;

CBs (especially planar);

Dioxins;

Benzofurans.

Physical and sedimentological measurements:

Temperature;

Total organic carbon.

Research requirements:

Experimental determinations of concentration response curves for EROD in fish liver are required for many organic contaminants;

Studies of exposure via natural routes at environmentally realistic concentrations;

Variability in induction of EROD due to natural causes, e.g., maturation cycles;

Understanding of inhibitory effects at higher exposure concentrations;

Routine analytical methodology to be developed for many of the chemical determinands.

2 Metallothionein in flatfish liver/gills and possibly invertebrates

Metallothionein is an environmentally induced protein which selectively binds copper, cadmium, and zinc. The highest concentrations of metallothionein are found in the liver, but this protein is also present in other tissues. Measurements of tissue concentrations of copper, cadmium, and zinc are essential.

Analytical requirements in sediments:

Measurements of copper, cadmium, and zinc.

Physical and sedimentological measurements:

Total organic carbon;

Redox.

Research requirements:

Concentrations of metals in interstitial water;

Importance of route of uptake of the metals from food and water by flatfish or invertebrates;

Studies of metallothionein induction in invertebrates;

Bioavailability of copper, cadmium, and zinc in sediments.

3 Acetylcholinesterase inhibition in flatfish brain/muscle, invertebrate tissues and whole animals

Acetylcholinesterase (AChE) is an enzyme responsible for the degradation of the neurotransmitter acetylcholine which is sensitive to the presence of organophosphates. The enzyme can be measured in a variety of tissues in both invertebrates and fish.

Analytical requirements in sediments:

Organophosphorus compounds of industrial (triaryl-phosphates) and agricultural (pesticides) applications;

Carbamates;

Chlorobiphenyls (CBs) (especially the diortho-substituted isomers).

Physical and sedimentological measurements:

Total organic carbon.

Research requirements:

Dose/response relationships of organophosphates to AChE inhibition exhibited in target organisms;

Development of analytical methodology, possibly by adaptation from soil analyses, e.g., for carbamates and organophosphorus compounds;

Understanding of organophosphate degradation rates and persistence in the marine environment.

4 Fish disease in flatfish, confined to the development of liver tumours and pathology

The presence of tumour disease in liver and the occurrence of histopathological changes in the liver of flatfish have been proposed as good indicators of the biological effects of contaminants.

Analytical requirements in sediments:

Polycyclic aromatic hydrocarbons (PAHs);

Dioxins and benzofurans;

Planar CBs;

Other carcinogens.

Physical and sedimentological measurements:

Total organic carbon.

Research requirements:

Research into tools to give a more rapid assessment of steps leading to tumour formation.

5 Benthic community structure

Changes in benthic community structure have been used extensively in studies of the effects of point-source discharges.

Analytical requirements:

Since the measurement of stress in community structure is mainly utilized on gradients from point-source discharges, the analytical requirements will be determined by the predominant or representative contaminants in the discharge.

Physical and sedimentological measurements:

Grain size distribution;
Total organic carbon;
Redox;
Temperature;
Carbon/nitrogen ratio;
O₂ and H₂S in overlying water;
Sediment accumulation rate.

Research requirements:

Investigation of relative sensitivity of different benthic species or larger groups to contaminants;
Investigation of linkages between benthic faunal data and sediment geochemical data along contaminant gradients;
Investigation of the sensitivity of faunal indices as indicators of contaminant stress.

6 Whole sediment bioassays

Sediment bioassays have a wide range of applications from the assessment of the gross toxicity of dredged material to more subtle effects in sediments from the field. There are a suite of endpoints used to assess toxicity ranging from mortality to effects on growth and behaviour using acute or chronic time scales. Important criteria of the species selected for testing are that they live in and feed on the sediment. Broadly, sediment bioassays will be used:

- 1) to assess the toxicity of materials to be disposed at sea, e.g., dredged material;
- 2) to assess sediment quality on gradients away from point-source discharges; and
- 3) as a general measure of sediment quality.

Analytical requirements:

These are driven mainly by the particular application. If used to measure effects from point sources, then the major contaminant in the source would be measured. If used to assess the toxicity of a material to be disposed of at sea, then the sediment bioassay would provide an initial screening so that chemical measurements would only be carried out if the material showed signs of toxicity. For wider studies

of sediment quality, chemical measurements are not a necessary requirement but are useful for interpreting and explaining any observed effects.

Physical and sedimentological measurements:

Grain size distribution;
Total organic carbon;
Redox;
Ammonia in overlying water in static systems.

Research requirements:

The development of these assays is an on-going and active research field.

It is clear that whole sediment bioassays are robust techniques and offer the advantage of integrating exposure to the entire range of contaminants present in a sediment. Research and development of whole sediment tests are of importance and should focus on the development of sub-lethal endpoints, e.g., growth and reproduction, and should include infaunal and fish species.

Time Scales of the Biological Responses Observed

The time scales over which some of these biological responses occur may have implications for interpreting the chemical data. In many ways, the time scale of response is determined by the level of exposure to contaminants, and the nature of the response. This should be borne in mind when designing joint programmes.

Anon., 1992. Report of the Study Group on the Biological Significance of Contaminants in Marine Sediments. ICES, Doc. C.M.1992/Poll:7.

Table 1 Response times for biological effects measurements.

Biological effects measure	Time scale of response
EROD	days
Metallothionein	days
AChE	days or less
Fish disease	months/years
Benthic community analysis	
- impact	weeks/months
- recovery	years
Whole sediment bioassay	Not applicable

ANNEX 3

SUMMARY OF THE REPORT OF THE ICES WORKSHOP ON THE DISTRIBUTION AND SOURCES OF PATHOGENS IN MARINE MAMMALS

The Workshop on the Distribution and Sources of Pathogens in Marine Mammals was held in Cambridge, UK on 23 to 26 March 1993. A summary of the report of this Workshop is given below.

1 KNOWN PATHOGENS OF MARINE MAMMALS

The Workshop reviewed the known pathogens of marine mammals under two headings:

- 1) Microparasites, including all viruses, mycoplasmas, bacteria, protozoa, and fungi. The toxins produced by certain algae were also included in this category.
- 2) Macroparasites, including all metazoan parasites, such as digeneans, nematodes, and arthropods.

Microparasites

Viruses - Viruses which are known to cause large-scale mortality are members of the orthomyxoviridae and the paramyxoviridae (e.g., the phocid distemper virus).

Bacteria - A wide range of bacteria can be cultured from healthy, sick and dead marine mammals of all ages. In European seals, *Streptococcus* spp are generally the most common organisms found. *Corynebacteria* are also very common. Mycoplasmas are known to occur in marine mammals and were detected in 30% of the seals found dead in the Wadden Sea during the 1988 phocid distemper epidemic. A mycoplasma has recently been identified as the cause of the disease 'seal finger' in humans.

Although in many cases a particular species of bacteria could be identified as the ultimate cause of death of a marine mammal, they were generally considered to be secondary invaders of animals which were already sick or injured.

Fungi - A number of fungi have been isolated from marine mammals, but their pathogenicity is often unclear.

Toxin-producing algae - There have been a number of incidents in waters off the coast of the USA where toxins produced by algae have been associated with mortalities of marine mammals. Algal toxins such as

brevetoxins and saxitoxin have been found in fish taken from the stomachs of dead cetaceans.

Protozoa - Toxoplasmosis has been reported in a variety of marine mammals.

Macroparasites

A wide range of macroparasites have been detected in marine mammals. Some are highly host specific, while others are found in many species. In general, the effects of macroparasites are not fatal but, for a number of species, there is direct or indirect evidence that they may be a significant component of natural mortality.

2 POTENTIAL PATHOGENS OF MARINE MAMMALS

Anthropogenic Pathogens

Marine mammals are most likely to come into contact with anthropogenically derived pathogens from the discharge of untreated human sewage or effluent from facilities which contain domestic animals. Free-ranging individuals show no overt signs of disease, but observations in captivity indicate that infection can be fatal. The Workshop noted that *Salmonella* infection might have a serious effect on marine mammals.

Other Pathogens

The greatest threat to marine mammal populations from pathogens is likely to come from the introduction of a novel pathogen into a naive population (i.e., a population not previously exposed to that pathogen). A number of human activities can increase the risk of such introductions. The most obvious is the increase in international and intercontinental movements of wild and domestic animals. There are also risks from the rescue, rehabilitation, and release of sick, vagrant marine mammals. It is important that rehabilitation centres are professionally run with adequate quarantine facilities to ensure that vagrant animals cannot come into contact with other species which may be a source of novel pathogens.

Human activities may also have indirect effects on the behaviour of marine mammals which can increase their exposure to novel pathogens. Changes in the composition of fish stocks are sometimes a consequence of high

fishing mortality. This could lead to changes in marine mammal diet and thus exposure to novel toxins.

3 THE ROLE OF CONTRIBUTORY FACTORS

Morbilliviruses were the primary cause of the recent mass mortalities of marine mammals in Europe. These viruses are known to cause high levels of mortality, especially when they are introduced into naive populations. However, in view of claims that additional contributory factors may have led to higher mortality or triggered the disease outbreak, the Workshop reviewed information on the potential role of a number of factors.

Contaminants - A number of environmental contaminants (particularly organochlorine compounds and certain heavy metals) are known to have an immunosuppressive effect on laboratory animals. Organochlorines are preferentially associated with lipids and thus occur in particularly high concentrations in the blubber of marine mammals, but the evidence for a causal relationship, or compounding effect, between high contaminant levels and susceptibility to disease is inconclusive. After reviewing the results of recent experiments on the effects of consumption of organochlorine-contaminated fish on the immune systems of seals, the Workshop concluded that the evidence linking high contaminant burdens and resistance to infection in seals was still inconclusive.

Other microparasites - Some microparasites, particularly the morbilliviruses, are known to have a strong immunosuppressive effect. This could allow other parasites to establish themselves and ultimately kill an animal.

Macroparasites - Very high burdens of macroparasites are sometimes found in individual marine mammals. These macroparasites may reduce the functional capacity of the relevant organ (such as the lungs or gastrointestinal tract), but the infected animals are often in apparently good condition.

Body condition and food availability - Starvation and malnutrition can affect disease susceptibility. The Workshop concluded that body condition on its own was unlikely to affect the susceptibility of individual animals to virus infection, but poor body condition may encourage the proliferation of pre-existing infections.

Genetics - Although it is widely accepted that susceptibility to infection must have some genetic component, there is limited evidence of this for wild animal populations.

Climate - The Workshop noted that climate change could have a number of influences on the effect of

pathogens on marine mammals. Climate changes will affect behaviour, and this may also affect the transmission rates of some pathogens. For example, ringed seals in the Baltic Sea normally haul out in a widely dispersed pattern on spring sea ice, but in recent years ice cover has been very limited and there is a much higher density of seals on the haul-out areas, thus increasing the contact rate between individuals. Climate change is also likely to lead to a change in the distribution of pathogens and their hosts.

4 RISKS OF FUTURE OUTBREAKS OF INFECTIOUS DISEASE

Pathogens likely to cause outbreaks

The Workshop considered that the greatest risk of epizootic disease outbreaks in marine mammal populations was likely to come from viruses. The agents which are most likely to cause mass mortality are the morbilliviruses and influenza viruses.

Populations at risk

The Workshop concluded that the most vulnerable populations were those which might be exposed to novel pathogens or to pathogens which remained endemic within populations and caused episodic outbreaks when the number of susceptible animals rose above some critical level. Theoretical mathematical models of the epidemiology of morbillivirus infections predict that the number of infective individuals falls to very low levels in the post-epidemic period. However, there is evidence that some pathogens may persist in marine mammal populations that are smaller than predicted.

Simple epidemiological models suggest that phocid distemper virus should have disappeared from northern European seal populations soon after 1988. However, up to 50% of the seals born since 1988 which have been examined in the UK, The Netherlands and Sweden had significant levels of actively acquired (i.e., non-maternal) antibodies to morbillivirus. This implies that the virus is still circulating. The long-term consequences of this situation for population dynamics are unclear at present, but one consequence could be that the number of susceptible animals in the population will build up more slowly than expected, thus increasing the time between recurrent outbreaks of mortality. In the medium term, although harbour seal populations in the Wadden Sea and Kattegat/Skagerrak area suffered a mortality of around 60% in 1988, they are predicted to attain pre-epidemic levels by 1995 to 1997.

Action to reduce the risk for endangered and threatened populations

Rehabilitated marine mammals are a potential source of novel pathogens. The Workshop recommended that rehabilitation centres in general, but especially those operating within the range of any of the populations of endangered marine mammal species, should have a well-defined protocol for evaluating the risks of introducing novel pathogens. As a minimum, this should include a comprehensive disease screening programme and consultations with experts on infectious diseases of wildlife, and marine mammals in particular.

5 RECENT MASS MORTALITIES

The Workshop had been requested to draw up a protocol for the study of future disease outbreaks among marine

mammals. Although recognizing the need for a well-defined approach to future mass mortalities, the Workshop did not believe that a single specific protocol could be developed to address this issue. Rather, a more generalized approach was recommended.

The Workshop recognized that any protocol for dealing with future mortalities must explicitly take account of the large amount of media interest in the incident and the fact that initial reports are likely to be interpreted from a very specific viewpoint.

On the basis of its consideration of this topic, the Workshop proposed that working groups be established to develop standard protocols and methods on the following topics: (1) pathology and medicine, (2) infectious diseases, (3) toxicology, and (4) ecology. Funding will be required to conduct this work.

ANNEX 4

ACME/ACMP ADVICE ON A TOPIC BASIS FOR THE YEARS 1993 - 1982

Numbers in the table refer to sections of the present report and of the ACMP reports from 1992 to 1984 and to paragraphs in the ACMP reports from 1983 and 1982.

*Signifies major advice on that topic.

Topic	Sub-topic	1993	1992	1991	1990	1989	1988	1987	1986	1985	1984	1983	1982
Monitoring	Strategy	5	5.1				*4						
	Multi-purpose				6.2								
	Benthos		⁸ *An.6	8.1	9	*An.1	*7.1	8					
	NSTF-MMP	5.2			9.3	4							
	Sediments - Guidelines	6.1 *An.1				*14			15		*An.2	45-49 An.2	42-45
	Sed. data normalization					*14.1	14.1	15.2	16				
	Sensitivity of sediments						14.6 An.2						
	Metals/sediments						12.6						
	Tissue sample storage												52-55
	Matrix tables - gen. (JMP)				*An.1	*6.1	4						
	" " - organic				6.1								
	Matrix tables - NSTF				6.1								
	Use of seaweeds				6.8	6.3					4.6		

Topic	Sub-topic	1993	1992	1991	1990	1989	1988	1987	1986	1985	1984	1983	1982
Monitoring (ctd.)	CMP Guidelines												23-25
	Review of CMP											16-19	
	JMP Guidelines		13.3						4.5				
	BMP Guidelines	5.3						*12	4.4			90-91	
	AMAP	5.4											
	Trend monitor. Guidelines						5.2	6.2 6.3	*4.1 An.1	4.1	4.5	25-26	22/25
	" " Data analysis	6.2	5.2										
	" " Nutrients	6.3					11.1						
	" " Fish - JMP			5.1	6.2				An.1				
	" " Fish - CMP			5.1	6.5	*6.4	5.1	6.1	An.1	4.2	4.1	25-26	
	" " Mussels			5.1	*An.3			6.3					
	" " Pooling				6.7 An.5	6.4.3		6.2.1					
	" " Precision		*An.1			6.4.4							
	" " Sed. Storage						14.2						
	" " Sea water				6.6			6.5	4.2			27-28	
	Trend Monitor. Sediments						5.3 An.2	6.5	4.2				
	Sediment quality	6.4 An.2											
Biological Effects	Monitoring Strategy									5	5.1	33-37	41 An.3
	Concepts					*7.1							

Topic	Sub-topic	1993	1992	1991	1990	1989	1988	1987	1986	1985	1984	1983	1982
Biological Effects (ctd.)	Methods		6.2	7.2									
	Pathology								5.1				
	Oslo Workshop								5.2				
	A. Dohrn Workshop										5.2		
	Bremerhaven Workshop		6.1	7.1	8.1	7.2	6						
	Fish egg bioassays								5.3				
	Data analysis		6.3										
	" " EROD		*An.2										
	" " Oyster bioassay		*An.2										
Mariculture	Impacts		9.1		*11	10	9	10	10				
	Nutrient inputs Baltic		*9.2		11.1	10.4							
	Drug use control				An.6								
Algal Blooms	Primary production meths.	6.5	11	11.1	12.1		10.2						
	Initiating factors			*11.3	12.2				8				
	Dynamics	10											
	Exceptional algal blooms			11.2					8	*8	9	43-44 *An.1	58
	Phycotoxins/measurements			11.4	12.3		10.1		9				
	<i>C. polyepis</i> bloom					*11.1	10.3						
Regional Assessments	Guidelines				5		*20.1					53-55 An.3	46-51
	Preparation plans					5		21.4		10	10		

Topic	Sub-topic	1993	1992	1991	1990	1989	1988	1987	1986	1985	1984	1983	1982
Regional Assessments (ctd.)	Irish Sea							*21.1	24.2				
	Skagerrak/Kattegat							21.2	24.1				
	North Sea QSR		4	4	5			21.3	23				
	Baltic Sea					5							
	Baltic fish				17.2	17.3							
	Canadian waters			16									
	Nutrient trends - N. Atl.				13	12		16.1					
Baseline Studies	1985 Baseline Fish							*4	4.3.1		4.2 11.4	20-21 86	
	" " " Plans										An.9		
	ICES Baseline TM/SW			6	*7	6.5	13	5	4.3.2	7.2.1	4.3	22-24	
	Contamns. in Baltic sed.	8.1	13.2	14.1	15.1			15.1					
	Contaminants in North Sea sediments		13.1										
	HCH in sea water		14										
Fish Diseases	Relation to pollution			9.1		9.3			5.1	6.2	5.4		34-40
	Survey methods			9.2			8.2				5.3		
	Training guide				10								
	Immunocompetence				10								
	Survey results					9.1	8.1	9	6	6.1			
	Data analysis	9.4	7										
Quality Assurance	Philosophy			13.6									12-18
	Good lab. practice							13.5	11.5	An.1			

Topic	Sub-topic	1993	1992	1991	1990	1989	1988	1987	1986	1985	1984	1983	1982
Quality Assurance (ctd.)	Reference materials	7.11				13.1	12.8		11.4	7.3			
	Oxygen in water				14.5	13.6							
	Hydrocarbons					13.7							
	NSTF				14.7								
	Biological effects techs.	7.1		7.3									
	Sed. quality criteria				15.2	22.2							
	QA of sampling		*12.8										
Intercalibration	Status		An.8	An.3	An.9	An.2	An.3						An.1
	Nomenclature												*4
	Nutrients - sea water	7.8	12.4		14.1	13.4	11.3	16.2	19				
	Lindane (γ -HCH)								*13				
	Specific hydrocarbons							13.3	11.1	7.1.2			
	Hydrocarbon biol. tissue					13.7				7.1.2	6.5	14-15	10
	2-3HC/BT										6.5		
	Hydrocarbons in sediments					13.7							
	Hydrocarbons in sea water					13.7			*12	7.1.2			9
	PAHs - standards		12.2	13.1	14.2	13.2	12.1						
	PCBs/CBs in biota	7.5	12.1	13.2			12.3			7.1.1			
	Organochlorines										6.4	11-13	8
	5/OC/BT										6.4		
	CBs in sediments	7.5		13.2				14	14				
	CBs - standards				14.3	13.3	12.2		14				

Topic	Sub-topic	1993	1992	1991	1990	1989	1988	1987	1986	1985	1984	1983	1982
Intercalibration (ctd.)	TMs in sea water							13.1		7.2.2	6.2	5-8	6-7
	5/TM/SW										6.2	5-8	
	6/TM/SW							13.1					
	TMs in sediments						12.5		11.2.1 11.2.2	7.2.4 7.4	6.3		
	1/TM/MS								11.2.1				
	Baltic sediment intercal.									7.4	11.3	52	
	TMs in biological tissue							13.2		7.2.1	6.1	9-10	5-6
	7/TM/BT							13.2		7.2.1			
	Diss. oxygen in sea water		12.5	13.4	*14.5								
	Methyl Hg in biol. tissue						12.4	13.4					
	TMs in SPM	7.9	12.3	13.3	14.4	13.5	14.4 An.1		18.2	7.2.3			
	Primary production						10.2						
	Oyster embryo bioassay		An.4										
	EROD		12.6 *An.3										
Marine Mammals	Contaminants/effects							*11.1	7.2				
	Seal epidemic 1988				*18	*18.1							
	Baltic seal stocks		*18					11.3	*7.1		12 An.8		
	Populations - N. Atl.	11.1	*18	18									
	Pathogens	11.2 An.3											

Topic	Sub-topic	1993	1992	1991	1990	1989	1988	1987	1986	1985	1984	1983	1982
Classification	Human health				19								
	Hazardous substances		*15										
Overviews	Arsenic							*17.2					
	Mercury					*19.1							
	Zinc										*An.7		
	Lead												*An.5
	HCB				*20.1								
	Lindane (γ -HCH)				*20.1								
	HCBD											*An.5	
	PCDDS and PCDFs					*19.2					An.4		
	PAHs								*20.2				
	Phthalate esters									*13.2			
	Organo-tin and -lead										*An.5		
	Polychlorinated terphenyls										*An.6		
	Octachlorostyrene			20.1									
	Toxaphene											*An.4	
Sand/gravel extraction	Code of Practice				16								
	Effects			15	16	15	15						
	Environ. impact assessment	13											
Methods	SPM in sea water								18.1				
	Trace metals in SPM								18.2				
	Total nitrogen								19.4				

Topic	Sub-topic	1993	1992	1991	1990	1989	1988	1987	1986	1985	1984	1983	1982
Methods (ctd.)	Nutrients in sea water			13.5	*An.4				19				
	Low DO in sea water					13.6							
	Sediment normalization			14.2,3		*14.1	14.1	15.2	16				
	Analysis of total OCs						12.7						
Modelling	Radioactive contaminants in Baltic Sea		*17.1										
	Use in monitoring and assessment		17.2										
Special Topics	Context of ACMP advice				An.7	*21		22	25				
	Patchiness in Baltic Sea					17.1	19.1	20.1	22.1	12.1	11.1	84	85
	Nutr. trends OSPAR area				13	12	11.1	16.1					
	Nutrients & eutrophication	6.3	10	*11.3			10.4						
	Eutrophication in Baltic												*An.7
	Sediments German Bight							An.1			7.4.2	50	
	Sediments Kattegat							An.2					
	Sediments Skagerrak										7.4.1	50	
	Sediments Baltic			14.1	15.1	14.2	19.3	15.1	22.2	12.2	7.4.3	51-52	
	Bioavailability/sediments	6.4 An.2		7.4		7.3			17				
	Release of sed. contams.					14.3							
	Oil spill combatting											*An.6	
	Effects of low-level HCs									*9			
	Oxidation prods. of HCs										14.6		

[illegible]

Topic	Sub-topic	1993	1992	1991	1990	1989	1988	1987	1986	1985	1984	1983	1982
Introductions and Transfers	Code of Practice	12.1											
	Accidental transfers	12.3											
	Genetically modified organisms	12.2											

ANNEX 5

OVERVIEW OF INTERCALIBRATION/INTERCOMPARISON EXERCISES ON CHEMICAL ANALYSES COORDINATED BY ICES

Trace Metals in Biota

First ICES Intercalibration Exercise on Trace Metals in Biological Tissue (1/TM/BT) 1972

Coordinator : G. Topping, United Kingdom.
Sample : Fish flour prepared from commercial fish meal.
Metals analysed : Hg, Cu, Zn, Cd and Pb.
Participation : 8 laboratories from 7 countries around the North Sea.

Results published in Cooperative Research Report No. 80 (1978).

Second ICES Intercalibration Exercise on Trace Metals in Biological Tissue (2/TM/BT) 1973

Coordinator : G. Topping, United Kingdom.
Samples : Fish flour prepared from unskinned muscle of inshore cod and acidified solution of metals.
Metals analysed : Hg, Cu, Zn, Cd and Pb.
Participation : 15 laboratories in 11 countries around the North Sea and the Baltic Sea.

Results published for North Sea laboratories in Cooperative Research Report No. 80 (1978) and for Baltic laboratories in Cooperative Research Report No. 63 (1977).

Third ICES Intercalibration Exercise on Trace Metals in Biological Tissue (3/TM/BT) 1975

Coordinator : G. Topping, United Kingdom.
Samples : (a) Fish flour prepared from skinned muscle of distant water cod and
(b) individual reference standard solutions for each metal.
Metals analysed : Hg, Cu, Zn, Cd and Pb.
Participation : 29 laboratories in 17 ICES member countries.

Results published for North Sea laboratories in Cooperative ICES Research Report No. 80 (1978) and for Baltic laboratories in Cooperative Research Report No. 63 (1977).

Fourth ICES Intercalibration Exercise on Trace Metals in Biological Tissue (4/TM/BT) 1977

Coordinator : G. Topping, United Kingdom.
Samples : Same fish flour as in 3/TM/BT.
Metals analysed : Cd and Pb.
Participation : 12 of the laboratories which had participated in 3/TM/BT.

Results published in Cooperative Research Report No. 108 (1981).

Fifth ICES Intercalibration Exercise on Trace Metals in Biological Tissue
(5/TM/BT) 1978.

Coordinator : G. Topping, United Kingdom.
Samples : (a) Fish flour prepared from skinned muscle of distant water cod and
(b) the same fish flour extracted to produce a lower Hg concentration.
Metals analysed : Hg, Cu, Zn, Cd and Pb.
Participation : 41 laboratories, including those associated with the Joint Monitoring Programme, from all 18 ICES member countries plus several laboratories in Australia.

Results published in Cooperative Research Report No. 108 (1981).

Sixth ICES Intercalibration Exercise on Trace Metals in Biological Tissue
(6/TM/BT) 1979

Coordinator : G. Topping, United Kingdom.
Samples : (a) White meat of edible crab freeze-dried and ground into powder,
(b) commercial fish meal freeze-dried and ground into powder, and
(c) digestive gland of Canadian lobster treated and ground into powder.
Metals analysed : Hg, Cu, Zn, Cd and Pb.
Participation : 52 laboratories from 17 ICES member countries plus Australia.

Results published in Cooperative Research Report No. 111 (1981).

Seventh ICES Intercalibration Exercise on Trace Metals in Biological Tissue - Part 1
(7/TM/BT-1) 1983

Coordinators : S.S. Berman and V.J. Boyko, Canada.
Samples : (a) Lobster hepatopancreas homogenized, spray-dried and acetone extracted,
(b) scallop adductor muscle freeze-dried and ground, and
(c) plaice muscle freeze-dried and ground.
Metals analysed : Hg, Cu, Zn, Cd, As and Pb.
Participation : 51 laboratories from 17 ICES member countries.

Results published in Cooperative Research Report No. 138 (1986).

Seventh ICES Intercalibration Exercise on Trace Metals in Biological Tissue - Part 2
(7/TM/BT-2) 1985

Coordinators : S.S. Berman and V.J. Boyko, Canada.
Samples : (a) Cod liver, acetone-extracted and freeze dried,
(b) dogfish muscle, acetone-extracted and freeze dried,
(c) dogfish liver, acetone-extracted and freeze dried,
(d) whole dogfish, spray-dried, and
(e) *Mytilus edulis* soft material, freeze dried.
Metals analysed : Hg, Cu, Zn, Cd, As and Pb.
Participation : 49 laboratories from 16 ICES member countries.

Results published in ICES Cooperative Research Report No. 189 (1992).

Trace Metals in Sea Water

First ICES Intercalibration Exercise for Trace Metals in Sea Water (1/TM/SW) 1976

Coordinator : P.G.W. Jones, United Kingdom.
Samples : Two standard solutions of metals.
Metals analysed : Hg, Pb, Ni, Co, Fe, Cr, Cu, Cd, Zn and Mn.
Participation : 41 laboratories from 14 ICES member countries.

Results published in Cooperative Research Report No. 125 (1983).

Second ICES Intercalibration Exercise for Trace Metals in Sea Water (2/TM/SW) 1976

Coordinator : J. Olafsson, Iceland.
Samples : Two natural sea water samples and a mercury-spiked sea water sample; all acidified.
Metal analysed : Hg
Participation : 14 laboratories from 10 ICES member countries.

Results published in Cooperative Research Report No. 125 (1983).

Third ICES Intercalibration Exercise for Trace Metals in Sea Water (3/TM/SW) 1977

Coordinator : P.G.W. Jones, United Kingdom.
Samples : Two frozen samples of filtered sea water, one from open North Sea waters and one from coastal waters.
Metals analysed : Co, Fe, Ni, Pb, Cd, Cr, Cu, Mn, and Zn.
Participation : 49 laboratories from 14 ICES member countries.

Results published in Cooperative Research Report No. 125 (1983).

Fourth ICES Intercalibration Exercise for Trace Metals in Sea Water (4/TM/SW) 1978

Coordinators : J.M. Bowers, J. Dalziel, P.A. Yeats, and J.L. Barron, Canada.
Samples : Sets of six sea water samples consisting of four replicate sea water samples, one sample spiked with relevant metals and one dummy. Samples were frozen and acidified.
Metals analysed : Cd, Cu, Mn, Fe, Ni, Pb, and Zn.
Participation : 43 laboratories from 13 ICES member countries plus Monaco.

Results published in Cooperative Research Report No. 105 (1981).

Fifth ICES Intercalibration Exercise for Trace Metals in Sea Water (5/TM/SW) 1982

Coordinators : J.M. Bowers, P.A. Yeats, S.S. Berman, D. Cossa, Canada; C. Alzieu, P. Courau, France.
Samples : (a) sea water samples, filtered and acidified, for analysis of metals except Hg, and
(b) sea water samples, natural and spiked, for analysis of Hg. In addition, 6 laboratories participated in an intercomparison of filtration procedures for coastal sea water samples.
Metals analysed : Cd, Cu, Pb, Zn, Ni, Fe, Mn.
Participation : 59 laboratories from 15 ICES member countries plus Monaco.

Results published in Cooperative Research Report No. 136 (1986).

Exercises on trace metals in sea water coordinated by ICES for
the Joint Monitoring Group of the Oslo and Paris Commissions (1979)

Cadmium

- Coordinator : Y. Thibaud, France.
Samples : (a) Natural sea water,
(b) sea water with a low Cd spike, and
(c) sea water with a high Cd spike.
Participation : 33 laboratories from all 13 member countries of the Oslo and Paris Commissions plus Canada and Monaco.

Mercury

- Coordinator : J. Olafsson, Iceland.
Samples : (a) two samples of natural sea water,
(b) sea water with a low Hg spike, and
(c) sea water with a high Hg spike.
Participation : 36 laboratories from all 13 member countries of the Oslo and Paris Commissions plus Canada, Japan and the United States.

Results of both intercalibration exercises published in Cooperative Research Report No. 110 (1981).

Trace Metals in Marine Sediments

First ICES Intercalibration Exercise for Trace Metals in Marine Sediments
(1/TM/MS) 1984

- Coordinator : D.H. Loring, Canada.
Samples : (a) Estuarine calcareous sandy mud sediment,
(b) harbour sediment, and
(c) Baltic mud sediment "MBSS" (from Baltic Sediment Intercalibration Exercise).
Metals analysed : Cd, Cr, Cu, Ni, Pb and Zn.
Optional metals : Ti, Fe, Mn and Al.
Participation : 40 laboratories from 11 ICES member countries.

Results published in Cooperative Research Report No. 143 (1987).

Baltic Sediment Intercalibration Exercise

Step 1: Intercomparison of Analyses of Reference Samples ABSS and MBSS, 1983.

- Coordinators : L. Brüggmann, German Democratic Republic and L. Niemistö, Finland.
Samples : Two mud sediments ("ABSS" and "MBSS") from different locations, dried and homogenized.
Analytes : Cu, Pb, Zn, Cd, Mn, Fe, Cr, Ni, and organic C.
Optional : Hg, Co, Al, inorganic C, P and N.
Participation : 42 laboratories from 15 ICES member countries.

Additional Exercise on Hg and Cd, 1985.

- Coordinator : A. Jensen, Denmark.
Samples : Six samples, some of which were pre-treated.
Metals analysed : Hg and Cd.
Participation : 8 (Hg) and 10 (Cd) laboratories from 6 countries around the Baltic Sea.

Step 2: Intercomparison of Analyses of Sliced Wet Cores, 1984.

Coordinators : L. Brüggmann, German Democratic Republic, L. Niemistö, Finland, and P. Pheiffer Madsen, Denmark.
Samples : 20 cm cores, sliced into 1-cm slices and deep frozen.
Main analytes : Cu, Cr, Zn, Pb, Mn, Cd, Fe, Ni, Al, Co, Hg, dry matter content, dating by Pb-210 technique.
Optional : Cs-137, organic C, N, P, clay minerals.
Participation : 11 laboratories from 6 countries around the Baltic Sea.

Results for the entire exercise published in Cooperative Research Report No. 147 (1987).

Trace Metals in Suspended Particulate Matter

**First ICES Intercomparison Exercise for Trace Metals in Suspended Particulate Matter
(1/TM/SM) 1984**

Coordinators : Dr P. Yeats and Dr J.A. Dalziel, Canada.
Samples : Suspended particulate matter collected on pre-weighed 0.4 µm Nuclepore filters.
Analytes : Al, Fe, Mn, Zn, Cu, Pb, Ni, and Cd.
Participation : 8 selected laboratories from 7 countries.

Results published in J. Cons. int. Explor. Mer, 43: 272-278 (1987).

**Second ICES Intercomparison Exercise for Trace Metals in Suspended Particulate Matter
(Phase 1)
(2/TM/SM-1) 1989**

Coordinators : H. Hovind and J. Skei, Norway.
Samples : Standard reference materials from the National Research Council of Canada:
(a) PACS-1, (b) MESS-1, and (c) BCSS-1, from which participants should weigh out 1, 3, and 5 mg samples for analysis.
Analytes : Al, Cd, Cr, Cu, Fe, Mn, Ni, Pb, Zn.
Participation : 19 laboratories from 11 countries.

Results published in ICES Cooperative Research Report No. 184 (1992).

**Second ICES Intercomparison Exercise for Trace Metals in Suspended Particulate Matter
(Phase 2)
(2/TM/SM-2) 1993**

Coordinator : Dr C. Pohl, Germany.
Samples : Suspended particulate matter collected on pre-weighed 0.4 µm Nuclepore filters.

Exercise in progress.

Organochlorines in Biological Tissue

First ICES Intercalibration Exercise for Organochlorine Residues in Biological Tissue (1/OC/BT) 1972

Coordinator : A.V. Holden, United Kingdom.
Samples : (a) Natural fish oil and (b) same fish oil spiked with selected organochlorines.
Analytes : pp'-TDE, pp'-DDE, pp'-DDT, PCBs, dieldrin, γ -HCH
Participation : 9 laboratories from 7 ICES member countries.

Results published in ICES Cooperative Research Report No. 80 (1978).

Second ICES Intercalibration Exercise for Organochlorine Residues in Biological Tissue (2/OC/BT) 1974

Coordinator : A.V. Holden, United Kingdom.
Samples : (a) unspiked maize oil and (b) same maize oil spiked with selected organochlorines.
Analytes : pp'-TDE, pp'-DDE, pp'-DDT, PCBs, dieldrin, γ -HCH
Participation : 30 laboratories from 13 ICES member countries.

Results published in Cooperative Research Report No. 80 (1978) and, for Baltic laboratories, in Cooperative Research Report No. 63 (1977).

Third ICES Intercalibration Exercise for Organochlorine Residues in Biological Tissue (3/OC/BT) 1978.

Coordinator : A.V. Holden, United Kingdom.
Sample : Fish oil (capelin).
Analytes : pp'-TDE, pp'-DDE, pp'-DDT, PCBs, dieldrin, α -HCH, γ -HCH.
Participation : 30 laboratories from 16 ICES member countries.

Results published in Cooperative Research Report No. 108 (1978).

Fourth ICES Intercalibration Exercise for Organochlorine Residues in Biological Tissue (4/OC/BT) 1979

Coordinators : J.F. Uthe and C.J. Musial, Canada.
Samples : (a) Fish oil prepared from herring muscle tissue and
(b) same oil spiked with PCBs.
Analytes : PCBs
Participation : 23 laboratories from 12 ICES member countries.

Results published in Cooperative Research Report No. 115 (1982).

Fifth ICES Intercalibration Exercise for
Organochlorine Residues in Biological Tissue
(5/OC/BT) 1982

Coordinators : J.F. Uthe and C.J. Musial, Canada.
Samples : (a) Herring oil and
(b) same oil spiked with individual chlorobiphenyls (CBs).
Analytes : Individual CBs.
Participation : 30 laboratories.

Results published in Cooperative Research Report No. 136 (1986).

Sixth ICES Intercalibration Exercise for
Organochlorine Residues in Biological Tissue
(6/OC/BT) 1983

Coordinators : L. Reutergårdh and K. Litzén, Sweden.
Samples : (a) Standard solution of 12 pure CBs,
(b) solution of an internal standard, and
(c) herring oil.
Analytes : Individual CBs.
Participation : 12 laboratories.

Results published in ICES Cooperative Research Report No. 183 (1992).

ICES/IOC/OSPARCOM Intercomparison Programme on the Analysis of
Chlorobiphenyls in Marine Media - Step 1
(7/OC/BT-1 and 1/OC/MS-1) 1989

Coordinators : J. de Boer (Netherlands) (for ICES), J.C. Duinker (Federal Republic of Germany) (for IOC),
J. Calder (USA) (for JMG).
Samples : (a) Standard solution of 10 CBs in iso-octane,
(b) solution of the 10 CBs in iso-octane at unknown concentration,
(c) internal standard: octachloronaphthalene in iso-octane, and
(d) blank: iso-octane.
Analytes : CB Nos. 28, 31, 52, 101, 105, 118, 138, 153, 180, 189.
Participation : 57 laboratories from 17 countries.

Results published in ICES Cooperative Research Report No. 183 (1992).

ICES/IOC/OSPARCOM Intercomparison Programme on the Analysis of
Chlorobiphenyls in Marine Media - Step 2
(7/OC/BT-2 and 1/OC/MS-2) 1990

Coordinators : J. de Boer (Netherlands) (for ICES), J.C. Duinker (Federal Republic of Germany) (for IOC),
L. Reutergårdh (Sweden), and J.A. Calder (USA) (for JMG).
Samples : (a) standard solution of all CBs (in iso-octane) to be analysed;
(b) seal blubber extract in iso-octane;
(c) sediment extract in iso-octane;
(d) internal standard solution in iso-octane; and
(e) blank (iso-octane).
Analytes : CB Nos. 28, 31, 52, 101, 105, 118, 138, 153, 156, 180.
Participation : 58 laboratories from 16 countries.

Results will be published in early 1994.

ICES/IOC/OSPARCOM Intercomparison Programme on the Analysis of
Chlorobiphenyls in Marine Media - Step 3a
(7/OC/BT-3a and 1/OC/MS-3a) 1991

Coordinator : J. de Boer (Netherlands).
Sample : Certified Reference Material CRM 349 cod liver oil (from the Community Bureau of Reference (BCR) of the European Community).
Analytes : CB Nos. 52, 153, 156.
Participation : 45 laboratories from 15 countries.

Report on results to be published in early 1994.

ICES/IOC/OSPARCOM Intercomparison Programme on the Analysis of
Chlorobiphenyls in Marine Media - Step 3b
(7/OC/BT-3b and 1/OC/MS-3b) 1992

Coordinator : J. de Boer (Netherlands).
Sample : A cleaned and an uncleaned sediment extract; a cleaned and an uncleaned seal blubber extract; a standard solution.
Analytes : CB Nos. 28, 31, 52, 101, 105, 118, 138, 153, 156, 180.
Participation : 46 laboratories from 15 countries.

Report on results to be published in early 1994.

Hydrocarbons in Marine Samples

First ICES Intercomparison Exercise on Petroleum Hydrocarbons in Marine Samples
(1/HC/BT and 1/HC/MS) 1980

Coordinators : R.J. Law and J.E. Portmann, United Kingdom.
Samples : (a) Crude oil standard,
(b) aliphatic fraction of crude oil standard,
(c) marine sediment, and
(d) mussel homogenate.
Analytes : Total hydrocarbons, aliphatic hydrocarbons (nC7-nC33), and several aromatic hydrocarbons.
Participation : 36 laboratories from 12 ICES member countries and Bermuda.

Results published in Cooperative Research Report No. 117 (1982).

ICES/IOC Intercomparison Exercise on Petroleum Hydrocarbons in Biological Tissues
(2/HC/BT) 1984

Coordinators : J.W. Farrington, A.C. Davis, J.B. Livramento, C.H. Clifford, N.M. Frew, A. Knap, United States.
Samples : (a) Three samples of frozen, freeze-dried mussel homogenate,
(b) reagent grade chrysene,
(c) methylene chloride solution of n-alkanes,
(d) methylene chloride solution of aromatic hydrocarbons, and
(e) Arabian Light Crude Oil standard.
Analytes : Aliphatic hydrocarbons (nC15-nC32) and selected aromatic hydrocarbons.
Participation : 38 laboratories from 13 ICES member countries and 12 laboratories from 11 IOC member countries (most, if not all, ICES member countries are also members of IOC).

Results published in Cooperative Research Report No. 141 (1986).

Third ICES Intercomparison Exercise on
Polycyclic Aromatic Hydrocarbons in Biological Tissue
(3/HC/BT) 1984

Coordinators : J.F. Uthe, C.J. Musial, and G.R. Sirota, Canada.
Samples : (a) Acetone powder of lobster digestive gland, and
(b) the oil extracted during the preparation of this powder.
Analytes : 21 selected polycyclic aromatic hydrocarbons.
Participation : 11 laboratories from 7 ICES member countries.

Results published in Cooperative Research Report No. 141 (1986).

Fourth ICES Intercomparison Exercise on
Polycyclic Aromatic Hydrocarbons in Marine Media - Stage 1
(2/HC/MS) (4/HC/BT) 1988-1990

Coordinator : R.J. Law, United Kingdom.
Samples : Solutions of 10 PAHs in acetonitrile (for HPLC analysis), or solutions of 10 PAHs in hexane (for GC analysis).
Analytes : Phenanthrene, fluoranthene, pyrene, benz[a]anthracene, chrysene, benzo[e]pyrene, benzo[a]pyrene, benzo[b]fluoranthene, benzo[ghi]perylene, and indeno[123-cd]pyrene.
Participation : 17 laboratories from 9 countries.

Report on results will be published in early 1994.

Nutrients in Sea Water

Fourth ICES Intercomparison Exercise for Nutrients in Sea Water
(4/NU/SW) 1989

Coordinators : D. Kirkwood (United Kingdom), A. Aminot (France), and M. Pertilä (Finland).
Samples : (a) Natural oceanic water, with no preservatives or pre-treatment,
(b) natural shelf sea water, filtered, bottled in glass and autoclaved, and
(c) sea water depleted in nitrate and phosphate, then filtered and bottled (blanks for nitrate and phosphate).
Analytes : Nitrate + nitrite, phosphate, silicate, nitrite, ammonia, total nitrogen and total phosphorus.
Participation : 68 laboratories from all 18 ICES member countries.

Report on the results published in ICES Cooperative Research Report No. 174 (1991).

Fifth ICES Intercomparison Exercise for Nutrients in Sea Water
(5/NU/SW) 1993

Coordinators : D. Kirkwood (United Kingdom), and A. Aminot (France).
Samples : Six samples of sea water (three for nitrate + nitrite determinations and three for ammonium and phosphate determinations).
Analytes : Nitrate + nitrite, ammonium, phosphate.

Report on the results in preparation.

ANNEX 6

RECENTLY PUBLISHED RELEVANT VOLUMES OF THE ICES COOPERATIVE RESEARCH REPORTS

No.	Title
177	Report of the ICES Advisory Committee on Marine Pollution, 1991
178	A Review of Measurements of Trace Metals in Coastal and Shelf Sea Water Samples Collected by ICES and JMP Laboratories during 1985-1987
180	Review of Contaminants in Baltic Sediments
181	Effects of Harmful Algal Blooms on Mariculture and Marine Fisheries
182	Effects of Extraction of Marine Sediments on Fisheries
183	Report on the Results of the ICES/IOC/OSPARCOM Intercomparison Exercise on the Analysis of Chlorobiphenyl Congeners in Marine Media - Step 1 and the Intercomparison Study of the Determination of CBs in Baltic Herring Oil
184	Report of the Second ICES Intercomparison Exercise on the Determination of Trace Metals in Suspended Particulate Matter
186	Report on the Eighth Dialogue Meeting, 13-14 September 1991
189	ICES Seventh Round Intercalibration for Trace Metals in Biological Tissue, ICES 7/TM/BT (Part 2)
190	Report of the ICES Advisory Committee on Marine Pollution, 1992
194	Atlas of North Sea Fishes

ACRONYMS

AChe	-	Acetylcholinesterase
ADP	-	Automatic Data Processing
AMAP	-	Arctic Monitoring and Assessment Programme
BMP	-	Baltic Monitoring Programme of the Helsinki Commission
CBs	-	Chlorobiphenyls
CMP	-	Cooperative ICES Monitoring Studies Programme
DSP	-	Diarrheic Shellfish Poisoning
EROD	-	Ethoxyresorufin-O-deethylase
GESAMP	-	IMO/FAO/UNESCO/WMO/WHO/IAEA/UN/UNEP Joint Group of Experts on the Scientific Aspects of Marine Pollution
IGOSS	-	Integrated Global Ocean Services System
IOC	-	Intergovernmental Oceanographic Commission
JMG	-	Joint Monitoring Group of the Oslo and Paris Commissions
JMP	-	Joint Monitoring Programme of the Oslo and Paris Commissions
MFO	-	Mixed-function oxidase
MMP	-	Monitoring Master Plan of the North Sea Task Force
NSTF	-	North Sea Task Force
OEB	-	Oyster embryo bioassay
PAH	-	Polycyclic aromatic hydrocarbons
QA	-	Quality assurance
QSR	-	Quality Status Report
SCOR	-	Scientific Committee on Oceanic Research
SPM	-	Suspended particulate matter
UNEP	-	United Nations Environment Programme
WMO	-	World Meteorological Organization (UN)