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ICES/OSPAR STEERING GROUP ON QUALITY ASSURANCE OF BIOLOGICAL MEASUREMENTS RELATED TO EUTROPHICATION EFFECTS

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1 INTRODUCTION

The ICES/OSPAR Steering Group on Quality Assurance of Biological Measurements Related to Eutrophication Effects (SGQAE) arranged its second meeting at the ICES Headquarters in Copenhagen from 17 to 20 February 1998 under the chairmanship of Dr Hubert Rees (UK). A list of participants at the meeting is given in Annex 1.

The Chairman opened the meeting at 10.00 hrs on 17 February, stating that SGQAE is a joint ICES/OSPAR initiative, designed to ensure that work under the new OSPAR Joint Assessment and Monitoring Programme (JAMP) guidelines, for the OSPAR Nutrients Monitoring Programme, is underpinned by adequate quality assurance (QA) procedures. Insufficient attention to the latter, especially in monitoring programmes involving co-operation among member states, could seriously devalue the assessment exercise. For example, inconsistencies between countries in approaches to surveys of the benthic fauna restricted the scope for a combined evaluation of the data in the preparation of the 1993 North Sea Quality Status Report.

The remit of SGQAE, which essentially has a co-ordinating role and is dependent on the 'will' of individual OSPAR member countries to participate, is given in the 1997 report (ICES CM 1997/Env:7, p.1).

At its first (poorly attended) meeting, SGQAE developed a strategy for pursuing the implementation of a QA programme among OSPAR member countries, to cover measurements of chlorophyll *a*, phytoplankton, macrozoobenthos and macrophytobenthos. This was approved by ACME and reproduced in their 1997 report. The ACME Chairman (Mr S. Carlberg) wished to convey to SGQAE members the appreciation of ACME for this. SGQAE will continue to report to ACME in the newly revised ICES committee structure.

SGQAE also spent some time in 1997 on the identification of critical aspects within each biological study area requiring attention from a QA perspective. These were tabulated as Annex 10 to the 1997 report, and provide a reference point for future SGQAE activities.

The terms of reference for the 1998 meeting of the Steering Group, as proposed by the Group (SGQAE 1997 report, Annex 14), were adopted by the ICES Council as ICES C.Res.1997/2:12:11 with only minor editorial amendments, and are as follows:

a) review relevant biological studies in OSPAR participating countries and related QA activities;

b) advise on approaches to the development of laboratory quality assurance manuals [OSPAR 1998/2.1];

c) develop proposals for the conduct of workshops/intercomparison exercises and identify 'expert groups' of individuals to be responsible for their conduct, and to provide advice on follow-up QA issues [OSPAR 1998/2.1];

d) identify the scope for joint initiatives on QA matters between SGQAE and the ICES/HELCOM SGQAB;

e) work with BEWG and WGPE in order to ensure harmonization in the future implementation of JAMP guidelines so that QA procedures are not compromised [OSPAR 1998/2.1];

f) as necessary, explore sources of funding for collaborative QA exercises identified under c) and d), above;

g) further consider the development of QA criteria for assessing the acceptability of data;

h) determine the scope for preparation of appropriate taxonomic lists of species, especially for phytoplankton [OSPAR 1998/2.1].

SGQAE will report to ACME before its June 1998 meeting and to the Baltic, Marine Habitat and Oceanography Committees at the 1998 ICES Annual Science Conference.

2 APPOINTMENT OF RAPPORTEUR

Dr Torgeir Bakke was appointed as Rapporteur for the Steering Group.

3 ADOPTION OF AGENDA

The revised agenda, as shown in Annex 2, was adopted for the meeting. A list of working documents is contained in Annex 3.

4 REVIEW OF RELEVANT BIOLOGICAL STUDIES AND RELATED QA ACTIVITIES BY COUNTRY AND BY DISCIPLINE, ESPECIALLY RECENT AND PLANNED FUTURE PROGRAMMES

As a result of the questionnaire distributed to the OSPAR representatives after the previous meeting (SGQAE 1997 report, Annex 4), the Chairman had received responses from several countries. In addition to these written contributions, the participants reported on relevant studies and activities in their own countries. The contributions are summarized below. It appears that all member countries are reasonably comfortable with the JAMP guidelines in their present state.

4.1 Belgium

Monitoring programmes include chlorophyll *a*, phytoplankton and macrozoobenthos, and details of methodology are provided (Annex 4). Belgium is

currently developing a programme for QA of chlorophyll *a* determinations. For samples taken since 1978, standard methodology has been employed (by the same person) in the analysis of the macrozoobenthos. Belgium is also fully involved in QUASIMEME procedures for nutrients. A detailed proposal was provided concerning 'study and modelling of eutrophication-related changes in coastal planktonic food-webs', which has been approved for funding (1997–2001) by the Belgian authorities.

4.2 Denmark

4.2.1 Eutrophication-related work

An action plan for the aquatic environment was agreed in 1987, and since 1988, a monitoring programme has been carried out in the counties and at a national level. The aim of this programme is to detect the effects of a reduced load of nutrients on the aquatic environment. This monitoring programme is under revision at present and the new programme will include studies of harmful substances.

Apart from the monitoring programme, a wide range of research projects has been financed by the government and other sources.

The programme includes six biological components (four of which fall within the remit of SGQAE): chlorophyll *a*, primary production, phytoplankton, zooplankton, macrozoobenthos and macrophytobenthos.

As an outcome of the revised monitoring programme, new guidelines for the monitoring procedures are to be published. These guidelines will include chapters on QA procedures and the intention is that these procedures will be regularly up-dated. The QA procedures include regular intercalibrations between different laboratories and taxonomic workshops in order to correct species identifications. Furthermore, re-sorting of phytoplankton, zooplankton and macrozoobenthos samples is recommended. The QA procedures are based on the outcome of the work in the relevant sub-groups of the ICES/HELCOM Steering Group on Quality Assurance of Biological Measurements in the Baltic Sea and future suggestions from these groups will be incorporated, where applicable.

4.3 Germany

4.3.1 Eutrophication-related work

Marine Monitoring Programme

Since January 1998, an official German Marine Monitoring Programme of the North Sea and the Baltic Sea (Bund/Laender-Messprogramm Nord- und Ostsee, BLMP), which has been revised in recent years, has been in place. This programme covers comprehensive measurements of a variety of physical and chemical components in different matrices (water/sediment/biota) as well as biological components in the North Sea and in the Baltic. With regard to eutrophication and its biological effects, the monitoring programme in the North Sea covers the following parameters:

- nutrients;
- phytoplankton;
- chlorophyll *a*;
- zooplankton;
- macrozoobenthos;
- macroalgae.

With regard to the previous monitoring programme, the effort to detect spatial distributions has been reduced in favour of time series measurements at fewer stations. This monitoring covers the measurement of nutrient concentrations in relation to temporal/annual variations and their biological effects in terms of planktonic and benthic organisms.

4.3.2 QA activities

In the framework of the national marine monitoring programme for the North Sea and the Baltic Sea (BLMP), a national Working Group on QA has been set up which is responsible for QA activities for the laboratories participating in the BLMP. Since the end of 1996, this group has been divided into a chemical and a biological part. As a first activity, a questionnaire was sent out to laboratories concerning the necessity of ring tests, intercalibration exercises and taxonomic workshops for biological variables. A compilation of the biological parameters measured in the marine monitoring programme under revision has been the basis for further activities. In this context, a programme for biological QA activities has been developed for the next few years giving priority to the parameters phytoplankton, chlorophyll *a* and macrozoobenthos. This programme includes the following objectives:

- *Procedures for the development of an internal QA Management System for laboratories*

These procedures will follow the requirements set up by international standards (e.g., DIN EN 45001 or ISO guide 25). With regard to these standards, a structure for non-standardized procedures/methods, as outlined in Paragraph 5.4.3 of DIN EN 45001, was discussed and transformed for biological purposes.

Documentation of the methods used by the laboratories has been started regarding the determination of phytoplankton biomass, chlorophyll *a*, and soft-bottom macrozoobenthos (species composition, abundance and biomass). It will be continued, including video documentation of the various steps of these methods (e.g., sampling and sample handling at sea, transport and

storage, preparation of samples and laboratory analyses). Initiatives will be taken to prepare a comprehensive taxonomic checklist for phytoplankton species in the North Sea.

- *Co-ordination of external (between-laboratory) QA exercises*

With respect to external QA measurements, ring tests and intercalibration exercises as well as taxonomic workshops have been developed and decided upon for phytoplankton and macrozoobenthos in 1997.

- *Ring tests and intercalibration exercises*

In 1998 various ring tests on phytoplankton, chlorophyll *a* and macrozoobenthos, an intercalibration exercise and interlaboratory cross-checks of samples of macrozoobenthos will be conducted.

- *Taxonomic workshops*

Taxonomic workshops will be conducted to raise the taxonomic level of knowledge, harmonize procedures for the newest taxonomical identification and update the literature used in the national monitoring programme. In 1998, national taxonomic workshops are planned for phytoplankton in spring and autumn (with a focus on toxic algae) and for zoobenthos at the end of March 1998 (with a focus on taxonomic identification of polychaetes in the North Sea and the Baltic Sea).

- *Assessment and validation of biological methods*

A prerequisite for producing correct and reliable monitoring data is the use of validated methods. Therefore, it is essential to validate methods used in the monitoring programme. Because for many of the biological methods used, assessment criteria for validation do not exist at present, the development of such criteria will be the first step for a further assessment.

- *Certified Reference Materials*

As a first step, the German working group dealt with the issue of the production and use of certified reference materials or standards for chlorophyll *a* measurements. This activity will be continued.

- *Data Reporting Formats*

The development of the requirements for data reporting formats for biological data, mainly phytoplankton and macrozoobenthos (for the marine data bank MUDAB), has been considered. Discussion will be continued this year.

4.4 The Netherlands

Information was provided by Dr Wetsteyn (SGQAE 1998/1) on the Dutch national phytoplankton monitoring programme, from which it is clear that, as well as some QA activity at the national level, they also have a strong interest in participation in international intercomparison exercises (see Section 6, below). Further reference to this submission, relating to the preparation of taxonomic lists of phytoplankton species, also appears under Section 9, below.

4.5 Norway

4.5.1 Eutrophication-related work

The eutrophication-related monitoring reported in 1997 (ICES CM 1997/Env: 7) has continued. By the end of 1998, a possible prolongation of the National Coastal Monitoring Programme, in operation since 1990, will be clarified. During the 1997 spring hard-bottom community survey, a methods comparison exercise between Norway and Sweden was conducted; the results from this are not yet available.

Under the auspices of the Norwegian Ministry of Environment, an inter-institutional expert group has prepared two reports assessing the degree of eutrophication impact and the potential vulnerability to eutrophication of the Norwegian Skagerrak and North Sea coastal waters. In this connection, all available physical, chemical and biological data series from the coastline covering pelagic as well as benthic ecosystems have been evaluated from the point of view of seeking trends related to eutrophication. A summary report in English has been prepared (Anon., 1997).

4.5.2 QA activities in 1997

The parallel analyses of chlorophyll *a* within the National Coastal Monitoring Programme were continued in 1997. The Institute of Marine Research finished an in-house procedure (Standard Operating Procedure = 'SOP') on phytoplankton monitoring (in Norwegian). The idea of certifying personnel/institutions for phytoplankton identification and enumeration was put forward and an initiative will be taken in 1998.

A revised version of the QA guidelines for local and regional environmental monitoring around Norwegian offshore fields was ratified by the Norwegian Pollution Control Authority in March 1997. The guidelines contain detailed QA requirements for soft-bottom macrozoobenthos studies, as well as criteria for the selection of laboratories to perform the surveys. Annual expert meetings to address and revise these issues have been institutionalized.

Under the auspices of the Norwegian Ministry of Environment and the Norwegian General Standardizing Body, a committee was established in 1997 to propose a Norwegian standard for quantitative analysis of marine sublittoral soft-bottom benthic fauna. The Pollution Control Authority, the universities, research institutions, and relevant consulting companies are represented on the committee. The proposed standard has been produced in harmony with the Norwegian guidelines for offshore monitoring, the JAMP guidelines for benthos, and the activities of the ICES Benthos Ecology Working Group (BEWG), and a draft is out for public review until 1 March 1998, before it is revised and ratified.

There has been no initiative to prepare a similar Norwegian standard for the analysis of hard-bottom communities. The JAMP guidelines for benthos form the basis for the present and future activities in Norway.

4.6 Portugal

Information was submitted by Dr Cavaco (see Annex 6). Portugal is also operating an advanced eutrophication-related programme for all biological measurements of interest to SGQAE. The work is being carried out by the Institute for Research of Fisheries and of the Sea (IPIMAR). The Institute has participated in a QUASIMEME intercalibration exercise for nutrients, and details are provided of sampling procedures for chlorophyll *a*, phytoplankton, macrophytobenthos, macrozoobenthos (hard- and soft-bottom), though no reference is made to formal QA of these activities. IPIMAR supported the 'critical QA factors' and the 'priority QA actions' mentioned in Tables 4 and 5 of the 1997 SGQAE report. Portugal is interested in participating in international QA exercises if external funding is available to do so.

4.7 Spain

The Instituto Español de Oceanografía (IEO) is conducting several research projects based on the systematic and continuous study of the ocean. The principal goal is to understand the underlying causes of temporal variability of the physical and biological properties and processes in the pelagic ecosystem in the coastal, neritic, and oceanic waters off the Spanish coast, focusing on those factors which influence biological production and could alter ecosystems. This research effort involves 1) time series measurements on several transects along the Spanish coast, and 2) specific studies of the main mesoscale processes and events that take place in Spanish coastal and neritic waters.

This research programme includes seven transect sites around the Spanish coast, four in the OSPAR area and three in the Mediterrancan. These involve an extensive physical, chemical and biological monthly sampling series at each site, with special attention to the sampling and analysis of nutrients, chlorophyll *a*, and phytoplanktonic species. Depending on the transect, the time series extend from 1988 (La Coruña), 1991 (Santander), and 1994 (Vigo and Asturias) in the OSPAR area. The work is also related to Spanish sampling effort based at Vigo concerned with pollution monitoring and harmful algal blooms.

In order to ensure that the data are of high quality, and to make sure that all data are processed in a similar manner, sampling is being carried out according to JGOFS protocols where possible, and/or following IEO guidelines. In the case of the analysis of nutrients, all the laboratories of the IEO where nutrients are being analysed have participated in the QUASIMEME exercise during recent years.

In response to the need to deal effectively with the large and varied volumes of data that have been accumulated as a result of the above-mentioned activities, the IEO has developed a database that serves as an archive of the data and as a tool for data analysis and elaboration of reports. In the case of hydrographical parameters, an indication of quality control can be added to the database if calibration has been applied to the data. However, this is not completely solved in the case of biological data, and the best approach to a data quality control is that obtained by means of metadata. With this objective and for unifying the type of information associated with IEO field and monitoring projects, a Data Reporting Format was created, which is of general use. The Data Reporting Format not only provides the results of the analyses and observations as well as the essential metadata, but also plays a role in data quality control.

Additional data on nutrients, chlorophyll *a*, and phytoplanktonic species are available from local and regional agencies maintained by the Comunidades Autónomas; these sources of information are especially important in the Vasque Country, Galicia and Andalucia. However, the QA from these data should be checked before they are included in an OSPAR database. With the aim of helping these agencies to report their data to OSPAR and to encourage them to implement JAMP in their coastal territory, the IEO has prepared a coordination plan in which IEO offers support to assist them in QA, in the evaluation of the acceptability of data, as well as in other logistic details (e.g., to have access to the IEO database).

4.8 Sweden

Information was provided by Dr S. Evans (Annex 5) and it is evident that there is a major commitment to eutrophication-related work. QA guidelines developed by OSPAR MON, HELCOM EC MON, QUASIMEME, ICES/HELCOM SGQAC and SGQAB are all implemented in the Swedish National Monitoring Programme. The quality policy associated with this programme covers not only technical aspects of sampling and analysis, but also the relevance, reliability and

accessibility of monitoring programmes. Sweden also has a sophisticated data management system.

4.9 United Kingdom

Activities described in the 1997 SGQAE report, including those relating to nutrient and phytoplankton studies within and around major estuaries are continuing, and are not repeated here. A report of the outcome of UK-wide sampling for the 'National Monitoring Programme' (including, *inter alia*, sampling for nutrients, chlorophyll *a* and the benthic macrofauna) will be produced in 1998. The following account concentrates on relevant activities in the sphere of benthos monitoring.

4.9.1 National Marine Biological AQC Scheme

The structure and activities of the NMBAQC were provided at the 1997 meeting (see 1997 SGQAE report, Annex 7A), and the work of the group is continuing into its fourth year. Its *raison d'etre* is QA of benthos studies for the UK's National Monitoring Programme, components of which are also designed to satisfy the requirements of international monitoring and assessment programmes. The scheme, which relies on funding from individual participating laboratories, concentrates on ring tests of identification proficiency for selected species, evaluation of performance in the analysis of 'whole samples' provided from a given location by the contractor, re-analysis of 'own samples', i.e., those taken by individual laboratories in their locality of interest and, finally, comparisons of particle size analyses of reference samples. About 25 laboratories participate, and the results are summarised in annual reports.

Key conclusions from the 1996/1997 reporting year include:

1) overall laboratory performance was relatively good but inconsistent (see Section 10, below);
2) particle size analyses showed high consistency within laboratories, but systematic differences between them, associated with the methods used (especially laser-sizing versus wet-seiving);
3) biomass estimates for individual species were variable between laboratories, and indicated the need for adoption of a standardised approach and a reporting format;
4) the importance of developing 'in-house' reference collections of identified species was highlighted;
5) taxonomic problems predictably recurred with certain groups, e.g., small molluscs, syllids and certain amphipod groups, indicating the need for more targetted ring tests;
6) extraction efficiency during sample sorting was generally good for the number of individuals present but, in some instances, was unacceptably poor in accounting for the numbers of taxa present;
7) there was still some inconsistency in the approach to handling headless and partial specimens, indicating the requirement for a written protocol;
8) the failure of some laboratories to submit results on time, though often reflecting a resource problem, can impede overall progress of the scheme, and required corrective action;
9) the practise of some regulatory laboratories to sub-contract analyses to commercial consultants can, inevitably, lead to complications in any 'certification' schemes currently under consideration;
10) tests involving re-analysis of samples taken from the areas of operation of individual laboratories, rather than tests of competency based on material from many sources, were favoured by a number of participants, especially those with only a limited geographical area of responsibility.

4.9.2 Field and laboratory methods workshop, March 1997

This workshop took place under NMBAQC auspices in the Humber estuary, where intertidal sand and mud sampling techniques, and a range of subtidal methods, were evaluated. All aspects of these procedures, conducted by several laboratories using their own equipment, including collection, sieving and preservation techniques, as well as some attention to laboratory sorting of material, were evaluated. Collected samples have since been analysed by a single contractor and a report and training video are in draft.

The workshop revealed the variety of practises currently employed in field processing of collected samples. Variations in results arising from analyses of five benthic samples taken by each laboratory from a single station are shown in Annex 7 (Figure 7A.1) and, overall, reveal an encouraging degree of consistency. Variability between replicates is illustrated for one station in the multi-dimensional scaling (MDS) plot and the cluster analysis in Annex 7 (Figures 7A.2 and 7A.3). There was little evidence of marked systematic differences between laboratories. The type of grab (Day, 'VanDay' and Van Veen) did not appear to be influential in explaining such differences as were encountered.

In the laboratory, an exercise involving the sub-sampling of material for density estimates of abundant species was also revealing for the variety of methods employed (Annex 7, Figures 7A.4a–c). The outcome (Annex 7, Figure 7A.5) indicated deficiencies in a number of these methods, and hence the future need to standardise on efficient—and cost-effective—approaches. Systematic differences were also evident in the outcome of an exercise requiring the determination of wet-weight biomass for a selection of species. This applied especially to soft-bodied animals, and errors appear to be largely associated with approaches to the drying of specimens.

An NMBAQC workshop concerned with effective sampling design for monitoring programmes is planned for 1998.

4.9.3 UK marine Special Areas of Conservation (SAC) monitoring workshops

Two SAC monitoring workshops were held in 1997 by the UK Joint Nature Conservation Committee, with EU support, with special emphasis on intertidal and shallow subtidal sampling procedures, including the use of divers. A diverse range of methods was considered, a number of which raise important QA issues, and a summary of the outcome is given in Annex 8 (Table A, Monitoring objective: to detect changes in habitat or biotope diversity or extent; and Table B, Monitoring objective: to detect changes in species diversity and abundance), reproduced from the workshop report (Worsfold and Dyer, 1997).

These workshops form part of wider efforts within the UK and other EU states to develop coherent monitoring and management strategies for marine SACs established under the EC Habitats Directive. This will include the production of a comprehensive Handbook for such monitoring, currently in draft, in which QA issues will be addressed. A European workshop on SAC monitoring issues is planned for 1998.

4.9.4 Workshop on methods for sampling and recording of the epifauna from 2-m beam trawls

This workshop was held on the Danish research vessel 'Dana' in the North Sea in October 1997, as part of an ongoing EC-funded project on 'Monitoring biodiversity in the North Sea using groundfish surveys', and co-ordinated by the UK. It included evaluation of acoustic methods for recording variability in habitat type in the vicinity of trawl tows, trials of devices to measure the distance during active towing, protocols for trawl sampling and processing of the catch, and methodology for species identification and quantification. A draft SOP for 2-m trawl sampling has been produced. Consistency in procedures is essential to ensure that data from co-operating countries are compatible.

4.10 Nordic Countries

The Nordic intiative to prepare an overall guidance on QA in environmental monitoring (atmospheric, terrestrial, freshwater and marine systems), coordinated by the Swedish Environmental Protection Agency, has been completed (cf. 1997 SGQAE report, Section 5.2 and Annex 6). The guidelines have been published in two reports (Nordic Council of Ministers 1997a, 1997b). They cover the following aspects:

- general guidance on QA in environmental monitoring and assessment;
- QA in programme design;
- QA of fieldwork;
- QA in analysis and use of environmental data.

The guidance document has been written to be in general harmony with international standards, and is intended to be a complete administrative document on QA in environmental montoring.

5 OUTCOME MEETINGS OF THE BENTHOS ECOLOGY AND PHYTOPLANKTON WORKING GROUPS; NATURE AND SCOPE OF FUTURE INTERACTION

5.1 Benthos Ecology Working Group (BEWG)

The BEWG has made written comments (ICES CM 1997/L:7, Annex 19) to the draft OSPAR JAMP guidelines for benthos monitoring. These comments have been adopted in the latest version of the Guidelines, dated 9 June 1997.

The BEWG has also responded in writing (ICES CM 1997/L:7, Section 10) to the specific questions asked by SGQAE after its meeting in February 1997. BEWG supported the tabulation of critical QA factors covering benthos studies, and believed that high priority should be given to the training element in raising quality standards. BEWG also proposed to review case studies concerning the application of QA criteria for acceptance or rejection of benthos data in member countries, noting that, in general, commercial consultants appeared to be more familiar with operating to such criteria. The group also considered that a compilation of an inventory of guidelines for the conduct of benthos surveys operated by different countries would be useful (i.e., in addition to recognised international publications, e.g., of ICES and HELCOM), and need not be restricted to the OSPAR area. BEWG expressed support for the development of computer-based taxonomic aids as a contribution to the QA of benthos measurements. Finally, BEWG offered a revision of the basic guidelines for surveys of soft-bottom macrofauna under OSPAR auspices (subsequently endorsed by ACME) (ICES, 1997a).

SGQAE noted that the BEWG recommended (ICES CM 1997/L:7, Section 12, No.5) the preparation of guidelines for epifaunal sampling and epifauna community description during its next meeting, which is to be held in April 1998. SGQAE emphasised the importance of considering QA aspects as a part of this review. Also, with reference to the BEWG recommendation No.7 on the upgrading of existing guidelines with respect to benthos sampling approaches and new sampling devices, the QA elements should be upgraded accordingly. SGQAE sees an important element of interaction with the BEWG on these issues.

5.2 Working Group on Phytoplankton Ecology (WGPE)

The Working Group on Phytoplankton Ecology (WGPE) was requested to answer a couple of questions related to QA activities concerning phytoplankton studies (1997 SGQAE report, Annex 4), but was unable to give refined answers because the questions arrived with the WGPE Chairman just before their meeting. However, in their report (ICES CM 1997/L:5), the WGPE gave high priority to phytoplankton methodology for measurements of pigments, growth rates and primary production, including standardising of methods and QA. WGPE also recommended that SIME develop QA protocols for the measurement of chlorophyll *a* and for phytoplankton. SGQAE noted that several of the items on the Terms of Reference for the WGPE meeting in March 1997 (ICES CM 1997/L:5, Section 2) had strong relevance to the work of SGQAE, primarily the following:

a) propose new pigment procedures for measurement of chlorophyll *a*, ...,

The WGPE will continue its work with the aim of preparing a concrete proposal for a standard method of chlorophyll *a* measurement. The work will draw from the recently published SCOR WG 78 report (details of which appear in the 1997 WGPE report), and closer contact with the SCOR WG will be established.

d) continue the evaluation of new techniques for the measurement of primary production and biomass ...,

A series of new techniques for the study of phytoplankton dynamics are being reviewed as part of the WGPE activities. The report refers to a QA programme on phytoplankton, as part of a Swedish monitoring programme for the occurrence of harmful algal species, details of which would be of interest to SGQAE in the OSPAR context.

j) review the quality assurance associated with primary production measurements ...

The WGPE refers to papers in preparation which contain results on intercomparisons and intercalibrations with respect to production measurements, and stated that these papers are a good basis for the preparation of in-house QA manuals by the various laboratories. Although primary production measurements are outside the remit of SGQAE, the group felt that further information on QA developments in this area would be helpful in relation to the agreements made under Section 7, below.

The WGPE will meet again in March 1998. Specific items on the Terms of Reference for the meeting and the action list for WGPE for the coming year with relevance to the SGQAE work are:

Terms of Reference:

g) review, in a joint session with WGHABD, the status of taxonomic coding systems with a view to recommend the adoption of a single coding system for use in ICES.

Action list:

- to prepare a more complete checklist of phytoplankton for different parts of the ICES area;
- to prepare or support the preparation of quality assurance procedures for phytoplankton measurements (= chlorophyll *a*, species composition, primary production measurements).

6 ACTIVITIES OF OTHER INTERNATIONAL QA GROUPS, ESPECIALLY SGQAB AND SGQAC AND SCOPE/BENEFIT OF INTERACTION

6.1 Joint Session between SGQAE and SGQAB

A joint session with the ICES/HELCOM Steering Group on Quality Assurance of Biological Measurements in the Baltic Sea (SGQAB) was held on the afternoon of 17 February. One main point of interest was progress in the handling of biological data.

Jan Rene Larsen, ICES Environmental Data Scientist, reported on progress in the handling of biological data. His written report can be found on www.ices.dk/env/biorep/bacgro. The ICES Data Centre has been requested by the Oslo and Paris Commissions and by the Helsinki Commission to prepare the set-up of databases to support the biological components of the Commissions' monitoring programmes. ICES is focusing its work on the Commissions' biological data and especially on the exchange of data. To ensure that national contributions are taken into account, ICES had undertaken an e-mail conference. Contributions from twelve persons have been received so far, but have not yet been evaluated. The main problem at present related to species coding systems.

The participants in the joint session discussed the necessity and use of species coding systems. During the discussion, the following points were made:

- If a species code is used, regular updating is necessary. If this is not possible, the system will break down. The RUBIN code was mentioned as an example.
- Some countries use the U.S. NODC code, Version 7, as the basis for their database. This code is no longer updated and it has the disadvantage that it cannot react to a change in taxonomic order of a species. Recoding is not possible. Therefore, the NODC

Version 7 code should not form the basis for the ICES database.

- The new U.S. Interagency Taxonomic Information System (ITIS) code, that is being established to replace the NODC Taxonomic Codes, has the advantage that it is flexible and recoding is possible. The disadvantage is that marine species have low priority in the development of this North American coding system and that there is at present no procedure for updating of the code. Therefore, the ITIS code cannot form the basis for the ICES database at present. J.R. Larsen later noted that this system also carries a numeric code but this is not hierarchical and therefore bears no relationship to the NODC system which it supercedes.
- The joint session agreed that the ICES database should be based on the scientific name of the species, not on a code. There are already several species lists existing within HELCOM (for phytoplankton and zooplankton as part of the HELCOM plankton counting program) and in the OSPAR area on a regional level. A procedure has to be found for how these lists can be used by ICES and how they can be updated regularly. The ICES system should not preclude the use of other systems on a national basis.

Finally, both Steering Groups exchanged information on their ongoing work. They agreed that the HELCOM Manual, Part B, containing the guidelines on QA, may also form the basis for an OSPAR guideline on QA. SGQAB will make the draft guideline on QA available to SGQAE.

SGQAB also presented their comments on the SGQAE report from February 1997. As in the OSPAR area, a number of habitat types (and therefore the associated biological targets of interest) were not uniformly distributed throughout the Baltic Sea. This had a practical, as well as a strategic consequence, in that experience had shown that workshops were better supported, and therefore more successful, when organised at a regional rather than a Baltic-wide level, and it may be helpful to consider this in planning comparable OSPAR initiatives for some of the biological measurement of interest.

SGQAB was largely content with the identification of critical QA factors and priority QA actions in relation to studies of chlorophyll *a*, phytoplankton, macrozoobenthos and macrophytobenthos contained in Annex 10 of the 1997 SGQAE report. However, while recognising that the most important issue in any joint monitoring exercise was the eventual comparability of results rather than the use of identical methods in sampling, SGQAB felt that the report may have been rather too generous in allowing for variability in sampling and analytical methods, and further effort may be required in order to standardise approaches.

SGQAB considered intercomparisons mandatory within HELCOM (a distinction between intercomparisons and intercalibrations was stressed). One must be able to reject data from laboratories falling outside an accepted range. This requirement is still new to biological activites, but criteria will be developed for application within HELCOM. Ideally, ICES and OSPAR should follow the same practice.

6.2 Activities of the SGQAC

The report from the meeting of the ICES/HELCOM Steering Group on Quality Assurance of Chemical Measurements in the Baltic Sea (SGQAC) in February 1997 (ICES CM 1997/E:2) was available to the Group. This report contains a comprehensive Appendix 1 presenting the chemistry quality assurance guidelines. These had formed a basis for the preparation by SGQAB of general guidelines on quality for monitoring in the Baltic including biology. SGQAE considered the SGQAC Appendix 1 to be an important input to its further activities (see Section 7, below). It was pointed out that the material in SGQAC Appendix 1 was reviewed and accepted by ACME in June 1997 for transmission to HELCOM. This material has now been included in the HELCOM Manual as Part B.

7 PRODUCTION OF QUALITY ASSURANCE MANUALS

As a basis for the discussion, SGQAE received the OSPAR Quality Assurance Policy (SGQAE 1998/2), as outlined below:

1) Contracting Parties acknowledge that only reliable information can provide the basis for effective and economic environmental policy and management regarding the Convention area;

2) Contracting Parties acknowledge that environmental information is the product of a chain of activities, constituting programme design, execution, evaluation and reporting, and that each activity has to meet certain quality assurance requirements;

3) Contracting Parties agree that quality assurance requirements be set for each of these activities;

4) Contracting Parties agree to make sure that suitable resources are available nationally (e.g., ships, laboratories) in order to achieve this goal;

5) Contracting Parties fully commit themselves to following the guidelines adopted by JMG and the Commissions in accordance with this procedure of quality assurance.

SGQAE identified a need to resolve any possible confusion arising from the use of QA terminology. For example, reference to the following are commonly encountered:

quality assurance guidelines;

quality assurance manuals;

standard operating procedures (SOPs).

For SGQAE purposes, the above terminology is used in the following way: *Standard Operating Procedures* provide detail on the conduct of specific sampling or analytical tasks, and are generally contained within *QA manuals*. The content of a QA manual is invariably developed for use at the level of the individual organisation but, at the same time, would be expected to accurately reflect more general QA guidelines, where available.

Definitions of a range of QA terms were contained within Part B of the draft HELCOM monitoring manual (see below), and their utility in the OSPAR context will be reviewed by SGQAE.

SGQAE had at its disposal several documents as a basis for discussions under this item (ICES CM 1997/E:2, Appendix 1 (1997 SGQAC report); Nordic Council of Ministers, 1997a, 1997b; Annex 9; SGQAE 1998/3; SGQAE 1998/4).

SGQAE supported the production of 'in-house' laboratory QA manuals as the most valuable practical expression of a national or international QA policy. The production of 'Standard Operating Procedures' ('SOPs') for field and laboratory biological methods relevant to SGQAE interests is an essential part of QA manual preparation, and a high degree of consistency in their content among laboratories and among countries is to be expected, where guidelines have been fully adopted, and correctly translated into local courses of action. An example of content specifications for SOPs is given in Annex 9.

An evaluation of the content of SOPs across laboratories (or countries) for specified measures in order to ensure that inconsistencies are resolved, would therefore appear to represent a potentially useful means to improve the quality of the resultant data. In the context of JAMP guidelines, harmonisation of methodology by this means should significantly reduce the risk of data incompatibility before major monitoring effort is expended.

SGQAE therefore recommends that all laboratories engaged in OSPAR monitoring of the relevant biological measures should, as a minimum, ensure that their sampling and analytical procedures are fully documented in the form of SOPs, and that this activity is co-ordinated at a national level, preferably in conjunction with advice from the relevant specialist international Working Groups (see below). In practice, this may operate (and have benefits) in two directions:

1) 'top-down': in some circumstances, it may already be feasible to produce specifications, at an appropriate level of detail, at national level, which may then be used as a 'blueprint' for local (within-laboratory) application. An example of this is the proposed Norwegian national standard for soft-bottom macrofauna sampling;
2) 'bottom-up': the gathering and then critical review of laboratory SOPs provide the means to iron out any inconsistencies; at the same time, the exercise may be extended to produce a generic (country-wide) specification.

In the course of this discussion, SGQAE considered the level of direction and advice at which it might reasonably be expected to operate. While it had been the intention to review specimen SOPs as a means to resolve potential future problems in data acquisition, it soon became clear that the level of detail contained therein was more appropriate for consideration by expert groups (e.g., within ICES). SGQAE therefore recommends this course of action, with the proviso that such a review should be illustrative rather than exhaustive. Thus, a limited number of representative SOPs (submitted anonymously, if necessary) should be evaluated in such a way as to establish the scope, if any, for errors in data acquisition, and their likely significance, arising from variation in the content, and to permit recommendations to be made in order to rectify inconsistencies. Such a process would then act as a trigger for appropriate action elsewhere at a local or national level, which may range from simple modifications to the procedures, to the conduct of intercomparison exercises on the effectiveness of different sampling or analytical approaches.

SGQAE considered that it had a role in the further development of a general framework for the structuring of SOPs (subject to the outcome of the above exercise), alongside guidance on the preparation of quality manuals in their entirety, and in overall quality policy.

With reference to Section 6.1, above, SGQAE stated that the draft HELCOM COMBINE Programme Manual Part B, General Guidelines on quality assurance for monitoring in the Baltic Sea (SGQAE 1998/4), may serve as the basis for producing a general QA manual for the OSPAR area, but felt that this document was not directly applicable in its present form. SGQAB intends to revise the document (with emphasis on biological applicability) during spring 1998. This may call for some intersessional activity of SGQAE in order to evaluate the scope for adapting the HELCOM QA guidelines to OSPAR. Subject to receipt of the revised SGQAE 1998/4 from SGQAB, the members of SGQAE will evaluate it with emphasis on specific OSPAR geographical conditions and specific parameters, and distribute their views within SGQAE by e-mail before the next meeting.

8 IDENTIFICATION OF RELEVANT QA EXERCISES (TAXONOMIC OR SEA-GOING WORKSHOPS, RING TESTS, ETC.) AND ACTION TO IMPLEMENT INTERSESSIONAL ACTIVITY

SGQAE effort directed at the organisation of specific QA exercises (as suggested in the title of this agenda item) was considered, at this stage, to be premature. Discussion under item 7, above, had helped to further clarify the scope for SGQAE activity, and had also highlighted the different circumstances under which this Group was presently operating, when compared with the ICES/HELCOM SGQAB. The framework for their activity was provided by the Baltic Monitoring Programme, a long-standing international activity with participating countries all having a common interest in ensuring the production of data of consistent quality suitable for combination in overall assessments.

For the biological measurements under consideration by SGQAE in the OSPAR area, there is no such history of consistent joint activity and, further, the uneven distribution of monitoring effort arising from geographical variability in eutrophication potential does not necessarily provide a uniform incentive to harmonise on methodolgy and QA approaches. Nevertheless, evidence to date suggests that most countries are responsive both to the need for sound QA of biological measurements, at least at the national level, and to the benefits of adopting internationally agreed guidelines, where available.

SGQAE will continue to encourage this trend through the development of general guidelines covering all aspects of QA procedures, accompanied by the stimulation of effort in areas where knowledge is presently deficient, especially through liaison with the relevant ICES Working Groups.

9 PREPARATION OF TAXONOMIC LISTS

Apart from the initiative of the WGPE to prepare a more complete checklist of phytoplankton for different parts of the ICES area (cf. Section 5.2, above), several initiatives relating to the preparation of inter-institutional taxonomic lists were mentioned.

- The second edition of the UK 'Species Directory' has just been published (see reference list in Section 14, below). It was noted that this includes benthic but not planktonic algae.
- In a written communication, Dr Wetsteyn (cf. Section 4.4, above, and SGQAE 1998/1) had informed SGQAE that an annotated phytoplankton species list for the Netherlands has been prepared and is in operation.
- Dr Schwarzbach noted activities in Germany to compile a definitive list of phytoplankton species from the records of various German institutes.
- An 'atlas of North Sea benthic infauna', containing the data from the 1986 ICES North Sea Benthos Survey, had recently been published by ICES (see reference list in Section 14, below).
- Also, under the EU MAST programme, a 'concerted action' proposed and coordinated by Mark Costello (Ireland) will be funded in 1998 and 1999, in order to produce an EU-wide marine species directory, linked with a bibliography of taxonomic literature, a register of taxonomic experts, and locations of specimen reference collections. The information will be accessible through the World Wide Web.

10 CRITERIA FOR EVALUATING THE ACCEPTABILITY OF DATA

SGQAE realised that criteria for acceptance/rejection of eutrophication-related data under ICES/OSPAR would have to be developed at several levels depending on the parameters or study objects in question.

For chlorophyll *a* measurements, SGQAE envisaged that principles already adopted for chemical monitoring activities, regarding permissible tolerances in analytical error (e.g., for limits of detection and quantification, accuracy, precision, and repeatability) and success within QUASIMEME or similar proficiency schemes could be adopted. To some extent, acceptance/rejection criteria for phytoplankton data could be based on similar principles.

For biological measurements based on sampling and laboratory analysis, acceptance criteria based on the inclusion of standard samples and interlaboratory cross-analysis of common samples were envisaged. Dr Rees reported on such activities conducted recently in the UK, as described in the following paragraphs:

In 1996/1997, the UK NMBAQC (see Section 4.9, above) applied pass/fail criteria to participating laboratories, according to their proficiency in the analysis of a benthos sample that each was responsible for collecting, and in the determination of the % silt/clay content of a sediment sample. The criteria were:

i) 'own sample' extraction efficiency;
   a) total taxa to within ± 10 % or ± 2 taxa (whichever is greater) after re-analysis;
   b) total individuals to be within ± 10 % or ± 2 individuals (whichever is greater) after re-analysis;

ii) 'own sample' total wet-weight biomass to be within ± 20 % of the re-analysed value;

iii) 'own sample' Bray-Curtis similarity with the re-analysed sample should be ≥ 90 %;

iv) % silt/clay fraction to be within ± 10 % of the mean of the results from all laboratories.

An overall pass/fail flag was arrived at using the outcome from analyses of three 'own samples' during the year. Laboratories were, for the purposes of this exercise, considered to have returned an acceptable performance if they passed six of the nine exercises. (Pending resolution of some difficulties with biomass determinations, they were excluded from consideration.)

The results showed that 84 % of the comparisons were within the target for identification of taxa, 82 % for densities, and 72 % for the Bray-Curtis comparison. (There was about a 70 % failure rate for the biomass standard, and procedures are under review.) The net score resulted in only eight (of sixteen) laboratories passing. For determination of % silt/clay, all but one (of fifteen) laboratories passed, and indeed they could also have passed a more restrictive standard of ±5 %, which would seem more realistic.

An attempt to evaluate the acceptability of laboratory performances, based upon their success in identifying species of ecological relevance or commercial importance, was also noted. The rationale for such an approach, as an additional means for judging competency, was outlined in the 1997 SGQAE report (p.8), but further work is required in order to reduce the element of subjectivity in the selection of appropriate species.

For measurements based on direct registration (e.g., hard-bottom community studies), it seemed more realistic to achieve acceptance/rejection criteria on the basis of repeatability tests, defined compliance to other in-house QA routines, and routines for certifying that field taxonomists hold defined levels of qualifications.

SGQAE further noted that the BEWG (ICES CM 1997/L:7) also had little experience with the application of QA criteria for acceptance/rejection of benthos data, but had noted that commercial consultants may be somewhat more accustomed to operating under such criteria. SGQAE supports the suggestion by BEWG to further examine experience with the application of such criteria.

11 FUNDING PROSPECTS FOR QA ACTIVITY: NATIONAL/ INTERNATIONAL

Dr Rees drew attention to two EU–connected QA initiatives which were of direct relevance to ICES/OSPAR interests.

1) At its 1997 meeting SGQAE noted a plan, originating from the ICES Working Group on Biological Effects of Contaminants, to pursue EC funding for development of a QA scheme covering biological effects measurements. A proposal has now been submitted, entitled 'BEQUALM' ('Biological Effects Quality Assurance in Monitoring Programmes'). The proposal, developed by nine contracting laboratories within EU, primarily addresses QA intercomparison/inter-calibration activities for biological effects measurements related to contaminants, but includes phytoplankton and zoobenthos community responses among these. The European QUASIMEME programme on chemical QA has formed a model for the proposed activities.

2) The 'QUASH' ('Quality Assurance of Sampling and Sample Handling for Marine Environmental Measurements') programme is in progress with EU funding, and covers nutrients in water, contaminants in water and sediments, and biota required for contaminant analyses.

Both of these programmes were acknowledged by SGQAE as initiatives within the scope of its activities. The former, if approved for funding, may open the possibility for participation by a number of biologists in OSPAR countries, and hence will be of particular interest to SGQAE.

12 DATE/VENUE FOR NEXT SGQAE MEETING

SGQAE agreed that several questions concerning QA issues should be addressed by ICES Working Groups with specific expertise in these areas. The questions addressed to the specific Working Groups are attached as Annex 10.

A list of intersessional activities to be performed by the Steering Group members was adopted (Annex 11).

The Steering Group further recommends that it meets in Copenhagen for four days during the last half of February 1999 in order to address the topics given in Annex 12.

13 ANY OTHER BUSINESS

No issues were raised.

14 REFERENCES

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Nordic Council of Ministers. 1997a. Quality assurance in environmental monitoring. TemaNord Report 1997: 591. Nordic Council of Ministers, Copenhagen. 87 pp.

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ANNEX 1

LIST OF PARTICIPANTS

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ANNEX 2

ICES/OSPAR STEERING GROUP ON QUALITY ASSURANCE OF BIOLOGICAL MEASUREMENTS RELATED TO EUTROPHICATION EFFECTS (SGQAE)

AGENDA

1) Opening of meeting.
2) Appointment of Rapporteur.
3) Adoption of Agenda.
4) Review of relevant biological studies and related QA activities by country and by discipline, especially recent and planned future programmes.

   [*To include: progress in relevant eutrophication-related biological work and in the implementation of JAMP guidelines.*]
5) Outcome of discussions of the Working Group on Phytoplankton Ecology (WGPE) and the Benthos Ecology Working Group (BEWG); nature and scope of future interaction.
6) Activities of other international QA groups, especially the ICES/HELCOM Steering Group on Quality Assurance of Biological Measurements in the Baltic Sea (SGQAB) and the ICES/HELCOM Steering Group on Quality Assurance of Chemical Measurements in the Baltic Sea (SGQAC), and scope/benefits of interaction.
7) Development of laboratory QA materials.

   [*To cover: experience with the development and use of quality manuals; benefits of OSPAR-wide or regional manuals for eutrophication-related biological measures; development of SGQAE guidelines for their production; Standard Operating Procedures for key sampling and analytical methods: evaluation of examples submitted by members.*]
8) Identification of relevant QA exercises (taxonomic or sea-going workshops, ring tests, etc.), and action to implement intersessional activity having regard to available resources.
9) Preparation of taxonomic lists (especially phytoplankton).
10) Criteria for evaluating the acceptability of data.
11) Funding prospects for QA activity: national/international.
12) Date/venue for next Steering Group meeting.
13) Any other business.

ANNEX 3

LIST OF WORKING DOCUMENTS

SGQAE 1998/1	Letter and enclosures from Dr L.P.M.J. Wetsteyn (National Institute for Coastal and Marine Management/RIKZ, Division Middelburg, P.O. Box 8039, NL-4330 EA Middelburg, The Netherlands) concerning methodology for phytoplankton monitoring employed in the Netherlands, and the documentation of species occurrences in Dutch waters.
SGQAE 1998/2	OSPAR, 1990. OSPAR policy for quality assurance. Report of the 1990 Joint Meeting of the Oslo and Paris Commissions, paragraph 8.12, p. 19.
SGQAE 1998/3	One-page specification for an in-house quality assurance manual, provided by H. Rumohr.
SGQAE 1998/4	Draft Manual for Marine Monitoring in the COMBINE Programme of HELCOM. Part B. General guidelines on quality assurance for monitoring in the Baltic Sea. (Annotated text arising from preliminary editing by SGQAB at their 1998 meeting.)
SGQAE 1998/5	Note from L. Hernroth, Chairman of SGQAB, containing an example of a table of contents of an in-house quality assurance manual.

ANNEX 4

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Beheerseenheid Mathematisch Model
Noordzee en Schelde Estuarium

20. X. 1997

Dr. H. REES
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United kingdom

Dear Dr. Rees,

Subject : - Quality assurance activities related to eutrophication-related studies
- ASMO 97/16/1. Para 4.37b

Please find enclosed a document with a short summary of the Belgian quality assurance activities related to studies on eutrophication including the description of the sampling and/or analytical methods.

Yours faithfully,

Mia DEVOLDER
Assistant MUMM

Quality assurance activities related to eutrophication

Sampling

The samples are taken with the Belgian oceanographic research vessel 'R.V. Belgica'.

Chlorofyll-a sampling by the Management Unit of the Mathematical Models of the North Sea (MUMM) :

The samples (5 l in oligotrophic waters and 1 l in eutrophic waters) are taken on a standard depth of -3 m and filtrated in situ on a Whatman glassfiber filter after addition of Mg(OH)CO3.
The filters are deepfreezed in a stamp bag and in aluminium folie -20 °C.

Chlorofyll-a sampling by the 'Université Libre de Bruxelles' (ULB)

Surface seawater is sampled with a bucket (in order to avoid *Phaeocystis* colony disruption). Seawater is stored in Dewar bottles until further analysis in the laboratory.
In the laboratory the particulate matter is isolated by filtration of the sample on Wathman GF/F filters. The filters are frozen until analysis (within one month).

Phytoplankton sampling by the 'ULB'

Surface seawater is sampled with a bucket in order to avoid *Phaeocystis* colony disruption. Seawater is stored in Dewar bottles until further analysis in the laboratory.
Samples are preserved by adding 1% of a specific Lugol solution preserving intact *Phaeocystis* colonies, and stored in the dark at 4° C until examination (within 6 months).
The Lugol solution is prepared by mixing a equal volume of solution A (60 g/l KI, 39 gr/l I_2) and solution B (63% v/v Ethanol, 7% Glutaraldehyde, 3% glacial acetic acid).

Macrobenthos by the 'Rijksstation voor Zeevisserij' (RVZ)

Van Veen grabs are taken at the sampling stations with a surface sample of 0.1 m². The samples are stored in individual recipients and preserved in a 10 % formaldehyde-seawater solution.

Analytical method

Chlorofyll a :

Clorofyll a is extracted using a cold 90 % aceton.
Chlorofyll a is determined spectrophotometrically using the method and equations recommended by Lorenzen (1967).

Phytoplankton enumeration :

Phytoplankton is analysed in settling chambers using the technique of Utermohl (1958): 10 ml subsamples are settled for a period of 12 h and examinated under an inverted microscope (Leitz Fluovert). Diatoms are enumerated at a 100 X magnification on the whole chamber area and determined generally to the genus level unless a species is particularly frequent and easily identifiable. *Phaeocystis* colonies are enumerated at a 40 or 100 X magnification and their size is measured visually by comparison with an ocular micrometer in order to calculate their volumes by regarding them as spheres or ellipsoids. *Phaeocystis* colonial cell number is then calculated using a relationship established by Rousseau *et al.* (1990). *Phaeocystis* solitary cells are counted at a 400 X

magnification on several fields randomly chosen on the chamber area, the number of fields depending on the homogeneity of the sedimentation. *Phaeocystis* carbon biomass is determined from colony/solitary cells counts and biovolume measurements, using the conversion factors established by Rousseau *et al.* (1990).

Macrobenthos :

In the laboratory, the sediment is washed through a 1 mm sieve to collect the macrobenthic fauna. After sieving, the residue of the macrobenthos is stained with 0.1 % eosin to facilitate subsequent sorting by microscope and identification to species level. Total number of species, diversity and dominance are determined.

Quality assurance

Chlorofyll a :

In MUMM, validation of the spectrophotometer is done with a certified standard kit and later with control standards. The investigations for a quality assurance program for method validation for chlorofyll a started recently. This will be done with standard chlorofyll ampulles. An information document is included in Annex.

Macrobenthos :

The analyses have been performed by the same person using a standardized method since 1978.

References

Lorenzen, G.J. 1967. Determination of chlorophyll and phaeopigments: spectrophotometric equations. *Limnol. Oceanogr.* 12: 343-346.

Rousseau, V., Mathot, S. and Lancelot, C. 1990. Calculating carbon biomass of *Phaeocystis sp.* from microscopic observations. *Mar. Biol.* 107: 305-314.

Utermohl, H. 1958. Zur Vervollkommnung der quantitativen Phytoplankton Methodik. *Mitt. Int. Verein. theor. angew. Limnol.* 9: 1-38.

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14. X. 1997

Dr. H. REES
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United Kingdom

Dear Dr. Rees,

Subject : - Eutrophication-related studies
- ASMO 97/16/1. Para 4.37 a and c.

The Belgian authorities has recently launched an important five years (1997-2001) research programme on the sustainable development of the North Sea.

One chapter of this programme concerns the "study and modelling of eutrophication-related changes in coastal planktonic food-webs" for which the here enclosed proposal has been accepted, after international review and without change.

I prepare a short note on the quality assurance activities concerning the eutrophication-related parameters, other than the classical ones such nutrients for which we are fully involved in the QUASIMEME procedures.

I apologise for the late submission of this information.

Yours faithfully,

G. PICHOT
Head MUMM.

- Copy : Carolyn Symon, OSPAR Secretariat.

ANNEX 5

SWEDISH EUTROPHICATION-RELATED MONITORING ACTIVITIES IN THE OSPAR CONVENTION WATERS

1 Sub-programmes

- Macrozoobenthos
- Macrophytobenthos
- Pelagic monitoring
  - frequent pelagic monitoring
  - low frequent pelagic monitoring
- Coastal fish
  - stock assessment
  - physiology

2 Description of Sub-programmes

2.1 Macrozoobenthos

Objectives: Demonstration of long-term trends related to above all eutrophication and oxygen deficit. Provides reference data for local pollution monitoring programmes.

Geographical Coverage: The Skagerrak and Kattegat. Off-shore and coastal waters mainly unaffected by pollution.

Timely Coverage: Start year and period of operation: 1993 – Sampling frequency: Once a year (May-June)

Sampling Strategy: Macrozoobenthos are collected at 16 soft-bottom stations with a van Veen grab. At every station, 4 replicates are collected.

Variables: Main groups: Indicators of eutrophication and oxygen deficit.

List of variables:

- Macrozoobenthos: Species distribution, abundance, biomass.
- Sediment: Sediment description, texture, grain size, water content, loss of ignition, smell of hydrogen sulphide.
- Bottom water: Temperature, salinity, oxygen content.

2.2 Macrophytobenthos

Objectives: Demonstration of long-term trends related to above all eutrophication. Provides reference data for local pollution monitoring programmes.

Geographical Coverage: The Skagerrak. Coastal waters mainly unaffected by pollution.

Timely Coverage: Start year and period of operation: 1993 – Sampling frequency: Once a year (August).

Sampling Strategy: Samples are collected at six stations within a restricted coastal area. Within every station, a fixed horizontal distance are chosen at the first visit, serving as a baseline during the following visits. Five coordinates are chosen at random on the baseline, giving the starting points of 5 transects perpendicular to the baseline. At each transect two separate stereophotographs, covering 0.25 m^2 are taken at fixed depths, between 0 and a maximum of depth of 20 m. The two replicates are positioned at random within a 2 m horizontal distance from the transect line. When necessary, canopy species (*aminaria* spp., *Halidrys siliquosa*) are gently moved aside after documentation, for appropriate recording of the underlying strata. The upper and lower limits of the dominating species as well as the largest depth of non-crustose vegetation are recorded, too. The field work generates a bank of slides from which different kinds of data

can be extracted and analysed. Digitising of the slides by using image analysis provides coverage data for different taxa and information of frequencies and abundance's of algae in the different substrata. For large-sized algae, determination to species level is made while for less conspicuous algae functional groups can be used. For canopy species and most sessile macrofauna, abundance can also be recorded.

Variables: Main groups: Indicators of eutrophication.

List of variables:

- Species distribution, abundance of plants.

Cover degree of conspicuous plant species.

2.3 Pelagic Monitoring

2.3.1 Frequent pelagic monitoring

Objectives: Demonstration of long-term trends related to above all eutrophication. Provides reference data for local pollution monitoring programmes.

Geographical Coverage:

The Kattegat and the Skagerrak. Off-shore waters mainly unaffected by pollution.

Timely Coverage: Start year and period of operation: 1993. Older data from these stations are filed at the Swedish Meteorological and Hydrological Institute. Sampling.

Sampling frequency: 8–12 times/year in the Kattegat and 6–12 times/year in the Skagerrak.

Sampling Strategy: Water samples are collected at totally 7 off-shore stations in the Kattegat (3) and the Skagerrak (4).

Samples for pelagic biology are collected at totally 2 stations in the Kattegat.

Variables: Main groups: Indicators of eutrophication and toxic

List of variables:

- Abiotic: Secchi disc depth, temperature, salinity, O_2/H_2S, PO_4, P-tot, NH_4, NO_2, NO_3, N-tot, SiO_2.
- Biotic: Chlorophyll.

2.4 Coastal Fish

2.4.1 Fish stock assessment

Objectives: Demonstration of long-term and large-scale trends in coastal areas related to eutrophication, toxic substances, and resource exploitation. Provides reference data for local pollution monitoring programmes.

Geographical Coverage: The Skagerrak. Coastal waters mainly unaffected by pollution.

Timely Coverage: Start year and period of operation: 1989 – Similar programmes have been performed since the 1960s.

Sampling frequency: Once a year (October).

Sampling Strategy: Samples of stationary fish are collected in one coastal area in the Skagerrak. The sampling stations are defined mainly according to depth. In each depth stratum there are two groups of stations (sections), representing different habitats as regards e.g., exposure and bottom type. The minimum number of stations per section is 6 for gill nets and maximally 18 for fyke nets. The collection of fish is repeated 6 times within a 3-week period at every station.

Variables: Main groups: Indicators of eutrophication and toxic substances.

List of variables:

- Stock analysis: Species composition, catch per unit effort, age composition.
- Individual analysis: Growth, gonad weight, fecundity, condition factor, external indications of diseases.

2.4.2 Fish physiology

Objectives: Demonstration of long-term and large-scale trends in coastal areas related to eutrophication and toxic substances. provides reference data for local pollution monitoring programmes.

Geographical Coverage: The Skagerrak. Coastal waters mainly unaffected by pollution.

Timely Coverage: Start year and period of operation: 1989 – Sampling frequency: Once a year (autumn).

Sampling Strategy: Samples of stationary fish are collected in one coastal area outside the spawning season.

Variables: Main groups: Indicators of eutrophication and toxic substances

List of variables:

- Gonadosomatic index, liversomatic index, hematocrit value, leucocyte count, plasma ions, cytochrome P-450, EROD activity, blood lactate and tissue glycogen.

QUALITY ASSURANCE

The Guidelines currently developed by OSPAR MON and HELCOM EC MON are implemented in the Swedish National Marine Monitoring Programme, as well as the Quality Assurance schemes by QUASIMEME and ICES/HELCOM SGQAC and SGQAB.

However, quality implies substantially more than the traditional quality aspects considered during sampling and analysis. The quality policy of the Swedish Environmental Monitoring System states that the result should be characterised by:

Relevance–the monitoring that is conducted should be relevant and cost-effective for the questions that it intends to address.

Reliability–the programme should be designed with consideration for its long-term existence, that is, the activity should produce data series with sufficient length and coverage. The task of determining the right level of data quality should be given the highest priority when the programme is designed. Loss of data should be kept to a minimum.

Accessibility–the results should be well documented and the information should reach the user according to a plan agreed on beforehand. The results should be comparable, that is, it should be possible to use the results when posing new questions, and compare them with results of other investigations with corresponding variables.

Quality control is achieved by managing the programme according to a special 'quality control' plan.

DATA MANAGEMENT

Main users of data from environmental monitoring are the government and the different authorities at national, regional and local level. In Sweden, all monitoring data, produced at governmental authorities and institutions, is by law open to the public (official).

Data handlers

The environmental monitoring in Sweden consists of ground truth measurements in the environment and of model and scenario calculations. The data collection and data flow are on accordance with agreements (contracts) between the Swedish Environmental Protection Agency (or County Administrative Boards on the regional level) and the respective contractors (institutions and consultants) and so-called data hosts.

Because of regional differences, specialist knowledge and costs a number of contractors are involved in the data collection. As a compromise between the policy to store the data near the data collector and to facilitate the use of data, data hosts are established. All data within a certain specialist field are gathered at one data host with the main task of making the information easily available.

Data structure

Comparability between data produced at different places by different contractors is achieved by using a common conceptual model, standardised by strict definitions, and quality assurance programmes. Approved sampling and analytical methods are specified for each programme.

A smooth exchange of data requires a common data model and common exchange formats. The Swedish Environmental Protection Agency is responsible for the development of these tools. The contracts stipulate data structure (data model), exchange formats, routine deliveries of data and costs.

Reference system

A reference system (meta database), containing all data sets that are produced by national (and in the future also regional) environmental monitoring, is under construction. The system will contain information on:

-programmes (objectives, who is responsible, who does the measurements and where the data are stored);
-variables (where, when and for how long, reference to method);
-stations (coordinates, name etc.).

The system should be equipped with GIS facilities. It will not contain specific data (measured or calculated data values).

ANNEX 6

MINISTÉRIO DA AGRICULTURA, DO DESENVOLVIMENTO RURAL E DAS PESCAS

S. R. **INSTITUTO DE INVESTIGAÇÃO DAS PESCAS E DO MAR**

Dear Mr.H Rees

As requested Portugal prepared a short answer to the three questions presented by SGQAE Steering Group on Quality Assurance of Biological Measurements Related to Eutrofication Effects.

Sincerely yours

Maria Helena Cavaco

Maria Helena Cavaco

IPIMAR-8

Avenida de Brasília, 1400 LISBOA (Portugal) Telefs. 301 08 14; 301 63 61/0; 301 46 98; 301 23 68; 301 46 75; 301 73 61/3
Linha Azul - Telef. 301 58 99 Telefax 301 59 48 Internet: http://www.ipimar.pt

Eutrophication - related Work: Portugal

With regard to eutrophication several projects are carried out by Institute for Research of Fisheries and of Sea (IPIMAR) and they include:

- Nutrients (Fig.1) and chloropyll a in Winter and Summer conditions, at standard depths between surface and 200m .
- Chloropyll a and phytoplankton , monthly, through water column from surface to 150m for chloropyll a and from 5m to 75m for phytoplankton on the 4 transects of Fig.1.
- Phytoplankton sampling, included in the Shelf Monitoring Program for Biotoxins and Toxic Microalgae involving harmful algae in about 80 bivalve production zones.
- Macrophytobenthos - Seaweeds -distribution and composition along Portuguese coast (Littoral and infralittoral zones). Evalution of stocks of economic relevant species.
- Macrozoobenthos distribution and composition along portuguese coast (in estuaries, coastal lagoons and coastal areas) involving areas subjected to anthropogenic disturbance.

QA Activities: Portugal

With regard to QA Activities carried out by Institute for Research of Fisheries and of Sea (IPIMAR) they include:

- Nutrients - Participation on Quasimeme Intercalibration Exercise (Round 6 and Round 8). Sampling with Nansen Bottles, frozen samples (vials of polyethylene of 25ml) and analysis in Laboratory on autoanalyser with the methodology recomended by Technicon and Grashoff.
- Chlorophyll a - Sampling with Nansen Bottles, 250ml , immediately filtered, frozen filters and concentration measured, in 90% acetone extracts, by fluorometry, in the laboratory. Calibration with one standard Chlorophyll a (Sagamy).
- Phytoplankton - Sampling with Nansen Bottles, 250ml, immediately preserved with Formol and quantification by Uttermhöl method.
- Macrophytobenthos - Sampling by collecting realized during low tide periods in intertidal areas or diving in infralitoral zones. Preservation of specimen's in formol

and/or herborized. Density estimation and use of taxonomic keys for identification (if available) and/or specimens descriptions books.

- Macrozoobenthos

SOFT-BOTTOM

Sampling procedure - use of grabs(Smith-McIntyre and Van Veen). A box-corer is available also. Extraction of fauna from sediments by washing through a 0,5mm mesh size metallic sieve and preservation of the material obtained.

Sample analysis - In the laboratory, sorting of organism from residual sediments under a magnifying microscope. Manual counting, identification and weighing of species. Use of taxonomic keys for identification (if existing).

As a complement for the interpretation of soft bottom benthos data, particle size analysis of the sediment and redox potencial, pH and TOM determinations are performed.

Data treatment - Use of biological indexes, univariate and multivariate analysis.

HARD-BOTTOM

Sampling procedure - Shoreline and diving transects and frames, photography and video.

Sampling analysis - Manual counting, weighing of species. Use of taxonomic keys for identification (if existing).

Data treatment - Use of biological indexes, univariate and multivariate analysis

N.B.: We fully agree with the critical QA factors and the priority QA actions mentioned on tables 4 and 5 of the SGQAE report.

International QA programme (external funding) - Portugal

Portugal through IPIMAR - Institute for Fisheries and Sea Research is interested to participate on:

- Chlorophyll a
- Phytoplankton
- Macrophytobenthos (Seaweeds)
- Macrozoobenthos

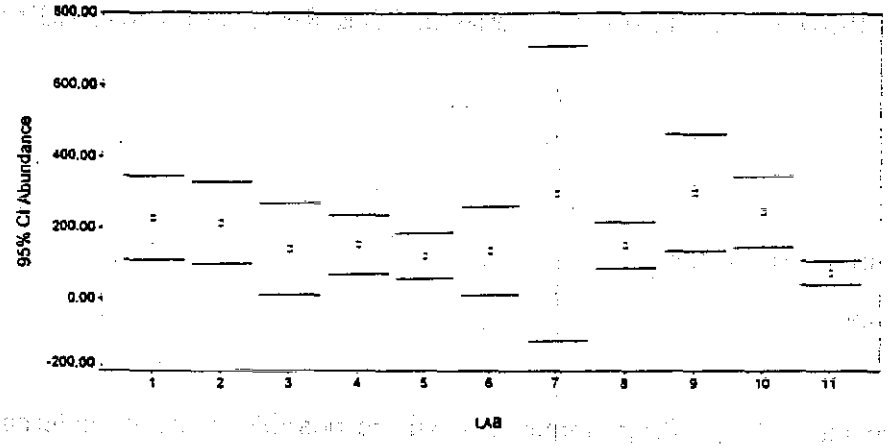
Quality Assurance International Programme, if it will be possible to obtain external funding.

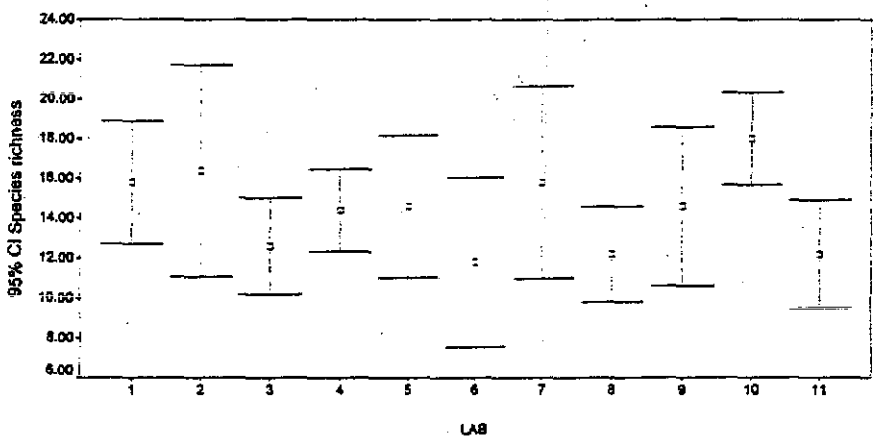
ANNEX 7

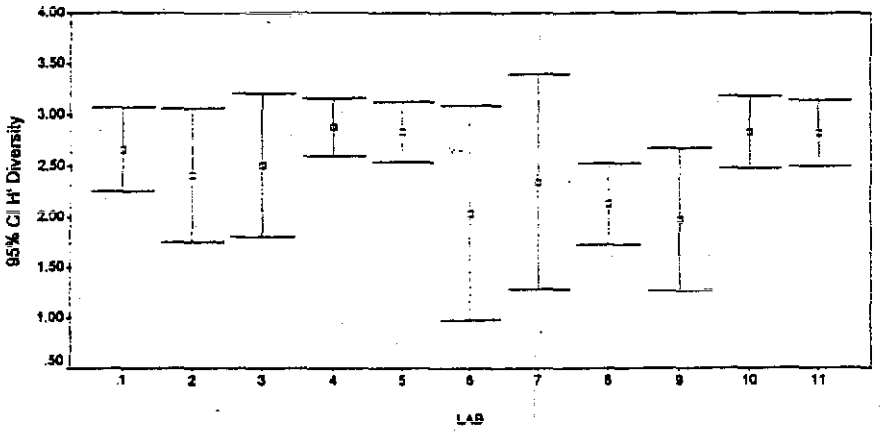
SPECIMEN OUTPUT FROM A UK FIELD METHODS WORKSHOP IN 1997

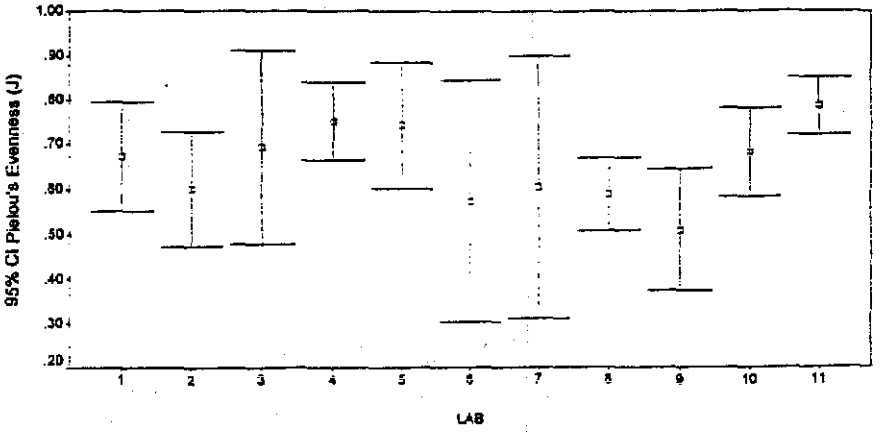
Figure 7A.1. Comparison of the results from analyses of benthos samples collected by 11 laboratories at a station in the Humber Estuary, UK during a 'field methods' workshop held in March, 1997 (see Section 4.9.2 in the body of the report).

Station 2









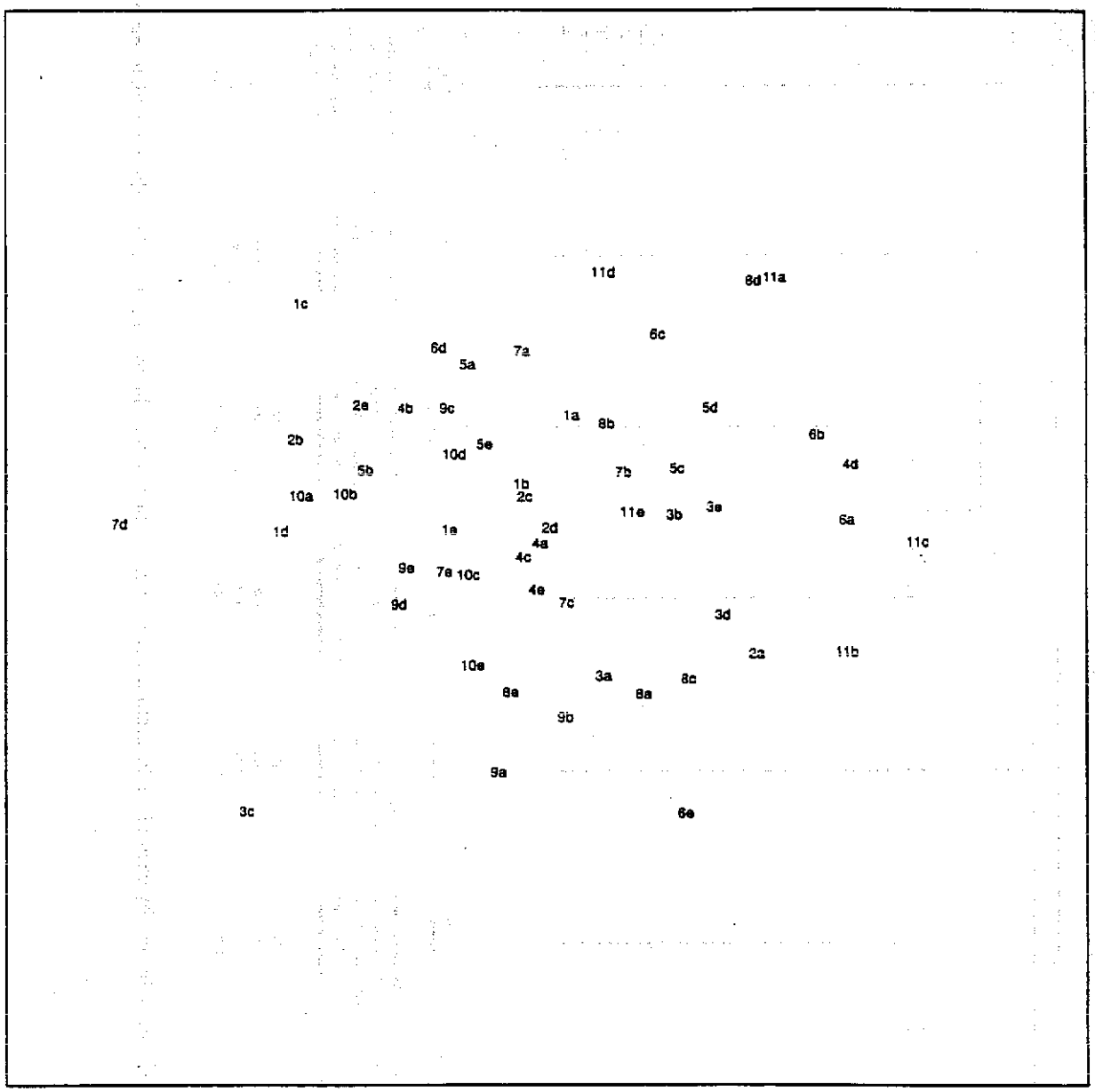


Figure 7A.2. 'Multi-dimensional scaling plot' of the disposition of samples collected by 11 participating laboratories at a single station, during a 'field methods' workshop in the Humber Estuary, UK (1997).

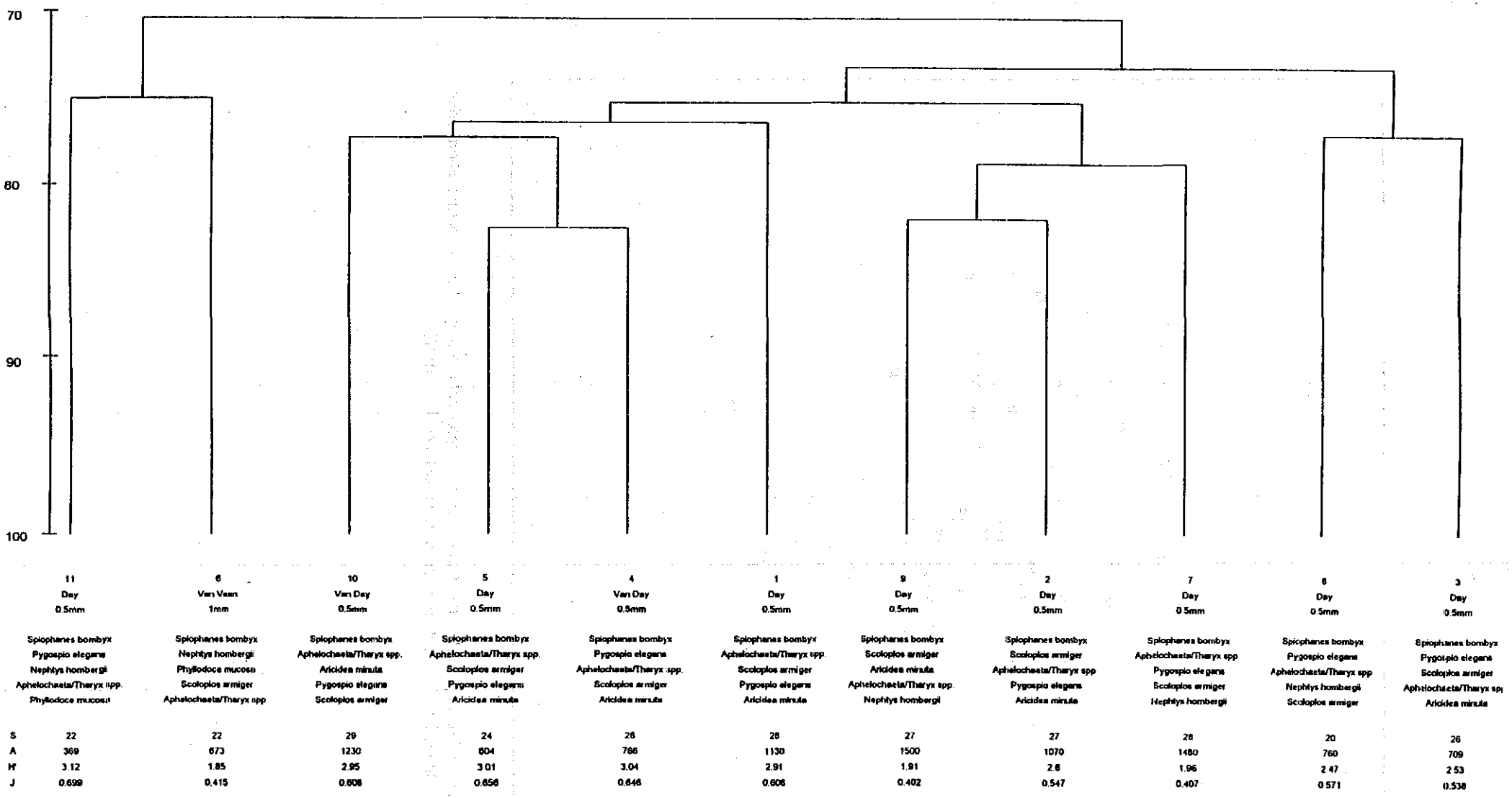


Figure 7A.3. Ouput from cluster of analysis of summed benthos data collected by each of 11 laboratories at a single station in the Humber Estuary, UK, during a 'field methods' workshop held in 1997.

Figure 7a.4 a–c. Methods employed for sub-sampling of material containing known densities of a polychaete worm. Their efficiency was examined during a 'field methods' workshop held in the UK in 1997 (see text).

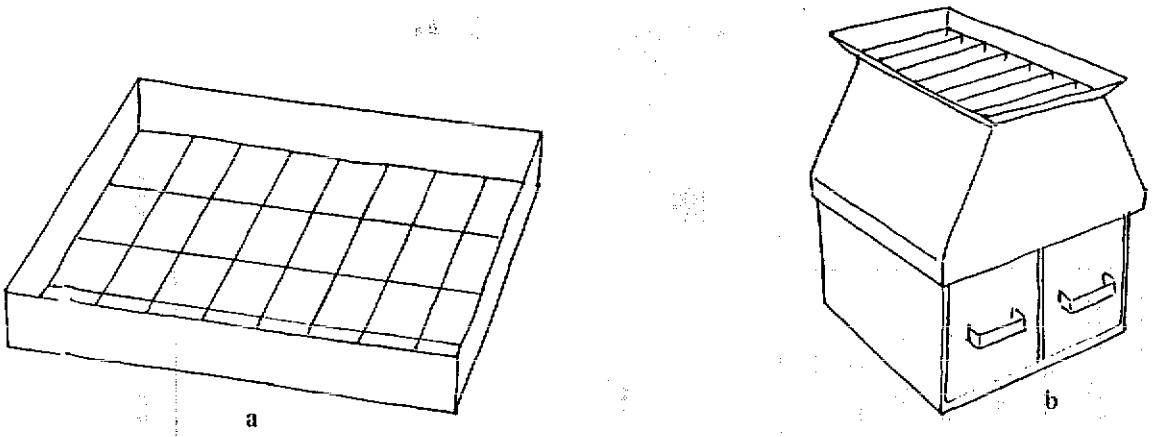


Figure 1. The Marked Tray (a) and Riffle Box (b).

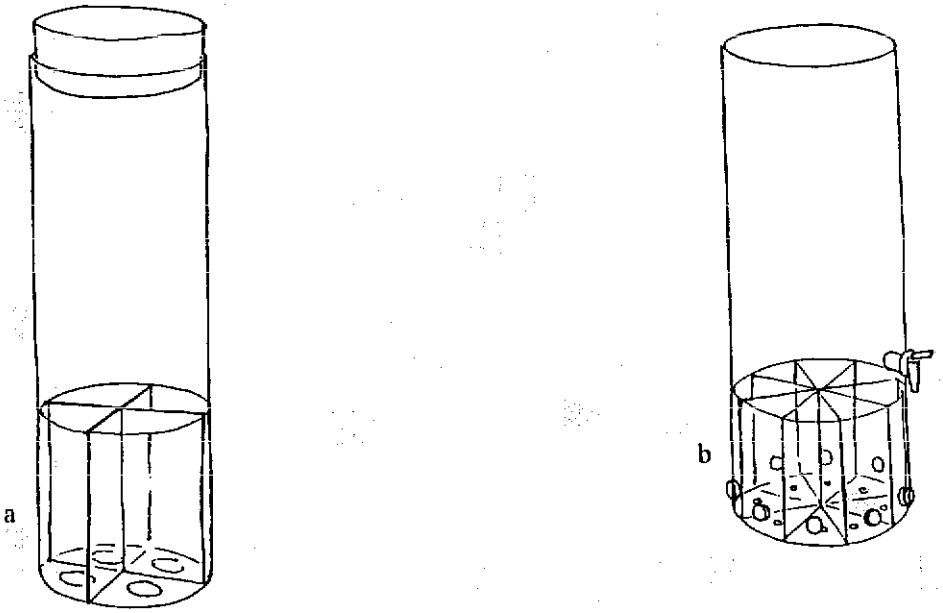


Figure 2. The Quarteriser (a) and the Aerated Column (b).

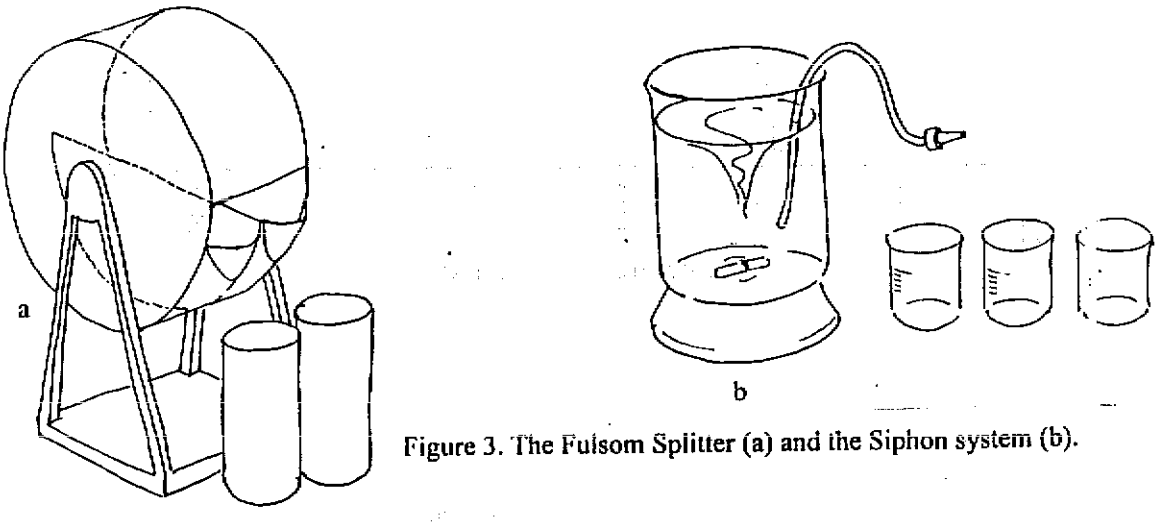


Figure 3. The Fulsom Splitter (a) and the Siphon system (b).

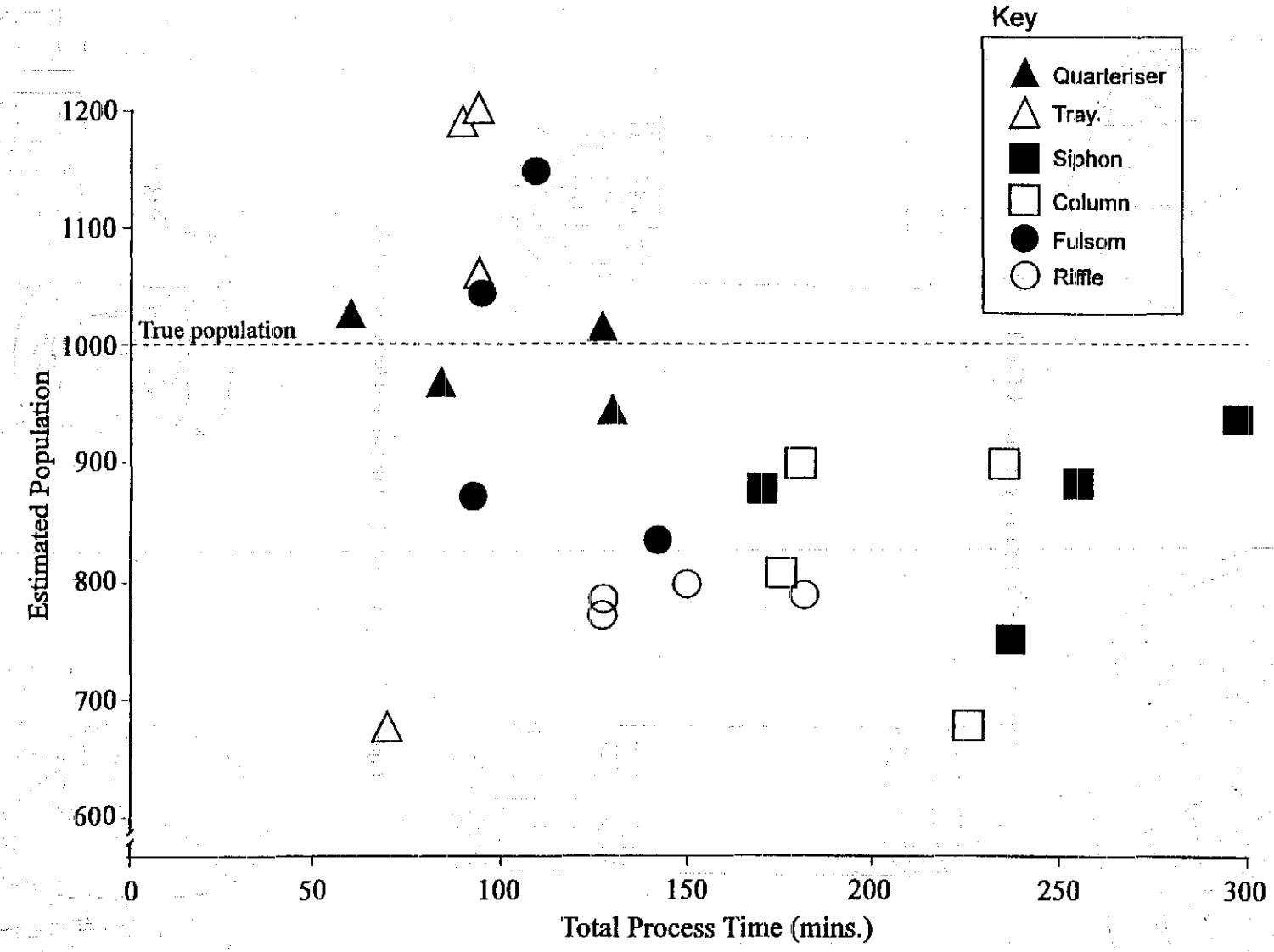


Figure 7A.5. Results from the testing of methodologies for sub-sampling of material containing a known density of a polychaete work (see Figure 7A.4 and main text).

ANNEX 8

MONITORING CONSIDERATIONS RELEVANT TO SPECIAL AREAS OF CONSERVATION: OUTCOME OF UK WORKSHOP IN 1997

Summary Table A. Monitoring objective: to detect changes in habitat or biotope diversity or extent.

Technique	Quantitative ?	Qualitative ?	Apply to: Intertidal sedi.	Intertidal rock	Subtidal sedi.	Subtidal rock	Limitations	Solutions & suggestions for further testing	Workshop coverage: Exercise	Discussion	Questionnaire
Satellite images	1	✓	✓	✓	2	2	Not detailed enough for most for most biotope recognition.	Ground truthing essential to get best matching. Test repeatability of identification of habitats, biotope complexes and biotopes from images.			✓
							Poor penetration below sea level.	Accept lack of suitability. Use other techniques.			
							High cost.	Use of loaned images			
							Interpretation difficult (including cannot rely on classification of spectral images).	Use trained/experienced staff			
							Images often not coinciding with low water or clear sky.	Future developments?			
Acoustic survey	1	✓			✓	✓	Not descriminatory enough for most biotope recognition.	Accept level of distinctiveness to habitat, biotope complex or biotope and adopt method if adequate. Improve technology.			✓
							Limited to deeper than 5-6m.	Use other techniques for shallower depths.			
							Repeatability not fully tested.	Testing/development required for boundary and biotope distinction.			
							Interpretation difficult.	Experienced staff only to interpret including with assistance.			
Aerial photography	1	✓	✓	✓	2	2	Lack of detail for identification of biotopes.	Improve ground-truthing. Accept level of accuracy possible. Technical improvements may help.			✓
							Unlikely to differentiate sediment biotopes.	Use other techniques. Fly lower. Try improving ground truthing.			
							Interpretation difficult (including cannot rely on classification of spectral images).	Use trained/experienced staff			
							Poor penetration below sea level.	Accept lack of suitability. Use other techniques.			
							High cost.	Use of loaned images / collaborative projects.			
Viewpoint photography (including video)	✓	✓	3	✓	3	✓	Lack of detail.	Establish camera to subject distance required for objectives.			
							Images taken at different times do not match.	Care to identify camera position exactly. Use previous image to match.			
							Overgrowth obscures encrusting or low growing organisms.	Be content to include top layer only. Use other techniques.			
							Interpretation of photographs difficult and time consuming.	Use trained/experienced staff. Detailed analysis for key species only.			

Technique	Quantitative ?	Qualitative ?	Apply to: Intertidal sedi.	Intertidal rock	Subtidal sedi.	Subtidal rock	Limitations	Solutions & suggestions for further testing	Workshop coverage: Exercise	Discussion	Questionnaire
Detailed biotope mapping		✓	✓	✓	✓	✓	Poor repeatability.	Training and care. Simplification of methods.	✓	✓	✓
							Boundaries inaccurate, not statistically rigorous.	Use measures with accuracy established by repeat recording. Target 'key' biotopes where area of extent is important. Better standardisation of biotopes. Develop/use more accurate locational methods e.g. DGPS.			
							Cost of aerial photographs.	Use of loaned images / collaborative projects.			
Rapid biotope mapping		✓	✓	✓			Lack of detail.	Accept limitation. Expand to detailed biotope mapping.			✓
							Poor repeatability.	Accept limitation. Use trained/experienced staff.			
							Confusion between different manuals – incomplete catalogues.	Better standardisation of biotopes.			
Biotope inventory		✓	✓	✓	✓	✓	Limited scope (information restricted to a list of catalogued biotopes).	Accept limitation. Expand to mapping survey.	✓	✓	✓
							Poor repeatability.	Accept limitation. Use trained/experienced staff.			
							Confusion between different manuals – incomplete catalogues.	Better standardisation of biotope			
Seasearch		✓			✓	✓	Lack of detail.	Incorporation of other techniques			✓
							Poor repeatability	Accept limitation. Use trained/experienced staff.			
Divers on sledges or manta boards	1	✓			✓	✓	Logistically difficult due to poor visibility.	Plan survey for most likely period of good visibility.			✓
							Potentially hazardous.	Risk assessment especially important. Abandon if any significant risk.			
							Position fixing difficult.	Use DGPS and correct for position of sledge on seabed.			
							Often communication problems with surface.	Purchase reliable equipment. Train staff.			
							Limited area covered.	Use remote techniques to extrapolate results if relevant.			
Diver operated video	1	✓			✓	✓	Lack of detail.	Use mix of distance and close-up.	✓	✓	✓
							Cannot be used in poor visibility.	Accept limitation. Plan surveys for likely best visibility.			
							Limited to shallow (<50m) water.	Use other techniques for deeper water.			

Technique	Quantitative ?	Qualitative ?	Apply to:				Limitations	Solutions & suggestions for further testing	Workshop coverage		
			Intertidal sedi.	Intertidal rock	Subtidal sedi.	Subtidal rock			Exercise	Discussion	Questionnaire
Towed Video / ROV	1	✓			✓	✓	Limited area covered.	Use remote techniques to extrapolate results if relevant.	✓		✓
							Periferal vision poor to identify subjects for examination.	Accept limitation. Use *in situ* methods.			
							Cannot be used in broken rocky areas (danger of loss).	Accept limitation. Use *in situ* methods.			
							Logistical problems.	Careful planning of surveys			

Note
Many sampling methods, such as grabs or cores in a regular grid, could also be used for biotope mapping, with biotopes defined by cluster analysis. Problems would include difficulties in extrapolation between samples and the possible exclusion of large features.

Footnotes (numbers refer to those in columns)
1 Current techniques not fully quantitative but statistically rigorous methods could possibly be developed.
2 Applicability to subtidal habitats limited to very shallow water with good visibility.
3 Only suitable for surface fauna and flora.

Summary Table B. Monitoring objective: to detect changes in species diversity (i.e., richness) and abundance.

Technique	Quantitative ?	Qualitative ?	Apply to: Intertidal sedi.	Intertidal rock	Subtidal sedi.	Subtidal rock	Limitations	Solutions & suggestions for further testing	Workshop coverage: Exercise	Discussion	Questionnaire
In situ recording using abundance scales	1	✓	✓	✓	✓	✓	Limited to large species, over 4mm.	Add other techniques if smaller species are to be sampled.	✓	✓	✓
							Poor repeatability.	Improve discipline. Undertake comparative exercises at start of surveys.			
							Lack of statistical rigour.	Accept limitation.			
							Abundance scale poorly developed or incomplete.	Improve abundance scale.			
Abundance scale, Checklist, Exact location ('ACE')	1	✓	✓	✓	✓	✓	Limited scope to detect change in diversity due to reduced checklist.	Add other techniques (eg full listing or sampling) if required.	✓	✓	✓
							Limited to large species, over 4mm.	Add other techniques if smaller species are to be sampled.			
							Unknown repeatability and statistical rigour.	Further testing of repeatability and statistical rigour.			
							Abundance scale poorly developed or incomplete.	Improve abundance scale.			
Divers on sledges or manta boards	2	✓			✓	✓	Logistically difficult due to poor visibility.	Plan survey for most likely period of good visibility.			✓
							Potentially hazardous.	Risk assessment especially important. Abandon if any significant risk.			
							Position fixing difficult (repeat location)	Use DGPS and, most effectively, fixed transit marks where possible.			
							Often communication problems with the surface.	Purchase reliable equipment, train staff.			
							Limited to a few large spp.	Accept limitation. Use other techniques if required.			
Diver operated video	2	✓	3	✓	3	✓	Lack of detail due to poor visibility.	Plan survey for likely good visibility. Use other techniques.	✓	✓	✓
							Lack of statistical rigour in analysing results.	Accept limitation.			
							Lack of definition. Inability to see under layers.	Use mix of distance and close-up. Use other techniques.			
							Limited to shallow (<50m) water.	Use other techniques for deeper water.			
Towed video / ROV	2	✓			3	✓	Lack of detail, limited to large spp.	Accept limitation. Use mix of distance and close-up with ROV. Supplement with stills camera mounted with video.	✓		✓
							Logistically difficult due to poor visibility.	Plan survey for likely good visibility. Use other techniques.			
							Inability to see under layers.	Accept limitation.			

Technique	Quantitiative ?	Qualitiative ?	Apply to: Intertidal sedi.	Intertidal rock	Subtidal sedi.	Subtidal rock	Limitations	Solutions & suggestions for further testing	Workshop coverage: Exercise	Discussion	Questionnaire
Photographic records of marked locations (Viewpoint photography including video)	✓	✓	3	✓	3	✓	Lack of detail, limited to large spp.	Establish camera to subject distance required for objectives.		✓	✓
							Images taken at different times do not match.	Care to identify camera position exactly. Use previous image to match.			
							Overgrowth obscures encrusting or low growing organisms.	Accept limitation - include cover organisms only. Drape aside large fronds or photograph from below canopy (kelp).			
							Interpretation time consuming.	Use trained and/or experienced staff. Use standardised procedural guidelines. Restrict analysis to dominant and key species only.			
							Underwater sites are difficult to locate.	Use sites which can easily be re-found or plan for time required. Mark sites clearly. Use aids such as metal detectors to find markers.			
Fixed quadrat photography (Quantitative recording) **Limitations / solutions are additional to 'Photo-graphic records' above.**	✓	✓		✓		✓	Marking is time consuming.	Use imagination or employ navvies.			✓
							Photography at 90° essential.	Use framer attached to camera.			
							Shadows occur from larger organisms and obscure adjacent organisms.	Use dual flashguns.			
							Random stations (for statistics) would be too many to undertake and analyse.	Use sequentially placed quadrats and accept that certain stats. can't be used.			
Transects & quadrats(in situ)	✓	✓	✓	✓	✓	✓	High cost of field time.	Accept cost. Determine minimum sampling area and best plot design.			✓
							Limited to large spp. over 4 mm.	Accept limitation. Use additional techniques (sampling).			
							Statistical rigour compromised in heterogeneous areas.	Accept limitation. Adopt 'stratified' sampling procedure.			
Cores & grabs	✓	✓	✓		✓		High sample processing cost.	Process a proportion of samples only and store others against future need.			✓
Dredges & trawls	1	✓			✓		Poor statistical rigour.	Use dredge which takes quantifyable 'bite' or trawl over measured distance.			✓
							Destructive.	Use a dredge which takes a 'bite'.			
Timed searches	✓	✓	✓	✓	✓	✓	Ability to observe differs between workers.	Use trained/experienced staff. Use standardised procedural guidelines.			✓
							Mobile species (eg fish) may be counted more than once.	Calibrate workers and establish/remove reasons for differences.			

Technique	Quantitative ?	Qualitative ?	Apply to: Intertidal sedi.	Intertidal rock	Subtidal sedi.	Subtidal rock	Limitations	Solutions & suggestions for further testing	Workshop coverage: Exercise	Discussion	Questionnaire
Suction samples	✓	✓	✓	✓	✓	✓	Logistically difficult.	Perception unfounded. Raise and lower sampler from boat. Use two workers.			✓
							High sample processing cost.	Process a proportion of samples only and store others against future need.			
Cryptofaunal samples	✓	✓		✓		✓	High sample processing cost.	Process a proportion of samples only and store others against future need.	✓	✓	✓
							Limited to small species.	Use other techniques for larger species.			
Artificial substrata	✓	✓		✓		✓	Uncertain relevance to natural biota.	Further testing of similarity to natural biota.		✓	✓
							High sample processing cost.	Process a proportion of samples only and store others against future need.			
Sweepings & traps	1 2	✓	✓	✓	✓	✓	High sample processing cost in some cases.	Process a proportion of samples only and store others against future need.			✓
							Limited scope.	Incorporate other techniques.			
							Statistical rigour difficult.	Use standardised approach.			
Micro-samples (eg. meiofauna)	✓	✓	✓	✓	✓	✓	High sample processing cost.	Process a proportion of samples only and store others against future need.			✓

Footnotes (numbers refer to those in columns)
1 Semi-quantitative
2 Quantification difficult but possible with refinement of method
3 Only suitable for surface fauna

ANNEX 9

PROPOSED CONTENT OF A STANDARD OPERATING PROCEDURE (SOP)

(Modified from DIN EN 45001, Chapter 5.4.3.)

In general line with the requirements of the international standard DIN EN 45001, procedures/methods are recommended which are published as international, regional or national standards.

Regarding procedures/methods which are not standardized, it is recommended to give a description of operational procedures which should include the following subjects:

A Scope of procedure used

B Description of the study target

C Variable to be determined

D Equipment necessary, reference material (e.g., voucher specimens), taxonomic literature used

E Specification of working conditions required for effective sampling

F Description of procedure/method with respect to the following aspects

1) Sampling and sample treatment, labelling, handling, transport and storage of samples, preparation for laboratory analysis

2) Instrument control and calibration

3) Recording of data

4) Safety aspects

G Criteria to adopt or reject results/measurements

H Data to be recorded and methods for their analysis

I Assessment of uncertainty of measurements

ANNEX 10

QUESTIONS CONCERNING QA FOR CONSIDERATION BY ICES WORKING GROUPS

1 Working Group on Phytoplankton Ecology

SGQAE noted proposed work at the 1998 WGPE meeting to compile a more complete checklist of phytoplankton species for parts of the ICES area, and would seek the views of the Working Group on the scope for producing a universal checklist (or, if not feasible, regional versions) for the OSPAR area.

SGQAE would also seek the preliminary views of the Working Group on the role of QA in relation to survey objectives and design, which would represent a widening of QA activity beyond the traditional pre-occupations with sampling methodology and sample analysis.

2 Benthos Ecology Working Group

SGQAE would seek the views of the Working Group on the feasibility of conducting a review of the content of submitted Standard Operating Procedures covering the various aspects of benthos sampling within the OSPAR area, as a potentially important way of improving the quality and consistency of the data eventually produced.

SGQAE would also request that, during Working Group discussions on epifauna sampling and on survey design at their 1998 meeting, members should highlight, in outline, the implications of any recommendations for QA of the two activities.

3 Working Group on Marine Sediments in Relation to Pollution

SGQAE would request information, in outline, from the Working Group concerning quality assurance of particle size analyses, determination of organic matter content and measurement of redox potential, which were identified by SGQAE as important 'supplementary variables' in biological studies of eutrophication effects at the seabed. (This information was sought by way of re-assurance for biologists who are dependent on the physico-chemical data for correct interpretations of possible eutrophication effects in the OSPAR area.)

ANNEX 11

ACTION LIST

1) **Members** to critically evaluate revised guidelines for the development of a QA programme in the Baltic area, produced by SGQAB, from the standpoint of their applicability to the OSPAR area.

2) **Members** to report on any experiences with implementation of JAMP guidelines, and QA implications.

3) **Members** to review proposals regarding the new ICES biological data reporting format.

4) **Members** to report on the development of criteria for evaluating the acceptability of data, including the role of certification of individual taxonomic expertise in a QA context.

5) **ICES Secretariat** to ensure that there is reciprocal exchange of SGQAB, SGQAC and SGQAE reports among members, and that the chairmen of the Phytoplankton Ecology and Benthos Ecology WGs also receive copies of the SGQAE report.

6) **J. Pawlak** to ensure that any update of the 1997 ASMO paper on the distribution of JAMP sampling (which presently does not include information on chlorophyll *a*, phytoplankton, macrozoobenthos and macrophytobenthos stations) is circulated to members.

7) **Dr Shwarzbach** to report on intersessional activities of the ICES/HELCOM QA groups (SGQAB, SGQAC).

8) **Dr Jensen and Dr Rees** to report on QA-related issues arising from the 1998 ICES Benthos Ecology WG meeting.

9) **Dr Dahl** to report on QA-related issues arising from the 1998 meeting of the ICES WG on Phytoplankton Ecology.

10) **Dr Rees** to write to the chairmen of the Phytoplankton Ecology and Benthos Ecology Working Groups with a request for consideration of QA issues by these Groups in 1998.

11) **Dr Rees** to write to the Chairman of the ICES WG on Marine Sediments in relation to Pollution concerning the state of development of QA procedures covering particle size analyses, and the determination of redox potential and organic matter content of sediments.

ANNEX 12

RECOMMENDATIONS

SGQAE recommends that it meet at ICES Headquarters for four days during the last half of February 1999 in order to:

a) review guidelines for development of a QA programme in the Baltic area, produced by SGQAB, evaluate their suitability for application to the OSPAR area, and make appropriate recommendations;

b) consider QA in relation to survey objectives and design, with particular reference to the outcome of discussions in the relevant ICES Working Groups and in other fora;

c) advise on approaches to the development of quality assurance manuals;

d) harmonise QA approaches in the OSPAR and HELCOM areas through joint activities with SGQAB;

e) review the draft biological reporting format produced by the ICES Environmental Data Centre;

f) review progress in the application of JAMP guidelines and associated QA activities, especially the outcome of workshops/intercomparison exercises, within OSPAR member countries;

g) further evaluate criteria for judging the acceptability of biological data in international monitoring programmes;

h) review progress in the preparation of appropriate taxonomic lists, especially for phytoplankton.