REPORT OF THE

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

ICES Headquarters
16–19 February 1999

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1 INTRODUCTION

The ICES/OSPAR Steering Group on Quality Assurance of Biological Measurements Related to Eutrophication Effects (SGQAE) arranged its third meeting at the ICES Headquarters in Copenhagen from 16 to 19 February 1999 with Dr Hubert Rees (UK) chairing the meeting. A list of participants attending the meeting is attached in Annex 1.

The Chair opened the meeting at 10.00 hrs on 16 February, stating the fact that the agenda (Agenda item 10) calls for a somewhat wider role of SGQAE in preparing QA principles and guidelines than stated in the original terms of reference for the Group (SIME 97/6/7-E). Also in view of the attendance at the SGQAE meeting, it was stated that the missing of certain OSPAR countries should not preclude the preparation of QA guidelines or manuals for the OSPAR area.

The terms of reference for the 1999 meeting of the Steering Group, as proposed by the Steering Group (SGQAE 1998 report, Annex 14), were adopted by the ICES Council as ICES C.Res.1998/2:12:11 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 1999 meeting and to the Baltic, Marine Habitat and Oceanography Committees at the 1999 ICES Annual Science Conference.

2 APPOINTMENT OF RAPPORTEUR

Dr Torgeir Bakke was appointed as Rapporteur for the meeting.

3 ADOPTION OF AGENDA

The revised agenda, as shown in Annex 2, was adopted for the meeting. The group envisaged that agenda item 8 (development of OSPAR/ICES QA guidelines), agenda item 10 (QA in relation to survey objectives and design), and agenda item 11 (Advice on development of QA manuals) are interconnected, and most fruitfully should be treated together. Regarding agenda item 9, Dr Colijn informed the meeting that no report was available since the planned meeting of the SGPHYT to prepare the report had been cancelled. A list of working documents considered at the meeting 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

4.1 Belgium

4.1.1 Eutrophication-related monitoring

Monitoring programmes related to eutrophication effects involve three laboratories from Belgian institutes including one university: MUMM (Management Unit of the North Sea Mathematical Models), GMMA-ULB (Groupe de Microbiologie des Milieux Aquatiques, Université Libre de Bruxelles) and RVZ (Rijkssstation voor Zeewisserij). These monitoring programmes include chlorophyll $a$, phytoplankton and macrozoobenthos as well as related environmental parameters.
A high-resolution time series sampling at the reference station in the Belgian coastal zone includes inorganic nutrients measurements, phytoplankton identification, phyto-, bacterio-, protozoo- and mesozoo-plankton enumeration and biomass determination as well as associated environmental parameters (salinity, temperature, turbidity). This monitoring programme is part of the five-year (1997–2001) research project AMORE ‘Advanced Modeling and Research on Eutrophication’ financed by the Belgian authorities under the framework of the Sustainable Development of the North Sea programme. The aim of this project is to study the quantitative changes in the coastal planktonic food-web in the ecosystem dominated by *Phaeocystis* related to reductions in nutrient inputs.

The spatial distribution of phytoplankton (chlorophyll *a*, species enumeration and identification, DOC) and associated parameters is assessed through MUMM’s monitoring performed in the frame of the OSPAR Convention. This monitoring includes a geographical survey four times per year of the national network of marine stations covering the whole Belgian coastal area and the Scheldt estuary.

### 4.1.2 QA activities

Belgium is presently developing a programme for QA for biological measurements. As a first step, a standard operating procedure (SOP) for sampling, storage, analysis, and data reporting for chlorophyll *a* has been produced by MUMM (in Dutch) according to national and international standards. Similar initiatives will be developed for phytoplankton enumeration and biomass determination.

It is also planned that QA procedures will include participation in national and international intercalibration exercises.

### 4.2 The Netherlands

#### 4.2.1 Eutrophication-related work

In 1989 the Directorate-General of Public Works and Water Management initiated a biological monitoring programme. The primary goal of this programme is to provide biological information, especially long-term developments, in the framework of the Monitoring of the National Water Systems. Within this context there are also chemical and physical (oceanographic) programmes which, as far as possible, are harmonized with each other in order to assess the ecosystem quality as a whole. The monitoring of the salt waters (marshes), the estuaries and the Dutch part of the continental shelf is coordinated by the National Institute for Coastal and Marine Management (RIKZ). With regard to eutrophication and biological effects, the biological programme covers the following parameters:

- chlorophyll (actually carried out as part of the chemical programme);
- phytoplankton;
- zooplankton;
- macrozoobenthos in soft sediments;
- flora and fauna on hard substrates;
- salt marshes;
- sea grass;
- water birds (along the coasts and in estuaries);
- seabirds;
- sea mammals.

New items that are on the list and, if possible, will be added to the programme are:

- mesozooplankton;
- epibenthos, a pilot study is to be done;
- fish, commercial as well as non-commercial, in cooperation with RIVO.

Additionally, a formal contribution to the Continuous Plankton Recorder project (AMFOS) is being made.

Until recently most of the data were stored in (individual) scientist’s databases. Effort is being put into converting old data, then storing them along with recent data in a central database (Donar) which already contains the chemical and physical data. At present, an evaluation of the biological monitoring programme is being carried out. This includes an
investigation to determine whether the programme still meets the information requirements as well as a statistical analysis of the data. As a consequence of the evaluation process, the programme may be modified.

4.2.2 QA activities

Sampling procedures as well as data measurements are carried out according to internal Standard Operating Procedures (SOPs, on paper). Chlorophyll is measured at RIKZ laboratories which are under review for accreditation by STERLAB. There is an interest in participating in intercomparison exercises, firstly for phytoplankton, secondly for macrozoobenthos.

4.3 Germany

4.3.1 Eutrophication-related studies

Two large research programmes dealing with eutrophication in the German Bight and the Wadden Sea were finished last year and the results are now in the process of being published: the German Bight programme was called KUSTOS and the Wadden Sea-related one TRANSWATT. Strong emphasis was placed on transport processes but also on the role of the Wadden Sea in the conversion of inorganic nutrients into organic material (primary production), and mineralization in the water column. Detailed information is available from the coordinators, Prof. Jürgen Sündermann at the Institute for Marine Research in Hamburg and Dr Karl Hesse at the Research and Technology Centre in Büsum (part of Kiel University). Long-term series on nutrients and phytoplankton on Helgoland Roads and Sylt will be continued in the future after positions have been reappointed.

4.3.2 QA-related activities

QA-related activities are under way in Germany for the monitoring of phytoplankton and macrozoobenthos in the North Sea (BMLP), the Wadden Sea (TMP), and the Baltic Sea (BMP). The current status of QA activities is depicted in Table 4.3.2.1, which indicates the types of activities presently in place. All activities are related to QA procedures for the identification of phytoplankton and macrozoobenthos in soft sediments.

Table 4.3.2.1. QA measures under the framework of the BMLP North Sea, Wadden Sea, and Baltic Sea (1998/1999).

<table>
<thead>
<tr>
<th>Laboratory intercomparison tests</th>
<th>Date, Status</th>
</tr>
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<tbody>
<tr>
<td>1. ring test with cultivated algal species</td>
<td>May–Aug.1998, report in progress</td>
</tr>
<tr>
<td>2. ring test on phytoplankton species identification via photographs</td>
<td>September–Oct 1998, report in progress</td>
</tr>
<tr>
<td>3. ring test with natural spring/summer phytoplankton</td>
<td>test is still running</td>
</tr>
<tr>
<td>Workshops</td>
<td></td>
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<tr>
<td>1st taxonomic workshop on phytoplankton in Kiel (small flagellates)</td>
<td>March 1998, report in progress</td>
</tr>
<tr>
<td>1st taxonomic workshop on macrozoobenthos in Neu Broderstorf (selected polychaete families)</td>
<td>March 1998, report available (in German)</td>
</tr>
<tr>
<td>2nd taxonomic workshop on phytoplankton in Büsum (unidentified species)</td>
<td>November 1998, report in progress</td>
</tr>
<tr>
<td>2nd taxonomic workshop on macrozoobenthos in Neu Broderstorf (Amphipods, unification of species lists)</td>
<td>September/October 1998, report in progress</td>
</tr>
<tr>
<td>Species lists</td>
<td></td>
</tr>
<tr>
<td>Standardized species list of macrozoobenthos</td>
<td>list available</td>
</tr>
</tbody>
</table>

All reports will be published in German with an English summary. The reports will be available in draft form in May 1999, and will later be made available through the Internet. The evaluation of the ring tests on phytoplankton and macrozoobenthos will be performed in national workshops in 1999. At present, there are no QA-related activities for macrophytobenthos and zooplankton in Germany. For phytoplankton several plans to participate in international ring tests are under way. Within the Fifth Framework Programme of the EU, a proposal will be submitted on the QA of phytoplankton (coordination by A. Zingone, Italy; German participation by FTZ, F. Colijn, and AWI/BAH).

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Regarding chlorophyll $a$, several comparative investigations have been performed within the labs involved in the National Monitoring Network (BLMP). It was agreed to use the results when considering which method performed best.

4.4 Norway

4.4.1 Eutrophication-related work

The National Coastal Monitoring Programme, in operation since 1989, has been extended for at least five years from 1999. The programme focuses on detecting long-term changes in the coastal ecosystem primarily as an effect of eutrophication. The comparison between Norwegian and Swedish monitoring methods on hard-bottom communities, which was done during the spring 1997 survey, has not yet been reported. The comparison dealt with photographic registration methods only.

Weekly updated information on the occurrence of selected harmful algae in areas of mussel production is now obligatory for mussel producers in Norway who want to sell in the market. Phytoplankton experts who perform the identification and enumeration of algae are expected to have some formal competence, but a formal quality control of this kind has not been established.

4.4.2 QA activities in 1998

Parallel analyses of chlorophyll $a$ among the participating laboratories of the National Coastal Monitoring Programme continue on a regular basis.

In autumn 1998, several scientists from Norway and Sweden participated in an exercise on phytoplankton identification and quantification. Lugol-fixed natural seawater subsamples were distributed to each participating laboratory with the request to quantify four different species present (Dinophysis acuminata, D. acuta, D. norwegica, and Gyrodinium aureolum) using their own standard procedure. The exercise covered different concentration (none, sedimentation, and filtration) and counting (inverted microscope, counting chambers) methods. Preliminary conclusions indicate that although all participants demonstrated skill and competence, the abundance figures showed considerable species-dependent variability, from a factor of 2 for Dinophysis to 6 for Gyrodinium. Most of the variability was probably due to statistical variation related to the number of cells counted.

A Norwegian standard (NS-9423) for quantitative analysis of marine sublittoral soft-bottom benthic fauna has now been produced by the Norwegian General Standardizing Body. The standard has been produced in harmony with the JAMP Guidelines for benthos and the activities of the ICES BEWG. A copy of NS-9423 (currently available only in Norwegian) will be distributed to SGQAE members.

A formal accreditation certification system for sampling and analysis of soft-bottom grab samples is now in operation in Norway. At this time, two scientific companies are accredited according to the system and several are preparing for accreditation. The system requires an annual assessment and renewal of certification. The State Pollution Control Authority will in principle only contract accredited institutions to perform components of the national monitoring programme.

4.5 Sweden

4.5.1 Eutrophication-related work

Monitoring programmes related to eutrophication effects in the Swedish OSPAR area, i.e., the Skagerrak, are executed by SMHI, Oceanographic Services and Kristineberg Marine Research Station. The programmes include physical, chemical, and biological investigations in the pelagic system and macrozoobenthos. The pelagic ‘offshore’ programme covers about four ‘basic’ stations visited 8–10 times per year and fifteen ‘mapping’ stations visited 1–2 times per year. Coastal regional pelagic programmes include about fifteen stations that are sampled once per month. In the national macrozoobenthos programme there are eleven stations, sampled once a year. There are also coastal regional programmes which comprise eight stations, also sampled once a year.
4.5.2 Quality assurance

All physical and chemical pelagic monitoring is done by accredited laboratories and there is a strict protocol for the in-house quality control. There is also a strict quality assurance protocol for the delivery of data to the data hosts and the management of data. Among the biological parameters only chlorophyll a is currently accredited, but there is work going on in order to get accreditation of quantitative phytoplankton species composition and primary production.

Sweden is continuously taking part in comparisons, tests, and training courses. In 1998 Sweden took part in a preliminary intercomparison in phytoplankton identification and quantification organized by Norway (see Section 4.4.2).

Sweden will take part in the Phytoplankton QA programme that has been submitted to the Fifth Framework Programme of the EC (coordination by Dr A. Zingone, Naples, Italy; Swedish participation by Dr L. Edler, SMHI).

4.6 United Kingdom

4.6.1 Activities of the UK National Marine Biological AQC Scheme (NMBAQC)

The UK National Marine Biological AQC Scheme is currently in its fifth year. It is intended to ensure the quality of macrobenthic data submitted to the UK National Marine Monitoring Programme (NMMP), but also has wider benefits in the conduct of marine and estuarine pollution surveys in UK waters. The scheme has addressed the efficiency of sorting and identification of benthic macrofaunal samples, and also the efficiency of biomass determination. Because of the relevance of sediment type to interpretation of biological data, competence in sediment particle-size analysis is also addressed. In 1997, the NMBAQC organised a field methods workshop dealing with the efficiency of sampling and initial processing of material (reported earlier), and has also had a role in sponsoring taxonomic workshops. Further workshops are planned in cooperation with other UK agencies, including a workshop concerning issues of epifaunal sampling and sampling design.

A total of 27 laboratories presently participate, ranging from regulatory authorities and University departments to private-sector consultants. In 1997/1998, evaluation of performance was done by the following means:

a) three participant-supplied macrobenthic samples (OS) to be (re)analysed by a nominated contractor;
b) ring tests:
   i) one normal ring test of twenty-five species to be supplied by the contractor,
   ii) one participant-supplied set of twenty-five species to be sent to the contractor for validation,
   iii) one ring test targeted at ‘problem taxa’ highlighted throughout the scheme;
c) one contractor-supplied macrobenthic sample (MB);
d) two sediment samples for particle-size analysis.

The aims of these exercises, along with a general summary of the outcome, were as follows:

- **Ring tests** (RTs) are generally accepted as a method of improving learning skills relating to taxonomy. Laboratories generally achieved good results. Areas of difficulty emerged with particular faunal groups that were tackled by the targeted RT and individual feedback. The standard ring test formed part of the core programme. It is recognised that the contractor-supplied ring tests do not necessarily reflect the skills of individual laboratories and for this reason RTs have not been used to set a pass/fail standard for NMMP labs. They can, however, be used to reflect overall lab performance and improve skills.

- The **Laboratory Reference** (LR) was perceived as a parallel to OS returns, i.e., this component test would apply quality control to ‘own specimens’. It has transpired however that while some laboratories are only beginning to set up a marine voucher collection, others have used the LR exercise to acquire a second opinion on their ‘difficult specimens’ from a consultant, rather than as a check on a range of their ‘standard’ fauna. If this component acquires a pass/fail standard, labs may well choose to send specimens they are confident in to achieve a high score! In the meantime, labs are urged to consider this component in a more ‘random’ fashion, selecting a range of animals from across a spectrum of taxa, substrates, and salinities if possible.

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• The MB sample, though sourced from a geographical location unfamiliar to many participants, was designed to examine sample processing skills in addition to taxonomic skills. It became apparent that a few labs had some serious problems in overlooking a number of taxa, in addition to many others overlooking some specimens. While overlooking a few individuals might be deemed to be insignificant, if these individuals comprise several taxa in a sparse community, interpretation could be compromised. The MB component is considered by many labs to be irrelevant or too time consuming and returns were not forthcoming.

• Determining biomass is a new skill for many laboratories that do not complete this analysis routinely. The derivation of a standardised effective protocol requires addressing by the NMBAQC committee. Biomass determination is a requirement of NMMP labs but no standard will be assigned by the AQC Committee until skills and protocols have been agreed and tackled.

• Own samples (OS). Pass/Fail standards for the NMMP database have been applied only to OS samples for enumeration and taxon extraction as representing the true reflection of local lab skills. There is no doubt that participants give a lot of weight to these samples and to this end may be selecting samples with specimens on which they are confident in order to gain a pass. A technique to avoid this selectivity will be developed.

• Particle-size determinations are accepted as a routine biological descriptor and can be carried out by a variety of techniques, each of which appears to be fairly consistent in its reproducibility. As a routine and NMMP determinand, this analysis has been assigned a pass/fail standard and must be completed by NMMP labs. Most labs in the scheme carried out the analysis by one of the two preferred techniques in common use.

More specifically, an indication of variability in laboratory performance in the identification of specimens from a ring test is shown in Annex 4, Figure 1, while Figure 2 shows the returns from an exercise to determine variability in the outcome of particle-size analysis. As the scheme has been running for about five years, it is possible to gain an overview of the performance of laboratories across several exercises. Figures 3 and 4 show the percent difference in numbers of taxa and individuals, ranked in increasing order, arising from the analysis by all laboratories of five samples that were subsequently re-analysed by a single contractor. (Note that a negative value indicates that the contractor found fewer species or individuals than was determined by the participating laboratory for that sample, and vice versa.) Figure 3 shows an even distribution in over- and under-reporting of numbers of taxa; Figure 4 shows that most laboratories tended to underestimate actual numbers of individuals.

Issues arising from the Scheme to date include continued problems with consistency in biomass analysis, sorting efficiency and variability in analysis of the fine fraction of sediments. Late returns or non-returns of analysed samples are problematic in a number of cases.

4.6.2 UK National Marine Monitoring Programme: Phase II

The first phase of the UK National Marine Monitoring Programme (NMMP: a spatial survey of environmental conditions at UK estuarine, coastal and offshore stations) has been completed and a summary report produced. (Copies were circulated at the meeting.) Phase II is geared to the evaluation of temporal trends at selected stations, and has the following general aims:

• to initiate monitoring programmes to detect with appropriate accuracy long-term trends in physical, biological, and chemical variables at selected estuarine and coastal sites;

• to support and ensure consistent standards in national and international monitoring programmes for marine environmental quality (for example, EC Directives, OSPAR);

• to make recommendations to the Marine Pollution Monitoring Management Group as to how new analyses and techniques are best implemented in the United Kingdom;

• to coordinate, make optimal use of, and gain maximal information from marine monitoring in the United Kingdom;

• to provide and maintain a high quality datasheet for key chemical and biological variables in the marine environment of the United Kingdom;

• to produce reports providing overviews of the spatial and temporal distributions of these variables and their inter-relationships.
All laboratories contributing to the work must participate in the relevant AQC scheme. A manual dealing with the practical implementation of sampling programmes is to be published shortly (a draft was made available to SGQAE members), and will include (inter alia) procedural guidelines for the collection, processing and analysis of subtidal and intertidal macrobenthic samples, and for the sampling and collection of sediment samples for physico-chemical analysis.

4.6.3 Other UK initiatives

An initiative entitled the Marine Life Information Network for Britain and Ireland (MarLIN) has recently been launched under the management of Keith Hiscock, at the Marine Biological Association, Plymouth. Its purpose is to provide a comprehensive database of information on marine species, communities and habitats, suitable for use in environmental management, conservation and education. Further details of the scheme, including the sources of information that will be utilised, are given in Annex 5.

Mention was made of work by the UK Environment Agency towards the establishment of a photometric method for continuous ship-board determination of chlorophyll a in coastal waters. An outline of this activity is given in Annex 6.

5 QA ISSUES ARISING FROM DISCUSSIONS WITHIN ICES WORKING GROUPS

5.1 Working Group on Phytoplankton Ecology (WGPE)

The Working Group on Phytoplankton Ecology (WGPE) discussed some of the items related to QA at their 1998 meeting. In the Manual for the Measurement of Primary Production in a Standard ICES Incubator (working document SGQAE 1999/1) most aspects of QA were discussed and taken on board. Also in the development of a procedure for standard chlorophyll a analysis, QA aspects such as the availability of pigment standards and the precision of the measurement will be considered. The work is led by Dr F. Rey of the Institute of Marine Research, Bergen, Norway, and is done in cooperation with the MCWG. A first draft is expected by April 1999 which will present a set of alternative procedures including their respective benefits and drawbacks.

Regarding phytoplankton species composition, the introduction of QA elements has proved to be complicated and can only be achieved by making small steps through the organization of workshops to train personnel and the performance of ring tests (see also Section 7). A local ring test was conducted last summer in a joint Norwegian-Swedish project, organized by E. Dahl (cf. Section 4.4.2). During the 1998 meeting of WGPE the recommendation to establish a Study Group on an ICES/IOC Checklist of Phytoplankton (SGPHYT) for the ICES region was agreed and the ICES Council accepted the proposal at the 1998 Annual Science Conference. Terms of Reference (TORs) were formulated for a meeting in Copenhagen in January 1999 with O. Moestrup (Denmark) as Chair of the group. However, this meeting did not take place, so attempts will be made through the WGPE to ensure that the work is done. F. Colijn has contacted O. Moestrup and made agreements on how to proceed. WGPE will continue to shadow this work and try to keep involved because of the pressure foreseen to produce these lists, which are needed for the ICES database system.

5.2 Benthos Ecology Working Group (BEWG)

At the April 1998 BEWG meeting, reports were provided on the activities of SGQAE and SQQAB by members of these groups (Drs Rumohr, Küntzer, and Rees were present). Further details of QA schemes operating in Germany and the UK were also provided. The BEWG endorsed the principle of extending QA approaches to cover issues of survey objectives and sampling design, since these will have a strong influence on any criteria set for data quality and may also be subject to change with time. Progress was made in compiling an inventory of published guidelines for benthos sampling (both within and beyond the ICES/OSPAR area), but it is still incomplete—the latest draft was circulated to SGQAE members, and is given in Annex 7.

Dr Rees (on behalf of the BEWG) undertook to review the content of submitted SOPs from various laboratories to establish the degree of variability in current practices and, in so doing, to allow appropriate recommendations to be made to enhance between-laboratory and between-country consistency in approaches. To date, the responses have been relatively poor, but it is hoped that further submissions prior to the April 1999 BEWG meeting will help to make this a worthwhile exercise. It was emphasised that the identity of individual laboratories would not be revealed (unless specifically requested) in this exercise.

The BEWG produced a draft structure for the preparation of guidelines for epifauna sampling, which would include recommendations regarding quality assurance. Further progress with this aim is anticipated at the 1999 BEWG meeting.
5.3 Working Group on Marine Sediments in Relation to Pollution (WGMS)

Dr Rees referred to the request for information on QA issues in relation to particle-size analysis, determination of organic matter and measurement of redox potential, which was sent to the WGMS after the last meeting of SGQAE. SGQAE has not yet received an answer to the request.

6 ACTIVITIES OF OTHER INTERNATIONAL QA GROUPS, ESPECIALLY SGQAB AND SGQAC

6.1 Joint Session between SGQAE and SGQAB

A joint session between SGQAE and SGQAB was held in the afternoon on 16 February addressing the draft biological data reporting format under development by the ICES Environmental Data Centre, and the possible harmonisation between the QA guidelines developed for the HELCOM COMBINE programme (HELCOM EC 8/97, updated by EC MON 3/98, Part B) and a corresponding set of QA guidelines for biological measurements to be developed for OSPAR/ICES (agenda item 8).

J. Nørrevang Jensen, the ICES Environmental Data Scientist, gave an outline of the draft biological data reporting format by reference to a handout showing the record layout description in the database. According to the current time schedule, the system should be ready for use in July 1999. The presentation was open for comments and several detailed suggestions to improve the layout were given. The handout is attached as Annex 8 to the present report and Steering Group members are encouraged to submit their comments directly to J. Nørrevang Jensen. It was also noted that ICES has a set of principles for QA of data to be submitted to their database. This would be an important input to the SGQAE meeting under agenda item 12.

During the joint session on harmonization of QA guidelines, Dr Henrroth reported that the HELCOM expert groups on phytoplankton and on macrozoobenthos both had arranged taxonomy training courses financed by the Helsinki Commission (cf. working document SGQAE 1999/4). A Finnish proposal to arrange annual ring tests on phytoplankton in the Baltic has also been submitted to the Commission, and is expected to be adopted in March 1999 (Annex 9). A practical outcome of these ring tests will be regional identification keys for selected phytoplankton groups. The phytoplankton expert group anticipated that considerable work remains to be done, especially concerning annotated species lists. It is expected that the ICES database will be very helpful. An updated phytoplankton manual for HELCOM is available on the worldwide web at http://www.helcom.fi/ manual2/contents.html.

Concerning chlorophyll a analysis, there is still an unsolved question on the most appropriate extraction solvent to be used, and SGQAB will await an ICES working group decision on this. Dr Colijn stated that the WGPE did not plan to address the question of solvents during their next meeting in April, but will aim to agree on the rest of the procedures. However, during the WGPE meeting he will refer to the request from SGQAB and SGQAE that a decision on solvents be made.

SGQAB further reported that a proposed guideline for phytobenthos has been produced for HELCOM. The proposal has been adopted by SGQAB as an important background document. A copy of the document was handed over to SGQAE (working document SGQAE 1999/5). The QA aspects of the document emphasized procedural standardization, but did not present any specific QA actions.

The two Steering Groups agreed that a harmonization in the level of QA ambitions in OSPAR and HELCOM is important. SGQAE therefore intends to use the HELCOM COMBINE Programme Manual Part B (working document SGQAE 1999/2) as a basis for preparing a general set of QA guidelines for monitoring in the OSPAR/ICES area. There are also certain QA elements given in the HELCOM COMBINE Programme Manual Part C which in an updated form would be relevant to SGQAE during its meeting.

6.2 Activities of SGQAC

At the SGQAC meeting from 8–11 February 1999, it was decided to recommend to ICES that the Guidelines on QA for Chemical Measurements in the Baltic Sea be published as a stand-alone document. In addition, a technical annex on the measurement uncertainty in chemical analysis was discussed. These documents may be of relevance for the development of QA guidelines in SGQAE, in particular, pertaining to chlorophyll a measurements. SGQAE also noted that SGQAC is planning a workshop on chemical QA procedures to be held in Helsinki in October 1999, during which QA matters related to biological parameters will also be addressed. Measures should be taken to ensure that SGQAE is informed about the outcome of this workshop.

1999 SGQAE Report
6.3 The BEQUALM Project

On 1 November 1998, the EC-funded (Standards, Measurements and Testing Programme) project BEQUALM (Biological Effect Quality Assessment in Monitoring) held its initial meeting in Brussels. The project has its roots in the ICES Working Group on Biological Effects of Contaminants (WGBEC). The project coordinator is Dr P. Matthiessen at CEFAS (UK). Relevant aspects of this project for the Steering Group meeting were presented by F. Colijn and include the improvement of chlorophyll a measurements, phytoplankton species identifications, and macrozoobenthos QA procedures (H. Rumohr). During the joint meeting of SGQAE and SGQAB, it was suggested to extend the ring tests on phytoplankton species composition to the Baltic and the Alga@Line activities. This will be taken into consideration. BEQUALM will also combine their chlorophyll a ring test with QUASIMEME who are planning a chlorophyll intercomparison exercise. This will, if possible, be extended to the Baltic. Further information on BEQUALM can be obtained from the BEQUALM web site at http://www.cefas.co.uk/bequalm.

6.4 Other Initiatives

Further note was made of an EU Concerted Action proposal entitled, ‘The European Register of Marine Species’, involving contributions from nine countries. In addition to the production of a comprehensive species list, the output will incorporate a widely accessible bibliography of identification guides, a register of taxonomic experts and locations of collections of reference specimens, and an Information Pack on European marine biodiversity. Details of this project can be accessed via the worldwide web (www.ermu.biol.soton.ac.uk/index.shtlm).

It was agreed that SGQAE should regularly compile a list of recently arranged and planned workshops, courses, ring tests, etc., on relevant taxonomic issues being arranged nationally or internationally within OSPAR. Members were requested to submit such information to the Chair.

7 REVIEW THE DRAFT BIOLOGICAL DATA REPORTING FORMAT PRODUCED BY THE ICES ENVIRONMENTAL DATA CENTRE

As a follow-up to the presentation by J. Nørrevang Jensen, a demonstration was given of the present data input interface for macrozoobenthos data to the ICES database. The demonstration gave a positive impression of the system as being user-friendly and practical, but it was realized that a lot of work still remains before the whole system is operative for all important biological variables.

A demonstration of the German MUDAP database system for monitoring data was later given to SGQAE by Dr S. Wilhelms of the Federal Maritime and Hydrographic Agency in Hamburg.

In the later discussion on agenda item 7, the importance of having principles for acceptance/rejection of data to the database was emphasised. It is the view of the Steering Group that ICES should not reject data sets at this stage, rather they should establish a system to flag those data sets which in some way or another may be sub-standard. The reason is that data that are inappropriate for some purposes may be fully suitable for others.

With regard to species coding, reference was made to progress (by Derek Moore, FRS, Aberdeen) in the application of hierarchical NODC codes to the recently published Marine Species Directory which lists the marine fauna and flora of the British Isles and surrounding seas. About 40% of the species have been encoded so far, in cooperation with the U.S., and it is intended that the task will be completed in 1999, when a full electronic version will be available.

It was further stated that ICES should not underestimate the effort necessary to resolve inconsistencies between laboratories at the data compilation stage. The experience of the 1986 ICES North Sea Benthos Survey was instructive in this respect and indicated the need for adequate time (and resources) to be allowed for wide consultation, including help from outside experts where necessary.

8 DEVELOPMENT OF OSPAR/ICES GUIDELINES FOR QA OF BIOLOGICAL MEASURES

A draft document on QA guidance for the relevant biological measurements under OSPAR/ICES was prepared, including QA guidance in relation to survey objectives and design (agenda item 10). The basis for the document was the corresponding HELCOM COMBINE Manual Part B (working document SGQAE 1999/2), a Guidance Document on QA in Environmental Monitoring prepared by the Nordic Council of Ministers (working document SGQAE 1999/3), the tables on critical QA factors for biological measurements prepared during the first meeting of the SGQAE, and other relevant documents. The guidance document is attached as Annex 10.

1999 SGQAE Report 9
9 REVIEW PROGRESS IN THE PREPARATION OF TAXONOMIC LISTS (ESPECIALLY PHYTOPLANKTON)

No new information was available regarding the review of taxonomic lists of phytoplankton. The WGPE has reported on and listed several checklists of phytoplankton species in different geographical areas (cf. WGPE 1998, 1999). Because of the lack of taxonomic expertise in the WGPE, the recommendation was made to set up a Study Group with the task of critically reviewing existing compilations. The meeting scheduled for January 1999 to be chaired by Prof. O. Moestrup of the University of Copenhagen was cancelled and new arrangements have been made to continue the work by correspondence. There is substantial pressure on this item because phytoplankton species lists are needed before data import in the ICES database can start. Several European initiatives are under way which might help to support this work (IODC-Dublin; new initiatives within the Fifth Framework Programme under the coordination of A. Zingone from Italy; MBA, Plymouth, Marine Species Directory, etc.). The WGPE will continue to shadow the review process on taxonomic checklists for phytoplankton. For macrozoobenthos this task will be accomplished by the BEWG.

10 QA IN RELATION TO SURVEY OBJECTIVES AND DESIGN

SGQAE stated that quality assurance related to survey objectives and design is an extremely important aspect of the total quality management of biological monitoring programmes and decided to include advice and guidance on this in the draft OSPAR/ICES QA guidelines produced under agenda item 8. One important basic document used to produce these guidelines was the TemaNord report on Quality Assurance in Environmental Monitoring (working document SGQAE 1999/3).

11 ADVICE ON DEVELOPMENT OF QA MANUALS

SGQAE felt that this item had been adequately dealt with under Section 8, above.

12 CRITERIA FOR EVALUATING THE ACCEPTABILITY OF DATA

Because of the very nature of many biological data sets, there is still little experience in setting criteria for the acceptability of data (cf. SGQAE reports from 1997 and 1998). However, some guidelines to improve data quality, which at the same time may be used as criteria, are:

- only those data should be accepted which are closely linked to the objectives set for the programme;

- use of standard up-to-date species check lists is a prerequisite and therefore a criterion for the adoption of data and can, or should, be used as a first quality check;

- re-analysis of a series of samples will enable a comparison of the quality with an independent expert (however, this procedure makes monitoring more expensive);

- incorporation of artificial samples of a known composition could also be used as check on the quality of the identifications (competence, experience); from this an acceptability criterion could be derived: at least 90% of the species in the mixture needs to be identified to accept the data.

The WGPE has not yet considered this aspect of quality control and assessment of data. A general idea will be derived in the upcoming meeting, as well as a direction to proceed.

The BEWG has also discussed the potential for QA of macrobenthos data.

The UK National Marine Biological AQC Scheme (NMBAQC) was set up in order to ensure that macrobenthos data submitted to the UK Marine Monitoring Programme were of a consistent and acceptable quality. To this end, a provisional set of criteria was agreed, to test the outcome of the analysis of samples by participating laboratories. The pass/fail criteria were assigned only to the outcome of the analysis of 'own samples' (OS), i.e., samples taken by individual laboratories participating in the scheme, which were then reconstituted, and re-analysed by the contractor.
i) ‘Own sample’—total taxa

This flag relates to the performance of the laboratory with respect to the efficiency with which the animals were extracted from a sample collected by that laboratory. The ‘correct’ total number of taxa is assumed to be that resulting from re-analysis of the sample by the nominated contractor. To achieve a pass the number of taxa extracted should be within ± 10 % or ± 2 taxa (whichever is greater) of the total.

ii) ‘Own sample’—total individuals

This flag reflects the efficiency with which a laboratory estimated the number of individuals in the sample. The total should be within ± 10 % or ± 2 individuals (whichever is greater) of the total resulting from re-analysis of the sample by the nominated contractor.

iii) ‘Own sample’—total biomass

The total value should be within ± 20 % of the value obtained from re-analysis of the sample.

iv) ‘Own sample’—Bray-Curtis comparison

Comparison of the two data sets, from re-analysis by the nominated contractor, and by the participating laboratory, should result in a Bray-Curtis similarity index of ≥ 90 %.

v) Particle-size analysis—silt/clay fraction

A laboratory is required to determine the silt/clay (< 63 micron) fraction to within ± 10 % of the mean of the results from all laboratories.

To attain an overall ‘pass’ flag for the OS exercise on which to base a filtering system for the NMMP database, it is required that (in any one year) laboratories obtain passes for six of the nine individually flagged exercises, i.e., 3 samples x 3 flagged items (numbers of taxa, individuals and Bray-Curtis similarity).

Because of the considerable variation in the estimation of biomass, the flag for this component was excluded from the determination of the overall flag for the OS exercise. Laboratories failing to supply OS or PS data were automatically assigned a fail flag by default.

The outcome of application of the above system to 1997/1998 data was that, while individually very few laboratories had consistent problems, eight of sixteen NMMP laboratories failed overall, seven of which supplied insufficient or no OS data (these were deemed to have failed). (Overall flags can only be applied to laboratories participating in biological components. They are not applicable to laboratories only participating in analysis of particle-size samples.) Achievement of the biological standards appeared to be posing a challenge for a number of laboratories. It is intended that the standards will be re-assessed (not necessarily relaxed) and peer reviewed in the near future. Particle size poses less of a challenge to laboratories although a number failed to return data and thus failed by default.

Criteria for evaluating the acceptability of samples during field collection are less well developed. However, for grab samples collected under NMMP auspices, those less than 5 cm depth (for sands) and 7 cm depth (in muds) at the centre of the closed grab buckets are routinely rejected.

Finally, it may be noted that the above standards have recently been applied to other UK project work as a means to evaluate data quality, and a report on the outcome is in preparation (a draft was made available to SGQAE members).

The Natural History Museum in UK runs a scheme for the certification, by examination, of proficiency in the identification of several groups of terrestrial, freshwater and marine species (see Annex 11). Such an approach may be viewed as a valuable alternative to formal (and often costly) QA accreditation schemes, in cases where work is conducted by small specialist units involving limited numbers of staff, or even single individuals. At present, marine certification (in the form of an ‘identification qualification’ or IdfQ) is limited to marine benthic macro-invertebrates.
13 DATE/VENUE FOR NEXT SGQAE MEETING

A list of intersessional activities to be performed by Steering Group members was adopted (Annex 12). A draft list of recommendations was discussed with the ICES Environment Adviser, J. Pawlak. Among the items treated, SGQAE agreed to discuss the scientific and QA merits for including additional eutrophication elements (e.g., zooplankton and primary production) during its next meeting.

The Steering Group recommended that it meet at ICES Headquarters in Copenhagen from 15–18 February 2000 in order to address the items listed in Annex 13 as its terms of reference.

14 ANY OTHER BUSINESS

No other issues were raised.

15 CLOSING OF THE MEETING

The Chair closed the meeting at 13.00 hrs on Friday, 19 February 1999.
## ANNEX 1

### LIST OF PARTICIPANTS

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*1999 SGQAE Report*
ANNEX 2

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) QA issues arising from discussions within ICES Working Groups (Working Group on Phytoplankton Ecology (WGPE), Benthos Ecology Working Group (BEWG), Working Group on Marine Sediments in Relation to Pollution (WQMS)).

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).

7) Review the draft biological reporting format produced by the ICES Environmental Data Centre (OSPAR 1998)*.

8) Development of OSPAR/ICES guidelines for QA of biological measures*.

9) Review progress in the preparation of taxonomic lists, especially phytoplankton (via the report of SGPHYT).

10) QA in relation to survey objectives and design.

11) Advice on development of QA manuals.

12) Criteria for evaluating the acceptability of data.

13) Date/venue for the next Steering Group meeting.

14) Any other business.

* Item for discussion during the joint SGQAE/SGQAB session on the afternoon of 16 February and the morning of 17 February.
ANNEX 3

LIST OF WORKING DOCUMENTS


Figure 1. The number of differences at the level of genus and species recorded for each of the participating laboratories for RT10. Arranged in order of increasing number of differences at the level of species.
Figure 2. Particle size distribution curves from participating laboratories for sediment samples from PS11. The average values for the AQC analysis of replicates are included.
Figure 3. Percent difference in number of taxa (arranged in increasing order) arising from the analysis of five macrobenthos samples by a contractor and participating laboratories.

Figure 4. Percent difference in number of individuals (arranged in increasing order) arising from the analysis of five macrobenthos samples by a contractor and participating laboratories.
ANNEX 5

MARINE LIFE INFORMATION NETWORK FOR BRITAIN AND IRELAND

MarLIN

Information to support marine environmental management, protection and education

BUSINESS PLAN

Introduction and Summary

Environmental decision-making requires information. That information is of two main types:

1) Descriptions of where particular habitats, communities and species occur;
2) Descriptions of the features of those habitats, communities and species which indicate sensitivity in relation to natural events and human activities.

The Marine Life Information Network (MarLIN) will provide a structure for linking available data on marine life around Britain and Ireland. MarLIN will improve the access, display and interpretation of information in support of environmental conservation, management, and education.

MarLIN will be the most comprehensive and easily used source of information about marine habitats, communities and species around Britain and Ireland and their sensitivity to natural events and human activities.

Specifically, MarLIN will undertake to:

1) Develop a Network for the location, cataloguing, collation and exchange of information on marine biodiversity in the coastal and shelf seas of Britain and Ireland.
2) Provide the marine node to the National Biodiversity Network (NBN) and adopt and help to develop and promote its standards.
3) Work within the NBN to link with and develop recording centres which will agree and use compatible data entry methods to optimise the utility of the information resource.
4) Develop facilities to access information from the Network of databases so that data on habitats, communities and species can be manipulated and displayed geographically and as text and pictures.
5) Link biodiversity information from the Network interactively with taxonomic, biological and sensitivity information derived from material held in the National Marine Biological Library and other sources to increase its value for environmental decision-making.
6) Develop accessible ‘front-end’ dissemination media for research and educational use, including Internet and ‘local’ versions.
7) Interlink data from various sources in a standardised format to facilitate common access to locational data on habitats, communities and species.
8) Manage marine biological information supplied from a variety of sources and on behalf of a variety of organisations to aid those concerned with environmental protection and management.
9) Develop the tools to analyse information so that it is more directly useful for environmental decision-making required under a wide range of statutes, directives and conventions.
MarLin will be set up by:

1) Establishing the Network by promoting partnerships with data providers and with organisations that undertake environmental decision-making and which require information on the marine environment.

2) Securing funding initially from the partners but later from funding agencies, the National Heritage Lottery Fund, and through income achieved by undertaking commissions etc.

3) Utilising the Marine Nature Conservation Review (MNCR) database, software and information developed in BioMar Viewer, and the facilities available at the Marine Biological Association (in collaboration with NERC-CCMS) to establish the primary links in the data structure.

4) Contributing to the development of the recording centres proposed under the National Biodiversity Network.

There are three pilot programmes initially planned within the project:

1) The seabed data acquisition and interpretation programme. The starting point for this programme is the MNCR database, which holds data from over 29,000 locations. Data sets from a wide variety of sources will be linked via the Network, concentrating especially on offshore areas and the seas to the west of Britain. The data will be capable of interrogation to map species and biotopes and to interpret new data by identifying which biotopes they represent, displaying contextual information and accessing illustrations.

2) The biology and sensitivity key information programme. Biotopes and species pages will be ‘tagged’ with information about their biology, environmental preferences and information that will assist in identifying sensitivity and recoverability in relation to natural events and human activities. A user-friendly front-end will be produced so that the enquirer can identify areas of interest and ask whether any species known to be sensitive or of marine natural heritage importance etc. are present. Hypertext links will access information describing statutes, directives and conventions and key literature sources.

3) The biological recording centres and education programme. This programme links especially to the National Biodiversity Network. It will develop marine biological recording through local recording centres and using amateurs and will promote the educational opportunities offered by access to images and descriptions of biology of biotopes and species and their geographical distributions.

Who, where and how much?

The Marine Life Information Network is being established by the Marine Biological Association of the UK in collaboration with the Joint Nature Conservation Committee and major holders and users of marine biological data and information in Britain and Ireland. The MarLin project team will be based in Plymouth and work will also be undertaken in various appropriate institutes including in Scotland, Wales and Ireland. The project will require in the order of £150,000 p.a. for a viable starter team and up to about £650,000 p.a. for each of three years to fulfil all of its objectives. The project is intended to continue after the three-year consolidation phase to maintain records up-to-date and for specific commissioned work to support its costs.

Contact

Dr Keith Hiscock, Project Director, Marine Life Information Network, Marine Biological Association of the UK, The Laboratory, Citadel Hill, Plymouth PL1 2PB, UK.

Alison Hood, Marine Life Information Network, Marine Biological Association of the UK, The Laboratory, Citadel Hill, Plymouth PL1 2PB, UK. E-mail: ahoo@pml.ac.uk.
ANNEX 6

MEASUREMENT OF CHLOROPHYLL IN COASTAL WATERS: THE ‘CHLOROFLOW’ TECHNIQUE

ICES/OSPAR Steering Group on QA of Biological Measurements Related to Eutrophication Effects


Date: 12 February 1999

PURPOSE

1. To brief the ICES/OSPAR Steering Group on developments in the measurement of chlorophyll in English waters.

INTRODUCTION

There is a requirement under national and international obligations (NMMP2, OSPAR, UWWTD) to accurately measure chlorophyll in coastal and estuarine waters. A large number of measurements over large spatial and temporal scales are required.

A simple to operate boat-based instrument is required. Spectral Signatures have developed such an instrument and over the past year have modified and refined it following tests in the Environment Agency’s Anglian Regions waters.

Under various national and international obligations (OSPAR, NMMP2, UWWTD), Anglian Region is required to monitor the state of its coastal and estuarine waters. A current major requirement is for detailed chlorophyll measurements.

This is currently done by collecting spot samples which are stored on board the vessel and subsequently transferred to the Agency’s laboratory service for analysis. Such an approach does not give sufficient samples to meet the requirement for the unambiguous interpretation of the data. More than 100 samples per month would be required to characterise our coast (with additional sampling for our major estuaries).

Spectral Signatures have developed a shipboard instrument that can measure chlorophyll continuously while the vessel is underway. Recent developmental effort has seen consultation with the Anglian marine section and with coast and estuarine trials aboard Sea Vigil to take account of local needs. The ‘ChloroFlow’ instrument provides in vivo photometric (ivp) measurement of chlorophyll.

The instrument is unique in that:

- it provides real time, discrete and continuous measurements;
- no sample filtering is required;
- no chemicals are required;
- no chlorophyll standards are required;
- it does not require cross calibrating with other methods.

There is obviously a saving in operator (and sampling) time and the ability to use it opportunistically while other surveys are being conducted. There is currently no other instrument with similar capabilities. Fluorometry is the only technique for which a robust system is available for use in the field but can only be used to detect trends or gross changes unless it is calibrated frequently by use of other methods for each specific algal suspension encountered (a complex and time consuming process). Other methods require the chemical extraction of pigments.

1999 SGQAЕ Report
The contacts for the operational development of this instrument are Mike Best (Regional Marine Scientist responsible for project management) and Ulric Wilson (Survey Officer responsible for operational development) at:

Environment Agency Anglian Region
Kingfisher House
Goldhay Way
Orton Goldhay
Peterborough PE2 5ZR
United Kingdom

Tel. 01733 371811
Fax. 01733 464472

Operational development will continue in 1999 with further sea trials in March. Specifically addressing the effects of turbidity in the highly turbid Anglian Region waters. A full report is expected toward the end of 1999.

Roger K Proudfoot
Marine Scientist (Quality)
(address as above)
ANNEX 7

INVENTORY OF PUBLISHED GUIDELINES FOR BENTHOS SAMPLING

DRAFT 09.02.99

1 NATIONAL

Essink, K. 1995. Standard procedures for monitoring macrozoobenthos in intertidal (e.g., Wadden Sea) and subtidal (e.g., North Sea) waters of the Netherlands. (In Dutch).


2 INTERNATIONAL


ANNEX 8

ICES DRAFT BIOLOGICAL DATA REPORTING FORMAT

6.1 RECORD LAYOUT DESCRIPTIONS FOR BIOLOGICAL DATA

6.1.1 File headers

The first record of every file must be a 00-record, specifying the version numbers of the reporting format, the screening program, and the valid code list file. With the release and use of Version 2.3, the following should be included in every file submission: 00 RF2.3 SV1.33 LR1. Periodically, updates of the valid code lists and screening program will be sent out by ICES. The valid file header which applies to the latest update will be supplied with the diskette files. For more information, refer to the screening program documentation.

6.1.2 General field specifications

The following sections describe the layout of each record type found in the biological data reporting format. Each record is presented in the form of a table where the following are described for each data field of the record: the data field code, the data field name, the field column numbers, the valid values for the field, the format for the field, and whether the field is mandatory.

The data field codes and the data field names are described in detail in Section 6 of this manual.

The column numbers refer to the column placement of the field in a given record.

The valid values for the field describe predefined values and ranges, and refer to appropriate annexes in Section 7 of this manual.

The format column for the field indicates the type of variable included in the indicated data field according to one of the following:

- **SPCn**: a 'space filled' character field, consisting of $n$ spaces.
- **CHARn**: a character field of $n$ characters. Character fields are formatted as left-justified, space filled.
- **NUMn**: a numeric (integer) field of width $n$. Integer fields are formatted as right justified, zero filled — e.g., the number 43 in a field NUM4:

```
| 0 | 0 | 4 | 3 |
```

- **NUMnim**: a numeric field of width $n$, including an **implied** decimal point; the rightmost $m$ positions in the field are decimal positions. Values are formatted as decimal justified, zero filled — e.g., the number 3.7 in a field NUM4i2:

```
| 0 | 3 | 7 | 0 |
```

- **NUMnem**: a numeric field of width $n$, including an exponent: the mantissa occupies the leftmost

$n - 4$ positions, including an implied decimal point; the rightmost $m$ positions in the mantissa are decimal positions. The exponent occupies the rightmost 4 positions ('E+dd'); Values are formatted as decimal justified, space filled — e.g., the number 56.1 in a field NUM9e4:

```
| 5 | 6 | 1 | E | 4 | 0 | 1 |
```
The **mandatory**, or 'M', column indicates those data fields which are mandatory in the context of the reporting formats, i.e., data which **must be reported**; the following codes apply:

- **m**  mandatory;
- **m?** mandatory in some cases, e.g., when reporting data for a specific programme;
- **mH** mandatory when reporting data to HELCOM (BMP/COMBINE);
- **mHpp** mandatory when reporting phytoplankton data (pp) to HELCOM (BMP/COMBINE);
- **mHzp** mandatory when reporting zooplankton data (zp) to HELCOM (BMP/COMBINE);
- **mHp** mandatory when reporting phyto-benthos data (pb) to HELCOM (BMP/COMBINE);
- **mHzb** mandatory when reporting zoobenthos data (zb) to HELCOM (BMP/COMBINE);
- **mO** mandatory when reporting data to OSPARCOM (JMP/JAMP);
- **mOpp** mandatory when reporting phytoplankton data (pp) to OSPARCOM (JMP/JAMP);
- **mOzp** mandatory when reporting zooplankton data (zp) to OSPARCOM (JMP/JAMP);
- **mOpb** mandatory when reporting phyto-benthos data (pb) to OSPARCOM (JMP/JAMP);
- **mOzb** mandatory when reporting zoobenthos data (zb) to OSPARCOM (JMP/JAMP);
- **x** mandatory and predefined (i.e., insert the characters specified in the valid values column).
### 6.1.3. Biological Sampling and Sorting Methods Record (30)

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<tr>
<th>Code</th>
<th>Field name</th>
<th>Columns</th>
<th>Databases</th>
<th>Valid values</th>
<th>Format</th>
<th>M</th>
</tr>
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<td>'30'</td>
<td>NUM2</td>
<td>x</td>
</tr>
<tr>
<td>DTYPE</td>
<td>Data type</td>
<td>3–4</td>
<td>PP ZP PB ZB</td>
<td>PB ZB PP ZP</td>
<td>CHAR2</td>
<td>x</td>
</tr>
<tr>
<td>RLABO</td>
<td>Reporting institute code</td>
<td>5–8</td>
<td>PP ZP PB ZB</td>
<td>Cf. Annex 3</td>
<td>CHAR4</td>
<td>m</td>
</tr>
<tr>
<td>ALABO</td>
<td>Analytical laboratory code</td>
<td>9–12</td>
<td>PP ZP PB ZB</td>
<td>Cf. Annex 3</td>
<td>CHAR4</td>
<td>m</td>
</tr>
<tr>
<td>MYEAR</td>
<td>Monitoring year</td>
<td>13–16</td>
<td>PP ZP PB ZB</td>
<td>1900 to present</td>
<td>NUM4</td>
<td>m</td>
</tr>
<tr>
<td>BSLNK</td>
<td>Biological sampling link</td>
<td>17–18</td>
<td>PP ZP PB ZB</td>
<td>01–99</td>
<td>NUM2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Field not used in biological data</td>
<td>19–24</td>
<td></td>
<td>spaces</td>
<td>SPC6</td>
<td></td>
</tr>
<tr>
<td>BDMET</td>
<td>Biological data sampling method</td>
<td>25–27</td>
<td>PP ZP PB ZB</td>
<td>Cf. Annex</td>
<td>CHAR3</td>
<td></td>
</tr>
<tr>
<td>PDMET</td>
<td>Plankton depth method</td>
<td>28–30</td>
<td>PP ZP PB ZB</td>
<td>Cf. Annex</td>
<td>CHAR3</td>
<td></td>
</tr>
<tr>
<td>SMVOL</td>
<td>Sample volume (l)</td>
<td>31–34</td>
<td>PP ZP PB ZB</td>
<td>0001–9999</td>
<td>NUM4</td>
<td></td>
</tr>
<tr>
<td>SSTYP</td>
<td>Sediment sampler type</td>
<td>35–36</td>
<td>ZP</td>
<td>ZB</td>
<td>CHAR2</td>
<td></td>
</tr>
<tr>
<td>SAREA</td>
<td>Sample area opening (cm²)</td>
<td>37–41</td>
<td>ZP ZB PB ZB</td>
<td>ZB 1–10000</td>
<td>NUM5</td>
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</tr>
<tr>
<td>MESH5</td>
<td>Mesh size of net or sieve (µm)</td>
<td>42–45</td>
<td>ZP PB ZB ZB</td>
<td>ZB</td>
<td>NUM4</td>
<td></td>
</tr>
<tr>
<td>WIRAN</td>
<td>Wire angle</td>
<td>46–47</td>
<td>ZP PB ZB ZB</td>
<td>ZB</td>
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</tr>
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<td>METPR</td>
<td>Method of fixation / preservation of sample</td>
<td>56–57</td>
<td>PP ZP PB ZB</td>
<td>A–z, 0–9</td>
<td>CHAR2</td>
<td>m</td>
</tr>
<tr>
<td>FLMTR</td>
<td>Flowmeter readings (original)</td>
<td>58–62</td>
<td>ZP PB ZB ZB</td>
<td>0–99999</td>
<td>NUM5</td>
<td></td>
</tr>
<tr>
<td>FLTRM</td>
<td>Flowmeter readings (corrected)</td>
<td>63–67</td>
<td>ZP PB ZB ZB</td>
<td>0–99999</td>
<td>NUM5</td>
<td></td>
</tr>
<tr>
<td>SDVOL</td>
<td>Sedimentation volume (ml)</td>
<td>68–70</td>
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<td>ZB</td>
<td>NUM3</td>
<td></td>
</tr>
<tr>
<td>SDTIM</td>
<td>Sedimentation time (hours)</td>
<td>71–72</td>
<td>PP PB ZB ZB</td>
<td>ZB</td>
<td>NUM2</td>
<td></td>
</tr>
<tr>
<td>CDATE</td>
<td>Counting date</td>
<td>73–78</td>
<td>PP PB ZB ZB</td>
<td>197001–present</td>
<td>NUM6</td>
<td></td>
</tr>
<tr>
<td>MLOW</td>
<td>Lowest magnification</td>
<td>79–81</td>
<td>PP PB ZB ZB</td>
<td>0–100</td>
<td>NUM3</td>
<td></td>
</tr>
<tr>
<td>PCLOW</td>
<td>Percent counted with lowest magnification</td>
<td>82–84</td>
<td>PP PB ZB ZB</td>
<td>001–100</td>
<td>NUM3</td>
<td></td>
</tr>
<tr>
<td>COEF1</td>
<td>Coefficient 1</td>
<td>85–87</td>
<td>PP PB PB ZB</td>
<td>001–999</td>
<td>NUM3</td>
<td></td>
</tr>
<tr>
<td>MGMED</td>
<td>Medium magnification</td>
<td>88–90</td>
<td>PP PB ZB ZB</td>
<td>0–100</td>
<td>NUM3</td>
<td></td>
</tr>
<tr>
<td>PCMED</td>
<td>Percent counted with medium magnification</td>
<td>91–93</td>
<td>PP PB ZB ZB</td>
<td>001–100</td>
<td>NUM3</td>
<td></td>
</tr>
<tr>
<td>COEF2</td>
<td>Coefficient 2</td>
<td>94–96</td>
<td>PP PB ZB ZB</td>
<td>001–999</td>
<td>NUM3</td>
<td></td>
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<tr>
<td>MCHG</td>
<td>Highest magnification</td>
<td>97–99</td>
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<td>0–100</td>
<td>NUM3</td>
<td></td>
</tr>
<tr>
<td>PCHG</td>
<td>Percent counted with highest magnification</td>
<td>100–102</td>
<td>PP PB ZB ZB</td>
<td>001–100</td>
<td>NUM3</td>
<td></td>
</tr>
<tr>
<td>COEF3</td>
<td>Coefficient 3</td>
<td>103–105</td>
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<td>001–999</td>
<td>NUM3</td>
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## 6.1.4 Contaminant Analytical Methods Record (21)

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<th>Databases</th>
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<th>Format</th>
<th>M</th>
</tr>
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<td>PP ZP</td>
<td>‘21’</td>
<td>NUM2</td>
<td>x</td>
</tr>
<tr>
<td>DTYPE</td>
<td>Data type</td>
<td>3–4</td>
<td>PP ZP</td>
<td>‘PP’ ‘ZP’</td>
<td>CHAR2</td>
<td>x</td>
</tr>
<tr>
<td>RLABO</td>
<td>Reporting institute code</td>
<td>5–8</td>
<td>PP ZP</td>
<td>cf. Annex 3</td>
<td>CHAR4</td>
<td>m</td>
</tr>
<tr>
<td>ALABO</td>
<td>Analytical laboratory code</td>
<td>9–12</td>
<td>PP ZP</td>
<td>cf. Annex 3</td>
<td>CHAR4</td>
<td>m</td>
</tr>
<tr>
<td>MYEAR</td>
<td>Monitoring year</td>
<td>13–14</td>
<td>PP ZP</td>
<td>’74’ to present year</td>
<td>NUM2</td>
<td>m</td>
</tr>
<tr>
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<td>Parameter code</td>
<td>15–19</td>
<td>PP ZP</td>
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<td>CHAR5</td>
<td>m</td>
</tr>
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<td>AMLNK</td>
<td>Analytical methods link</td>
<td>20–21</td>
<td>PP ZP</td>
<td>01–99</td>
<td>NUM2</td>
<td>m</td>
</tr>
<tr>
<td>METSW</td>
<td>Method of sampling seawater</td>
<td>22–23</td>
<td>PP ZP</td>
<td>A–Z, 0–9</td>
<td>CHAR2</td>
<td>m</td>
</tr>
<tr>
<td>METPT</td>
<td>Method of separation of solids / pretreatment of seawater samples</td>
<td>24–25</td>
<td>PP ZP</td>
<td>A–Z, 0–9 or spaces</td>
<td>CHAR2</td>
<td>m</td>
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<tr>
<td>METEX</td>
<td>Field not used in biological data</td>
<td>26–29</td>
<td>spaces</td>
<td>spaces</td>
<td>SPC4</td>
<td>m</td>
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<tr>
<td>COSED</td>
<td>Field not used in biological data</td>
<td>30–30</td>
<td>spaces</td>
<td>spaces</td>
<td>SPC1</td>
<td>m</td>
</tr>
<tr>
<td>METSP</td>
<td>Method of storage / preservation of water sample</td>
<td>31–32</td>
<td>PP ZP</td>
<td>A–Z, 0–9</td>
<td>CHAR2</td>
<td>m</td>
</tr>
<tr>
<td>METAN</td>
<td>Method of analysis of parameter/contaminant</td>
<td>33–35</td>
<td>PP ZP</td>
<td>A–Z, 0–9</td>
<td>CHAR3</td>
<td>m</td>
</tr>
<tr>
<td>DETLB</td>
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<td>36–36</td>
<td>spaces</td>
<td>spaces</td>
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<td>Detection limit value</td>
<td>37–45</td>
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<td>–0000 to 999999 plus ‘E’ plus –99 to +99</td>
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<td>m</td>
</tr>
<tr>
<td>ICCOD</td>
<td>Intercomparison exercise code</td>
<td>46–49</td>
<td>PP ZP</td>
<td>cf. Annex 4</td>
<td>CHAR4</td>
<td>m</td>
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<tr>
<td>CONCH</td>
<td>Control chart basis</td>
<td>50–52</td>
<td>PP ZP</td>
<td>‘CRM’, ‘IRM’, ‘LRM’ or spaces (cf. Section 6)</td>
<td>CHAR3</td>
<td>mO</td>
</tr>
<tr>
<td>CRMCO</td>
<td>Control chart reference material code</td>
<td>53–60</td>
<td>PP ZP</td>
<td>cf. Annex 14 and Section 6</td>
<td>CHAR8</td>
<td>mO</td>
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<td>CRMMB</td>
<td>Field not used in biological data</td>
<td>61–61</td>
<td>space</td>
<td>space</td>
<td>SPC1</td>
<td>x</td>
</tr>
<tr>
<td>CRMMV</td>
<td>Control chart RM mean value – value</td>
<td>62–70</td>
<td>PP ZP</td>
<td>–0000 to 999999 plus ‘E’ plus –99 to +99, or spaces</td>
<td>NUM9e4</td>
<td>mO</td>
</tr>
<tr>
<td>CRMSD</td>
<td>Control chart reference material – standard deviation</td>
<td>71–79</td>
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<td>NUM9e4</td>
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<td>CRMNM</td>
<td>Control chart reference material – number of measurements</td>
<td>80–81</td>
<td>PP ZP</td>
<td>01–99 or spaces</td>
<td>NUM2</td>
<td>mO</td>
</tr>
<tr>
<td>CRMPE</td>
<td>Control chart reference material – period</td>
<td>82–83</td>
<td>PP ZP</td>
<td>01–99 or spaces</td>
<td>NUM2</td>
<td>mO</td>
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<tr>
<td>RBMEA</td>
<td>Robust mean</td>
<td>84–92</td>
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<td>–0000 to 999999 plus ‘E’ plus –99 to +99, or spaces</td>
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<td>mO</td>
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<tr>
<td>ZSCOR</td>
<td>Z-score</td>
<td>93–101</td>
<td>PP ZP</td>
<td>–0000 to 999999 plus ‘E’ plus –99 to +99, or spaces</td>
<td>NUM9e4</td>
<td>mO</td>
</tr>
<tr>
<td>PSCOR</td>
<td>P-score</td>
<td>102–110</td>
<td>PP ZP</td>
<td>–0000 to 999999 plus ‘E’ plus –99 to +99, or spaces</td>
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### 6.1.5 Sample Master Record (01)

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<th>Columns</th>
<th>Databases</th>
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<th>Format</th>
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<td>Record identifier</td>
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<td>PP</td>
<td>ZP</td>
<td>PB</td>
<td>ZB</td>
</tr>
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<td>Data type</td>
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<td>ZP</td>
<td>PB</td>
<td>ZB</td>
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<td>RLABO</td>
<td>Reporting institute code</td>
<td>5–8</td>
<td>PP</td>
<td>ZP</td>
<td>PB</td>
<td>ZB</td>
</tr>
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<td>Monitoring year</td>
<td>9–12</td>
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<td>ZP</td>
<td>PB</td>
<td>ZB</td>
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<td>ZP</td>
<td>PB</td>
<td>ZB</td>
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<td>ZP</td>
<td>PB</td>
<td>ZB</td>
</tr>
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<td>ZP</td>
<td>PB</td>
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### 6.1.7 Parameter/Contaminant Data Record (10)

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### 6.1.8 Biological Abundance Data Record (38)

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1999 SGQAIE Report

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ANNEX 9

PROJECT PROPOSAL ON QUALITY ASSURANCE OF MACROZOOBENTHOS MONITORING IN THE BALTIC SEA

OVERALL AIM

The overall aim of the project is to improve the quality of zoobenthos identification by arranging taxonomic training workshops for zoobenthologists.

Project manager: XX

Project members: DK  
EE  
FI  
DE  
LV  
LT  
PL  
RU  
SE

The members of this project should be working within the HELCOM Monitoring Programme in the Baltic Sea.

INTRODUCTION

The aim of the zoobenthos monitoring programme within the HELCOM Monitoring Programme was always of central importance to follow changes in the Baltic ecosystem by measuring the abundance, biomass and species number on benthic invertebrates collected at routine stations within the Baltic Sea. Many problems are related to the observed changes in the system such as increased nutrient input, eutrophication and consequent hypoxia, man-made pollution and physical disturbances like trawling and sand and gravel extraction.

The three HELCOM Intercalibration workshops in Stralsund 1979, Rönne 1982 and Visby 1990 focused mainly on sampling differences at sea, sieving and handling, and comparative performance in laboratory procedures. The general outcome was not totally satisfactory. At the last Intercalibration study done in the ICES/HELCOM Workshop on Quality Assurance of Benthic Parameters in the Baltic (Convener: Dr Heye Rumohr) it was decided to do the intercalibration on a regional scale covering the Northern Baltic with the Bothnian Sea and the Gulf of Finland, the central Baltic with the Gulf of Riga, the southern Baltic including the Gdansk Deep, the Bornholm Basin and the Arkona Basin and the Belts Sea with the Kattegat including Mecklenburg Bay and Kiel Bay. Beside a joint sampling study the group performed a ring test from 70 grabs sampled at a station in Kiel Bay that were sorted and identified at a reference lab in Stockholm (ZOOTAX) and sent to the laboratories for re-evaluation. The results of this study revealed a serious problem with taxonomic questions among the participants that was greater than expected. As a consequence an ICES/HELCOM Taxonomic workshop was planned and held in November 1997 at the Zoological Museum in Copenhagen under the direction of lecturers from the Museum headed by D. Eibye-Jacobsen and O. Tendal. The outcome of this very successful workshop was reported to ICES and HELCOM in May/June 1998 by J. Nørrevang-Jensen who was, at that time, with NERI in Roskilde.

This workshop focused mainly on problematic groups of polychaetes, on the generally overlooked group of sponges and of selected bivalve and opisthobranch species. The lecturers provided tailored identification keys for the region that focused on applicability in the monitoring work.

There is a clear need for new taxonomic workshops since the ICES/HELCOM QA workshop requested them as a regular institution on a biannual basis with national workshops in the years between. Future workshops will also focus on biota from the central and Northern Baltic the representation of which was not complete at this event. Meanwhile the revised version of the ICES Techniques in Marine Environmental Sciences (TIMES No. 8) is in press covering not only recommendations for the collection and treatment of benthos samples but also the quality assurance measures when sampling benthos for monitoring purposes. This includes taxonomic training and exercise.

1999 SGQAE Report
The ICES/HELCOM Steering Group on Quality Assurance of Biological Measurements in the Baltic Sea decided at its February 1999 meeting in Copenhagen to write a proposal for two consecutive Taxonomic Workshops in 1999 and 2001 to be held at the Zoological Museum in Copenhagen, one of the leading institutions in the field. This project proposal will be prepared and submitted by Germany.

PROJECT AIMS

Taxonomic Training Course 1999

A taxonomic workshop for twenty persons will be held at the Zoological Museum in Copenhagen for four days in late October/early November 1999 with D. Eibye-Jacobsen and lecturers from the Zoological Museum. The topics shall cover applied taxonomic problems arising from monitoring work in the Baltic Sea and the Kattegat comprising different taxa still to be determined. The participants will be encouraged to bring their own material for demonstration, clarification, and comparison. This workshop will also cover new invaded Baltic species like *Marenzelleria viridis* that is morphologically distinguishable from its close relative *Marenzelleria wirenii* distributed in the North Sea and the Elbe estuary. Both species may nevertheless occur together. The main taxa to be covered will be announced well in advance by the Zoological Museum and the project manager. This will cover crustacea and further problematic polychaete species. If ready, CD-ROMs by ETI, Amsterdam, with computerized identification helps for benthic invertebrates will be tested with the material in question. Special written identification keys will be issued and the outcome of the workshop will be reported to HELCOM by the Project Manager who will attend and moderate the workshop.

In the year 2000 national taxonomic workshops will be held in different countries to disseminate the results of the 1999 workshop to persons engaged in identifying species from monitoring samples and reporting to national databases. This may include experts from private enterprises. Suggestions from these workshops may be forwarded to the Project Manager to be incorporated in the 2001 Training Course also scheduled to take place in Copenhagen.

Taxonomic Training Course 2001

A taxonomic workshop for twenty participants engaged in HELCOM monitoring work will be held during four days in late autumn 2001 (late October/early November) at the Zoological Museum in Copenhagen. Teachers will again include D. Eibye-Jacobsen and expert staff from the Zoological Museum. Taxonomic problems that have not been tackled at the previous workshops and/or that have arisen in the meantime will be covered during this workshop. Participants are again invited to bring their own materials for discussion and further determination by experts. Sampling and conservation methods that reduce destruction of specimens during determination will be discussed. It is anticipated that computer-based identification helps on CD-ROM will be ready for testing (ETI, Amsterdam) at the workshop. This development has been discussed at recent ICES Benthos Ecology Working Group meetings. The results of the training course and the special identification keys will again be reported by the Project Manager to HELCOM, including proposals for a new series of taxonomic training courses to further develop the experiences gained at the 1999/2001 courses.

ESTIMATED COSTS FOR HELCOM

Taxonomic Training Course 1999

- Compensation for three teachers, 1000 DKK per hour, 16 hours: 16 000 DKK (12 800 FIM)
- Travel and accommodation for Project Manager: 4 000 DKK (3 200 FIM)
- Administrative costs: 4 000 DKK (3 200 FIM)
- Total: 24 000 DKK (19 200 FIM)

Taxonomic Training Course 2001

- Compensation for three teachers, 1100 DKK per hour, 16 hours: 17 600 DKK (14 080 FIM)
- Travel and accommodation for Project Manager: 4 400 DKK (3 520 FIM)
- Administrative costs: 4 400 DKK (3 520 FIM)
- Total: 26 400 DKK (21 120 FIM)
- Total sum: 50 400 DKK (40 320 FIM)
REQUIREMENTS FOR THE CONTRACTING PARTIES

To cover the expenses for the participation of the national experts in the training courses.

(This does not exclude additional travel and accommodation grants from the Commission for participants from countries with economy in transition.)

Dr Heye Rumohr
Convener of the ICES/HELCOM Workshop for Quality Assurance of Benthic Parameters in the Baltic

Senior Scientist, Dept. Marine Zoology
Institut für Meereskunde Kiel
Düsternbrooker Weg 20
D-24105 Kiel
ANNEX 10
GENERAL GUIDELINES ON QUALITY ASSURANCE FOR BIOLOGICAL MONITORING IN THE OSPAR AREA
DRAFT (19 Feb 1999)

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DRAFT (19 February 1999)

GENERAL GUIDELINES ON QUALITY ASSURANCE FOR BIOLOGICAL MONITORING
IN THE OSPAR AREA

1 INTRODUCTION

1.1 Need for Quality Assurance of Analytical Procedures in Marine Biological Monitoring

As a consequence of the absence—or improper application—of measures to assure the quality of biological data, information about variations in the status of natural populations both in space and time is often uncertain or misleading, and the effects of political measures to improve the quality of the marine environment cannot be adequately assessed. Therefore, the acquisition of relevant and reliable data is an essential component of any research and monitoring programme associated with marine environmental protection. To obtain such data, the whole analytical process must proceed under a well-established Quality Assurance (QA) programme.

In guiding such a development, the OSPAR Commission has formulated the following quality assurance policy:

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 should be set for each of these activities;

4) Contracting Parties agree to make sure that suitable resources are available nationally (e.g., finances, 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.

1.2 Need for QA Guidelines Specific to Biological Measures

Adherence to well-documented QA/QC procedures is an established part of the activities of most chemical analytical laboratories, often occupying up to 20% of staff time and, in recent years, much effort has been devoted within ICES to improving interlaboratory and inter-country data quality in national/international monitoring programmes. In contrast, much less effort has traditionally been devoted to QA/QC of biological measures employed in marine monitoring. This is largely due to the subsidiary role that many such measures have played in international assessments of environmental quality (with the notable exception of Baltic monitoring activity). Recently, there has been a shift in emphasis within ICES and OSPAR towards holistic evaluations of the biological status of the marine environment in relation to man’s activities. This shift, along with a quite separate development towards increased contracting out of biological analysis by resource-limited regulatory bodies to commercial consultancies (who are, as a result, under competitive pressure to deliver data of a consistent quality), has sharply highlighted the need for more effective and harmonised approaches to QA within and between member countries.

SGQAE has developed the following guidelines with particular reference to the biological targets within its Terms of Reference, namely chlorophyll $a$, phytoplankton, macrozoobenthos and macrophytobenthos. In doing so, SGQAE has freely adapted guidelines applicable to a much larger suite of variables under investigation in the Baltic Monitoring Programme (the COMBINE Programme Part B). While the same general principles governing the development of QA programmes still apply, such adaptation was felt to be necessary as an acknowledgement of the very different organisational structures within which biological work may be conducted in OSPAR member countries. For example, at one extreme, local output may be vested in a single individual, where certification of that individual’s expertise may be more appropriate than a formal system of accreditation requiring a hierarchical QA management structure for its application.
Biological studies at the community level (in this context, macrozoobenthos, phyto-benthos, and phytoplankton) present particular challenges in QA, since each field-collected sample constitutes a unique multivariate entity, i.e., consisting of a combination of species and individuals peculiar to that sample. Of course, this is not to imply that all component species are unique in their occurrence, and some may be sufficiently widespread to be suitable for intercomparison exercises of identification proficiency among many countries. However, many species will be more localised in distribution, and competency in identification may, as a result, be more fairly tested at a regional level.

The general absence of recognised standards governing permissible change in animal communities in response to man-made influences also complicates the setting of criteria governing the acceptability of the data: the latter may often have to be somewhat arbitrary (though, it is to be hoped, 'precautionary') in their derivation.

The purpose of this document is to guide organisations (or individuals) towards the establishment of QA procedures, often for the first time, which will ensure that the data generated are suitable for contributing to international-level assessments of environmental quality. While some elements of any newly-incorporated QA scheme must, from the outset, be considered mandatory, past experience suggests the need for a pragmatic view of how such a scheme will initially proceed. Thus, enhancements in performance may well be step-wise, in response to the adoption of new in-house working procedures, and as lessons are learned from intercomparison exercises, workshops and so on. At this stage, a prevailing climate of encouragement will be the most helpful in facilitating such a progression.

1.3 Strategy for Practical Implementation of QA Programmes for Biological Measures

For phytoplankton/chlorophyll a, the priority is likely to be for international-level QA assessment, at least at the level of sampling methodology, since the same (or similar) approaches will apply throughout the OSPAR area. It is also self-evident that the habitat, i.e., the water column, is dependably present at all locations. This is in contrast to some benthos studies, where site-specific factors may determine differences in target organisms and sampling methods: not all countries will be involved in identical survey and sampling approaches. An example would be the presence or absence of a coastal rocky habitat. Also, biogeographical factors affecting phytoplankton populations and the benthos of widely distributed habitats (such as soft bottoms) may, in practice, limit the scope/necessity for intercomparisons of proficiency in species identification across all OSPAR countries. For example, biogeographical provinces across the OSPAR area range from Arctic Boreal to Lusitanian.

This suggests that a tiered approach to QA initiatives, i.e., varying from the level of the laboratory to the national or international level, would be appropriate. Such an approach would also, incidentally, highlight the priorities that would need to be given to the development of central databases for different subject areas.

It is also to be expected that there will be some examples of entrenched differences in sampling approaches between countries even for comparable habitats, e.g., where evidence for the greater efficiency of one sampling device over another is unconvincing. Here, personal preferences or historical precedents will be influential. There is no intrinsic reason why this should lead to significant problems with the quality of the resulting data, provided that acceptable documentation is available as to accuracy, precision, representativity, etc., of the data. However, the most cost-effective methods should be adopted in any new monitoring programme.

SGQAE emphasises the fundamental importance attached to agreement among participating countries on basic sampling issues such as mesh size, criteria for acceptance/rejection of field samples (e.g., for sediment macrofauna: based on sample volume and visual appearance), and consistency in timing of annual or more frequent surveys. Disparities here will nullify any benefits of sound QA, when it comes to intercomparisons of the results.

As part of this strategy, SGQAE identified a set of critical QA factors and priority QA actions for monitoring the relevant variables (chlorophyll a, phytoplankton, macrozoobenthos and phytobenthos). These are given in Appendix 1.

1.4 Objective

The objective of the Guidelines outlined here is to support laboratories working in marine biological monitoring to produce analytical data of the required quality. The Guidelines may also help to establish or improve quality assurance management in the laboratories concerned. Technical specifications pertaining to the variables of interest can be found in the JAMP guidelines (OSPAR 1997/8).
2 THE QUALITY SYSTEM

2.1 General

'Quality system' is a term used to describe measures which ensure that a laboratory fulfills the requirements for its analytical tasks on a continuing basis. A laboratory should establish and operate a Quality System adequate for the range of activities, i.e., for the type and extent of investigations, for which it has been employed. The Quality System should refer to methodology, organization and staff, equipment, quality audit.

The Quality System must be formalized in a Quality Manual that must be maintained and up-to-date. Some comments and explanations are given in this section.

2.2 Topics of Quality Assurance

In practice, Quality Assurance applies to all aspects of analytical investigation, and includes the following principal elements:

- A knowledge of the purpose of the investigation is essential to establish the required data quality.
- Provision and optimization of appropriate laboratory facilities and analytical equipment.
- Selection and training of staff for the analytical task in question.
- Establishment of definitive directions for appropriate collection, preservation, storage and transport procedures to maintain the integrity of samples prior to analysis.
- Use of suitable pre-treatment procedures prior to the analysis of samples, to prevent cross-contamination and loss of the determinand in the samples.
- Validation of appropriate analytical methods to ensure that measurements are of the required quality to meet the needs of the investigations.
- Conduct of regular intralaboratory checks on the accuracy of routine measurements, by the analysis of appropriate reference materials, to assess whether the analytical methods are remaining under control, and the documentation and interpretation of the results on control charts.
- Participation in interlaboratory quality assessments (proficiency testing schemes, ring tests, training courses) to provide an independent assessment of the laboratory's capability of producing reliable measurements.
- The preparation and use of written instructions, laboratory protocols, laboratory journals, etc., so that specific analytical data can be traced to the relevant samples and vice versa.

2.3 In-house Quality Manual

Every phase of a monitoring or assessment survey, even in small laboratories, must be enforced to ensure the quality of data acquisition, collection, handling and analysis, and subsequent reporting. In-house Quality Manuals must be developed in accordance with appropriate national and international standards and followed rigorously.

The person responsible for authorization and compilation of the Quality Manual should be identified. A distribution list of the quality manual and identification of holders of controlled copies of the quality manual should be included.

The in-house quality manual should contain, as a minimum, the following items or their equivalent:

1) Scope.
2) References.
3) Definitions.
4) Statement of quality policy.
5) Organization and management.
6) Quality system audit and review.
7) A formal listing of the staff involved in the monitoring, analytical and technical work as well as quality control management with respective training, professional qualification and responsibilities within the laboratory.
8) Standard Operating Procedures (SOPs) (see below).
9) Certificates and reports.
10) Sub-contracting of calibration or testing.
11) Outside support services and supplies.
12) Handling of complaints.

2.3.1 **Standard Operating Procedures (SOPs)**

SOPs should describe all steps performed in biological measurement. They should be established for:

- Handling and use of chemicals (i.e., fixatives, preservatives, reagents) used in marine environmental surveys;
- Handling, operating the maintenance and calibrating the field and laboratory equipment;
- Station selection and location, navigational accuracy;
- Collection of biological material;
- Storage of biological material including labelling, checking preservation status;
- Analytical methods of biological material;
- Distribution of biological material to external contractors/taxonomic specialists;
- Identification of biological material including taxonomic expertise of the personnel;
- Recording biological and environmental data;
- Analysis of biological and environmental data;
- Monitoring report writing and documentation including signed protocols in all steps of analysis.

SOPs should contain a description of operational procedures. An outline structure for a SOP (modified from DIN EN 45001, Chapter 5.4.3) is as follows:

- scope of procedure used;
- description of the study target;
- variable to be determined;
- equipment necessary, reference material (e.g., voucher specimens), taxonomic literature used;
- specification of working conditions required for effective sampling;
- description of procedure/method with respect to the following aspects:
  i) sampling and sample treatment, labelling, handling, transport and storage of samples, preparation for laboratory analysis,
  ii) instrument control and calibration,
  iii) recording of data,
  iv) safety aspects;
- criteria to adopt or reject results/measurements;
- data to be recorded and methods for their analysis;
- assessment of uncertainty of measurements.

2.4 **Organization, Management, and Staff**

2.4.1 **Organization**

The Quality System should provide general information on the identity and legal status of the laboratory and should include a statement of the technical role of the laboratory (e.g., employed in marine environmental monitoring).

The information must include general lines of responsibility within the laboratory (including the relationship between management, technical operations, quality control and support services, and any parent or sister organizations). In the case of smaller units, the organizational tasks must be allotted to fewer personnel or even one individual.
2.4.2 Management

Clear job descriptions, qualifications, training, and experience are necessary for all persons concerned with QA and QC. Job descriptions should include a brief summary of function, the pathways of reporting key tasks that the jobholder performs in the laboratory, and limits of authority and responsibility.

2.4.3 Staff

Minimum levels of qualification and experience necessary for engagement of staff and their assignment to respective duties must be defined. Members of staff authorized to use particular items of equipment should be identified and the institution should ensure that all staff receive training adequate to the competent performance of the relevant methods and operation of equipment. A record should be maintained which provides evidence that individual members of staff have been adequately trained and that their competence to carry out specific methods, identifications or techniques has been assessed. Managers should be aware that a change of experienced and well-trained staff might jeopardize the continuation of quality.

In the case of small units employing few staff or even single individuals responsible for the generation of data, a scheme for the certification of individual expertise (e.g., in aspects of species identification) may be a valid alternative to formal accreditation involving a hierarchy of quality managers, which may not be practicable.

2.5 Equipment

As part of its quality system, a laboratory is required to operate a programme for the necessary maintenance and calibration of equipment used in the field and in the laboratory to ensure against bias of results.

General service equipment should be maintained by appropriate cleaning and operational checks where necessary. Calibrations will be necessary where the equipment can significantly affect the analytical result.

Performance checks and service should be carried out at specific intervals on microscopes, balances and other instruments. The frequency of such performance checks will be determined by experience and based on the need, type and previous performance of the equipment.

2.6 Documentation

All biological data produced by a laboratory should be completely documented ('meta-information') and should be traceable back to its origin. The necessary documentation should contain a description of sampling equipment and procedures, reference to SOPs for sampling, sample handling and analytical procedures involved, and the names of persons responsible for Quality Control. In general, one signed protocol should accompany a sample through all steps of processing.

3 QA OF SAMPLING DESIGN

The following account is an edited version of text relating to this issue published by the Nordic Council of Ministers (ref.).

3.1 Quality Objectives

This section describes the planning process, which is the most critical process in the production of environmental information. The basis for all further work is the information requirements, to be described in detail by the users and decision-makers. In order to design a tailor-made environmental monitoring system, the key issue is the final use of data and the final utilization of the information obtained. The objectives of the planned programme shall be clearly and precisely formulated by the user and shall be put in writing.

The user should also formulate the requirements as qualitatively and quantitatively as possible. Precise sets of qualitative targets are essential in optimizing sampling, analysis and data-handling programmes. If data are to be treated statistically, the number of samples, sampling frequency, sampling locations, and other quantitative aspects are of great importance. A statistician experienced in these types of problems should be consulted.
Available resources and monitoring costs influence the programme design. Clear specification of objectives in relation to costs will ensure that only necessary and relevant data are collected. A consideration should also be made of the possible risk of incorrect decisions based on insufficient data acquisition as a result of financial constraints.

Information requirements in relation to available resources are the basic elements in the further planning process. The result of this planning process shall be documented in the quality objectives plan.

Periodic evaluation of the information requirements should be based on monitoring results and changes in the requirements of the users. Stability and continuity are of great importance in the monitoring process, that has an ongoing and iterative character. All changes shall be documented and validated before being implemented.

3.2 Specification of Information Needs

Many different approaches indicating different information needs can be identified in the design of monitoring programmes. There are mainly two broad categories:

- compliance monitoring or the emission-based approach, including sampling and analysis according to national regulations;
- ambient monitoring or the environmental quality approach, including sampling and analysis in order to establish baseline levels or trends, set from the original/desirable state of the environment.

These different approaches are interrelated and complement each other in many ways.

Define in detail the information needs:

- which questions are to be answered;
- which levels of overall reliability are to be attained;
- what are the intended uses of data/results.

The proper level of quality assurance can only be performed when the requirements of the information needed are made explicit.

In monitoring trends in the conditions of the environment, extreme care shall be exercised that observed trends are not influenced or biased by changing methodology, change of laboratory, differences in sample stability, or time and frequency of sampling.

Reuse of monitoring information should always be kept in mind. In case of new and unforeseen environmental questions, thoroughly documented and accessible information may be re-evaluated in the far future, tackling quite new problems and thus the reuse of data should be facilitated as far as possible.

The information needs, as the basis for further work, shall be:

- detailed, specified and put in writing in order to avoid ambiguity;
- subject to review for conformity to legal, scientific, technical and quality expectations;
- approved by top management and included in the quality management plan.

3.3 Strategy and Determinands

After defining the information needs, a strategy for monitoring must be defined. This involves decisions about what information is to be produced by the monitoring system, in order to translate the information needs to data collecting activities. What determinands are to be measured, physical, chemical, biological, microbiological, hydrological, etc., and which levels of quality are required.

The monitoring strategy shall define what is to be determined and in which media, as well as its required quality. The strategy should also include information on the final use of data, including data analysis, compilations, statistical calculations and evaluations.
In designing the monitoring strategy, the selection of determinands is of greatest importance. To obtain the most reliable and complete picture of the state of the environment, an integrated monitoring approach should be recommended, which means coordinating both chemical and biological measurements in order to assess ecosystem quality as a whole.

Spatial monitoring or mapping means coverage of chosen variables within geographically defined areas. It can be made on one occasion or be recurrent mapping. Remote sensing, the use of aerial photographs or satellite images are important tools in early discovery, surveillance and identification of objects to be further studied in field surveys by ground stations. The development of new satellite sensors means that remote sensing may be an alternative to ground stations in the near future.

Model calculations may be seen as an alternative to sampling programmes and/or remote sensing. Models are based on the assumption that a variable will continue to react as previously, depending on changes in one or more other control variables. Models are used for calculating loads and concentrations and for making prognoses. But there are difficulties in making predictions in the state of the environment and models are always simplifications of reality. All models used in monitoring should be clearly described, documented and validated. The quality of models depends mainly on the quality of entity and the correctness of the basic assumptions. Defined action for continuous follow-up and corrections of the model should be included in the quality control plan. Modelling and environmental indicators are further discussed in (ref.).

3.4 Data Quality Objectives

Data quality objectives (DQOs) are qualitative and quantitative statements derived from the DQO-process, which is a systematic planning tool based on a method that identifies and defines the type, quality and quantity of data needed to satisfy a specified use. The DQO-process provides a logical and quantitative framework for finding an appropriate balance between the time and resources that will be used to collect data and the quality of the data needed to make the decision. The quality level may be defined according to the tolerable total measurement uncertainty in different sets of data in order to achieve an acceptable level of confidence in final decisions. The DQO-process stresses the cooperation between the end users of the data and the scientific staff planning the monitoring programme.

The DQO-process was originally developed by the U.S. Environmental Protection Agency. The U.S. EPA has recently changed the three stages mentioned above to be a more manageable ‘seven steps of the DQO-process’. The seven steps are:

- state the problem;
- identify the decision;
- identify inputs to the decision;
- define the study boundaries;
- develop a decision rule;
- specify limits on decision errors;
- optimize the design;

and are fully discussed in the EPA Quality System Series documents. These seven steps of the DQO-process may profitably be applied to all projects where the intention is to collect environmental data and to make a specified decision. The seven-step DQO-process provides a method for establishing decision performance requirements by considering the consequences of decision errors. A statistical sampling design satisfying the DQO can be generated. The introduction of the data quality objectives process in the planning of monitoring programmes is of vital importance. In other cases a similar process is called the graded approach, basing the level of quality on the intended use of the data and the degree of confidence needed in the quality of the results. Quality assurance means to test, define and document the quality level needed and to maintain this quality level in all subsequent steps.

3.5 Sampling Design

The previous parts of this section emphasize the importance of precisely defining the objectives of the monitoring programme. The monitoring strategy considers what is to be measured, e.g., the selection of determinands. The data quality objectives process tries to find the proper balance between time, costs, resources, and the desired quality of the results. The sampling design concentrates on where and when: it specifies which determinands are to be measured at which location, at which time and frequency. In sampling design emphasis may be put on statistics. But it should also be

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borne in mind that the programme designers must have insight into the temporal and spatial variability and other relevant phenomena of the system studied.

In a representative sample, all relevant determinands have the same values as in the system at the point and time of collection. A sampling programme or a set of samples is said to be valid if it gives an adequately accurate representation of temporal and spatial variability of 'environmental quality' for the duration of the monitoring programme.

It must be noted that most factors are interrelated and in part exchangeable. In some cases, there may be a choice between many locations and low frequency of sampling or few locations and frequent sampling.

**Relevant factors in sampling design**

- Sampling location (system homogeneity, number of sampling locations, accessibility and safety precautions);
- Sampling time and frequency (system homogeneity over time, random and cyclic variations);
- Estimated nature and magnitude of total variations;
- Duration of sampling period—discrete or composite samples;
- Methods to change sampling frequency and number of sampling points (systems with a high degree of homogeneity and stability may allow reduction in sampling frequency and locations and vice versa);
- Economic and practical considerations;
- Quality control.

After a complete sampling cycle, all results are to be evaluated and tested to meet the pre-set quality targets.

Expert assessment of the final results may identify weak points and inconsistencies that can be corrected to increase the quality of the programmes.

**3.6 Specification of Sampling Procedures**

Sampling is the starting point in the collection of information and a cornerstone in the monitoring process. Mistakes in sampling may invalidate the whole process and normally it is not possible to correct errors made in sampling. Environmental monitoring means mostly sampling in time, which can never be reproduced. Sampling procedures include sample collection, preservation, transport and storage of samples. All decisions relating to sample strategy and sampling operations shall be thoroughly documented.

**4 QA FOR FIELD WORK**

**4.1 Sea-going Procedures**

The QA of sea-going procedures covers methods, instruments and equipment including their description, SOPs, applicability, limitations, calibration, and maintenance. Safety is also a critical consideration and will be an essential part of any QA programme.

The personnel are an additional important factor for the collection of data with high quality. QA covers the fields of responsibility and authority as well as education, experience, and all aspects of special training.

The description of the measuring site (station, area, transect, etc.) covers not only the unequivocal (geographical) identification of the site, but also the description of the physical environment (depth, sediment, etc.) as well as of the hydrographical and meteorological settings (temperature, salinity, currents, wind direction and speed, cloud cover, etc.). It is an indispensable need to have a comprehensive signed field log that covers all aspects and steps of the sampling process including personnel, instruments and equipment, and recording activity including deviations and deficiencies. A time log preferably using a calibrated time is of use especially when the results have to be combined.

The securing of results from instruments and data loggers is an indispensable and delicate step in QA that can be safeguarded by keeping parallel hard copies of results.

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The securing of samples and material is another important field for QA, where especially a persistent and clear (internal and external) labelling is of importance. Parallel documentation by photo and video can increase reliability.

There is a need for predetermined solutions in case of deviations, malfunctions and deficiencies and in cases of illness of personnel that makes them incapable of fulfilling their tasks.

Further criteria for changes of methods must be set up, including calibration, parallel measuring and other comparative measures. The recording and documentation of these results are very important.

The whole sea-going process (that ends when the samples, materials and documents are handed over to the analytical laboratory) must be accompanied by quality control activities such as:

- simultaneous records with different observers;
- parallel measurements with different instruments;
- test comparisons (intercomparisons);
- field blank samples;
- measuring reference materials;
- securing the stability of measuring instruments in changing ambient conditions (temperature, humidity);
- observing interferences with other instruments or installations of the ship (this includes the need for a stable voltage supply).

4.2 Coastal and Land-based Procedures

(Considerations: Diving: parallel checks among several divers, photo and video documentation, double recording of profiles/transsects, need for specific scientific diver training and certification; strict safety rules).

5 QUALITY ASSESSMENT FOR LABORATORY ANALYSIS AND DATA HANDLING

The objective of a quality assurance programme is to reduce analytical errors to required limits and to assure that the results have a high probability of being of acceptable quality.

5.1 Routine Quality Control

Having developed an analytical system suitable for producing analytical results of the required accuracy, it is of extreme importance to establish a continuous control over the system and to show that all causes of errors remain the same in routine analyses (i.e., that the results are meaningful). In other words, continuous quantitative experimental evidence must be provided in order to demonstrate that the stated performance characteristics of the method chosen remain constant.

[Here examples of within-laboratory quality control for biology are inserted for each variable].

For marine environmental monitoring programmes, it is essential that the data provided by the laboratories involved are comparable. Therefore, activities such as participation in external quality assessment schemes, ring tests, and taxonomic workshops and the use of external specialists by the laboratories concerned should be considered indispensable.

While the use of a validated analytical method and routine quality control (see above) will ensure accurate results within a laboratory, participation in an external quality assessment or proficiency testing scheme provides an independent and continuous means of detecting and guarding against undiscovered sources of errors and acting as a demonstration that the analytical quality control of the laboratory is effective.

Generally, proficiency testing, ring tests, etc., are useful to obtain information about the comparability of results, and ensure that each of the participating laboratories achieves an acceptable level of analytical accuracy.

Most ring tests and proficiency testing schemes are based on the distribution of samples or identical sub-samples (test materials) from a uniform bulk material to the participating laboratories. The test material must be homogeneous and
stable for the duration of the testing period. Amounts of the material should be submitted that are sufficient for the respective determinations.

The samples are analysed by the different laboratories independently of one another, each under repeatable conditions. Participants are free to select the validated method of their choice. It is important that the test material is not treated in any way different from the treatment of samples ordinarily analysed in the laboratory. In this way, the performance established by the proficiency testing results will reflect the actual performance of the laboratory.

Analytical results obtained in the respective laboratories are returned to the organizer where the data are collated, analysed statistically, and reports issued to the participants.

In cases where laboratories are formally accredited, external quality audits are carried out in order to ensure that the laboratory’s policies and procedures, as formulated in the Quality Manual, are being followed.

6 DEFINITIONS

**Accuracy.** Difference between the expected or true value and the actual value obtained. Generally accuracy represents the sum of random error and systematic error or bias.

**Analytical method/process.** The set of written instructions completely defining the procedure to be adopted by the analyst in order to obtain the required analytical result (Wilson, 1970).

An **analytical system** comprises all components involved in producing results from the analysis of samples, i.e., the sampling technique, the ‘method’, the analyst, the laboratory facilities, the instrumental equipment, the nature (matrix, origin) of the sample, and the calibration procedure used.

**Benthos.** Fauna in, on and above the bottom of waters (also in fresh water).

**Calibration** is the set of operations which establishes, under specified conditions, the relationship between values indicated by a measuring instrument or measuring system, or values represented by a material measure, and the corresponding known values.

**External quality assessment.** See Section 5.

**Intercalibration.** Comparative sampling, laboratory analysis, and evaluation with the aim of detecting systematic differences that have to be overcome.

**Intercomparison.** Comparative sampling, laboratory analysis, and evaluation with the aim of detecting systematic differences.

**Macrozoobenthos.** Benthic fauna retained on a 1 mm screen.

**Matrix.** The totality of all components of a material, including its chemical, physical and biological properties.

**Performance characteristics** of an analytical method used under given experimental conditions are a set of quantitative and experimentally determined values for parameters of fundamental importance in assessing the suitability of the method for any given purpose (Wilson, 1970).

**Phytobenthos.** Benthic flora.

**Phytoplankton.** ‘Chlorophyll-containing’, autotrophic, drifting organisms (mainly algae) in aquatic systems.

**Primary production.** Formation of organic material by photosynthesis by phytoplankton.

**Precision.** Closeness between parallel analyses.
Proficiency testing is the determination of the laboratory calibration or testing performance by means of interlaboratory comparisons.

Quality. Characteristic features and properties of an analytical method/analytical system in relation to their suitability to fulfill specific requirements.

Quality Assurance. Quality Assurance (QA) is the total management scheme required to ensure the consistent delivery of quality controlled information fit for a defined purpose. The QA must take into account as many steps of the analytical chain as possible in order to determine the contribution of each step to the total variation. The two principal components of QA are quality control and quality assessment.

Quality Control. The procedures which maintain the measurements within an acceptable level of accuracy and precision.

Quality Assessment. The procedures which provide documented evidence that the quality control is being achieved.

Quality audits are carried out in order to ensure that the laboratory’s policies and procedures, as formulated in the Quality Manual, are being followed.

Quality Manual is a document stating the quality policy and describing the quality system of an organization.

Quality policy. Overall quality objectives of a research unit and laboratory.

Quality system is a term used to describe measures which ensure that a laboratory fulfills the requirements for its analytical tasks on a continuing basis.

Quality Manager. Person responsible for QA (even in small laboratories).

Ring test. Interlaboratory test with either preserved samples, identical samples or artificial samples to compare the laboratory performance.

SOPs. Standard operating procedures. Detailed (cookbook-like) descriptions of analytical procedures in standardized format.

Technical Manager. The post-holder who has overall responsibility for the technical operation of the laboratory and for ensuring that the Quality System requirements are met.

Sample tracking. The ability to trace results or data back to their origin.

Voucher specimens. Specimens from routine collections put under museum curatorship to make later taxonomic checks possible.

Zoobenthos. Benthic fauna.

Zooplankton. Animal-like, heterotrophic organisms drifting in aquatic systems.

7 REFERENCES


## APPENDIX 1

**CRITICAL QA FACTORS AND PRIORITY QA ACTIONS FOR MONITORING CHLOROPHYLL \( a \), PHYTOPLANKTON, MACROZOOBENTHOS, AND MACROPHYTOBENTHOS**

### TABLE 1. CHLOROPHYLL \( a \).

<table>
<thead>
<tr>
<th>Steps</th>
<th>Method diversity</th>
<th>Critical QA factors</th>
<th>Priority QA actions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sampling procedures</td>
<td>3–4 methods according to JAMP Guidelines</td>
<td>Variability in accuracy among methods (effectiveness of methods in coping with patchiness).</td>
<td>intercomparisons (workshops) on sampling method performance: hose vs. bottle sampler vs. ( in situ ) fluorescence</td>
</tr>
<tr>
<td></td>
<td>- pump/hose</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- bottle sampler</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- ( in situ ) fluorescence</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>different QA procedure for chlorophyll ( a ) extracts</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sample analysis</td>
<td>2 (3) principles recommended</td>
<td>Accuracy and precision.</td>
<td>Certified reference material</td>
</tr>
<tr>
<td></td>
<td>- spectrophotometer</td>
<td></td>
<td>International calibration</td>
</tr>
<tr>
<td></td>
<td>- fluorometer</td>
<td></td>
<td>Calibration of ( in situ ) measurements (if ( in situ ) fluorometers are used, they should be calibrated with filtered water samples)</td>
</tr>
<tr>
<td></td>
<td>(-HPLC as clean-up option)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Data treatment</td>
<td>Low variety of statistical methods</td>
<td></td>
<td>Reporting of data should be followed by control charts</td>
</tr>
</tbody>
</table>

**Footnote.** Supplementary variables essential for interpretation of chlorophyll results include: suspended particulate matter, particulate nitrogen and phosphorus, particulate organic carbon, temperature, salinity, and light penetration.
<table>
<thead>
<tr>
<th>Steps</th>
<th>Method diversity</th>
<th>Critical QA factors</th>
<th>Priority QA actions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sampling procedures</td>
<td>High (4)</td>
<td>Large variability in accuracy between methods especially among nets.</td>
<td>Intercomparison of methods</td>
</tr>
<tr>
<td></td>
<td>- water bottles</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- hose</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- pumps</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- nets</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Treatment and storage of samples</td>
<td>High (4–6)</td>
<td>Algae may be impossible to identify as a result of group-specific fixation damage.</td>
<td>Intercomparison of fixative effects</td>
</tr>
<tr>
<td></td>
<td>- different fixatives</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- living samples</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Concentration of samples</td>
<td>High (4)</td>
<td>Large variability in accuracy between methods (species dependent).</td>
<td>Intercomparison of methods</td>
</tr>
<tr>
<td></td>
<td>- sedimentation</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- centrifugation</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- filtration</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- no concentration</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sample analysis</td>
<td>Use of light microscope offers different techniques such as:</td>
<td>Magnification. Quality of optics (resolution).</td>
<td>Intercomparison exercises</td>
</tr>
<tr>
<td></td>
<td>- brightfield</td>
<td></td>
<td>Control of optical quality</td>
</tr>
<tr>
<td></td>
<td>- darkfield</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- phase-contrast</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- epifluorescence</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Species identification</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Biomass transformation</td>
<td>Two main methods:</td>
<td>Large variability in size for the same species.</td>
<td>Use of standard geometric cell shapes</td>
</tr>
<tr>
<td></td>
<td>- cell measurements</td>
<td></td>
<td>Establish lists of standard volumes</td>
</tr>
<tr>
<td></td>
<td>- use of standard volumes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Data treatment</td>
<td>Use of ‘control charts’ with relevant information accompanying the data.</td>
<td>Simplicity and uniformity of control charts.</td>
<td>Develop and maintain control charts</td>
</tr>
</tbody>
</table>

Footnote. Supplementary variables essential for interpretation of phytoplankton results include: particulate and total organic carbon, particulate organic nitrogen, temperature, salinity, and light penetration.
<table>
<thead>
<tr>
<th>Steps</th>
<th>Method diversity</th>
<th>Critical QA factors</th>
<th>Priority QA actions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sampling procedure</td>
<td>High. At least 3 different method principles</td>
<td>Frame and transect work: representative (accuracy) of stations.</td>
<td>Guidelines on assessment of representativity of stations.</td>
</tr>
<tr>
<td></td>
<td>recommended:</td>
<td>Taxonomic competence of field observers.</td>
<td>Taxonomic intercomparison workshops</td>
</tr>
<tr>
<td></td>
<td>- aerial surveillance,</td>
<td></td>
<td>Preparation of regional check lists of taxa</td>
</tr>
<tr>
<td></td>
<td>- shoreline and diving</td>
<td>Operation of photographic and video equipment.</td>
<td>Internal assessment of observer precision (repeated registrations)</td>
</tr>
<tr>
<td></td>
<td>transects and frames,</td>
<td>Photo/video resolution.</td>
<td>Training courses</td>
</tr>
<tr>
<td></td>
<td>- photography or video.</td>
<td></td>
<td>Instrument intercalibration exercises</td>
</tr>
<tr>
<td>Sample analysis</td>
<td>Low for each of the above sampling procedures</td>
<td>Taxonomic competence.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Precision in quantification of abundances from photo and video images.</td>
<td></td>
</tr>
<tr>
<td>Data treatment</td>
<td>Low in OSPAR recommendations</td>
<td>None.</td>
<td>None</td>
</tr>
</tbody>
</table>

*Footnote.* Supplementary variables essential for interpretation of macrophytobenthos results include: substrate type, slope and bearing, presence of loose sediment, degree of wave exposure, tidal range, Secchi disk depth, and salinity.
### TABLE 4. MACROZOOOBENTHOS: HARD BOTTOM.

<table>
<thead>
<tr>
<th>Steps</th>
<th>Method diversity</th>
<th>Critical QA factors</th>
<th>Priority QA actions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sampling procedure</td>
<td>High. At least 3 different method principles recommended:</td>
<td>Frame and transect work: representativity (accuracy) of stations.</td>
<td>Guidelines on assessment of representativity of stations</td>
</tr>
<tr>
<td></td>
<td>- aerial surveillance,</td>
<td>Taxonomic competence of field observers.</td>
<td>Taxonomic intercomparison workshops</td>
</tr>
<tr>
<td></td>
<td>- shoreline and diving transects and frames,</td>
<td>Operation of photographic and video equipment.</td>
<td>Preparation of regional check lists of taxa</td>
</tr>
<tr>
<td></td>
<td>- photography or video.</td>
<td>Photo/video resolution.</td>
<td>Internal assessment of observer precision (repeated registrations)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Training courses</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Instrument intercalibration exercises</td>
</tr>
<tr>
<td>Sample analysis</td>
<td>Low for each sampling procedure</td>
<td>Taxonomic skill.</td>
<td>Taxonomic intercomparison workshops</td>
</tr>
<tr>
<td></td>
<td>High diversity in quantification of abundance (abundance scales)</td>
<td>Precision of quantification of abundances from photo and video images.</td>
<td>Standardized taxonomic lists</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Intercalibration workshops</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>- image analysis procedures</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>- abundance estimates</td>
</tr>
<tr>
<td>Data treatment</td>
<td>Variable principles with respect to inclusion/exclusion of species in community description</td>
<td>Criteria for inclusion of epigrowth and colonial organisms.</td>
<td>Standard approaches to pooling/exclusions of species</td>
</tr>
<tr>
<td></td>
<td>Numerous methods (and software packages) for univariate and multivariate analysis</td>
<td>Consensus on how to treat abundance of colony-forming species.</td>
<td>More specific guidelines</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Inconsistency in handling uncertain identifications.</td>
<td>Recommendations for best practice</td>
</tr>
<tr>
<td></td>
<td></td>
<td>‘Rounding’ errors with different computer packages.</td>
<td>Intercomparisons of analytical output from a standard data set</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Mistakes in data compilation.</td>
<td>Standardized taxonomic lists</td>
</tr>
</tbody>
</table>

**Footnote.** Supplementary variables essential for interpretation of hard-bottom fauna results include: substrate type, slope and bearing, presence of loose sediment, degree of wave exposure, tidal range, dominating macroalgal cover, and salinity.
<table>
<thead>
<tr>
<th>Steps</th>
<th>Method diversity</th>
<th>Critical QA factors</th>
<th>Priority QA actions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sampling procedure</td>
<td>Sample collection: Low; 2 main categories – grabbing and coring.</td>
<td>Variability in sediment and faunal sampling efficiency according to sampler design and handling.</td>
<td>Intercomparisons of sampling devices in the field</td>
</tr>
<tr>
<td></td>
<td>A wide variety of sampler designs are available within these categories</td>
<td>Mesh design (round vs. square, plastic vs. metal), sieving procedures, especially hose pressure.</td>
<td>Agreement on minimum acceptable sample volumes and sample quality</td>
</tr>
<tr>
<td></td>
<td>Field processing: Low; the aim is invariably to extract fauna from sediments, and</td>
<td></td>
<td>Intercomparisons of methods for field sample processing</td>
</tr>
<tr>
<td></td>
<td>to preserve the material.</td>
<td></td>
<td>Recommendations on “best practice”</td>
</tr>
<tr>
<td></td>
<td>Approaches to processing can vary substantially in the details</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sample analysis</td>
<td>Low: manual counting, identifying and weighing of species.</td>
<td>Extraction and sorting efficiency.</td>
<td>Independent (in-house or external) checks on sorting and identification efficiency</td>
</tr>
<tr>
<td></td>
<td>Variability is encountered in: 1) means to extract fauna from residual sediment;</td>
<td>Proficiency of species identification.</td>
<td>Workshops on species identification</td>
</tr>
<tr>
<td></td>
<td>2) use of magnification during sorting; 3) access to up-to-date taxonomic keys;</td>
<td></td>
<td>Access to up-to-date taxonomic keys</td>
</tr>
<tr>
<td></td>
<td>4) biomass determinations</td>
<td>Precision/accuracy of biomass estimates (method-determined).</td>
<td>Standardized taxonomic lists</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Ring tests (identification, counting, biomass)</td>
</tr>
<tr>
<td>Data treatment</td>
<td>High: numerous methods (and software packages) for univariate and multivariate</td>
<td>Inconsistency in handling of uncertain identifications.</td>
<td>Compilation of biomass conversion factors</td>
</tr>
<tr>
<td></td>
<td>analysis</td>
<td>‘Rounding’ errors with different computer packages.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Mistakes in data compilation.</td>
<td></td>
</tr>
</tbody>
</table>

**Footnote 1.** Supplementary variables essential to the interpretation of soft-bottom benthos data include: particle size analyses of sediment sub-samples; measurements of redox potential; concentrations of specified contaminants, e.g., heavy metals; organic matter content; chlorophyll a. QA procedures should already be established for many of these variables. However, for those not presently covered, advice is needed on the appropriate ICES/OSPAR groups to deal with them.

**Footnote 2.** Epi fauna are sampled by a variety of means across both coarse and soft bottoms. QA procedures must also be developed for this group. A wide variety of sampling methods is currently employed (e.g., underwater photography, dredges/sledges, trawls) and, in most cases, the results are strongly method-dependent.
APPENDIX 2

QUALITY AUDIT

Areas of particular importance to a chemistry laboratory (drafted by the WELAC/EURACHEM Working Group, 1992) but in most parts valid also for biology.

1 STAFF

- Staff are properly trained and up-to-date training records are being maintained.
- Tests are only carried out by authorized analysts.
- The performance of staff carrying out analyses is observed.

2 EQUIPMENT

- The equipment in use is suited to its purpose.
- Major instruments are correctly maintained and records of this maintenance are kept.
- Equipment, e.g., balances, thermometers, glassware, time pieces, pipettes, etc., is calibrated, and the appropriate calibration certificates demonstrating traceability to national or international standards are available.
- Calibrated equipment is appropriately labelled or otherwise identified.
- Instrument calibration procedures are documented and records of calibrations are satisfactorily maintained.
- Appropriate instructions for use of equipment are available.
- Instrument performance checks show that performance is within specifications.

3 METHODS AND PROCEDURES

- In-house methods are fully documented and appropriately validated.
- Alterations to methods are appropriately authorized.
- The most up-to-date version of the method is available to the analyst.
- Analyses are following the methods specified.

4 STANDARDS AND CERTIFIED REFERENCE MATERIALS

- The standards actually required for the tests are held.
- The standards are certified or are the ‘best’ available.
- The preparation of working standards is documented.
- Standards and reference materials are properly labelled and correctly stored.
- New batches of standards are compared against old batches before use.
- The correct grade of materials is being used in the tests.
- Where reference materials are certified, copies of the certificate are available for inspection.

5 QUALITY CONTROL

- There is an appropriate degree of calibration for each test.
- Where control charts are used, performance has been maintained within acceptable criteria.
- QC check samples are being tested by the defined procedures, at the required frequency, and there is an up-to-date record of the results and actions taken where results have exceeded action limits.
- Results from the random re-analysis of samples show an acceptable measure of agreement with results from the original analyses.
- Where appropriate, performance in proficiency testing schemes and/or interlaboratory comparisons is satisfactory and has not highlighted any problems or potential problems. Where performance has been unsatisfactory, corrective action has been taken.
6 SAMPLE MANAGEMENT

- There is an effective documented system for receiving samples, identifying samples against requests for analysis, and showing progress of analysis and fate of sample.
- Samples are properly labelled and stored.

7 RECORDS

- Notebooks/worksheets include the date of test, analyst, analyte, sample details, test observations, all rough calculations, any relevant instrument traces, and relevant calibration data.
- Notebooks/worksheets are completed in ink, mistakes are crossed out and not erased, and the records are signed by the analysts.
- Where a mistake is corrected, the alteration is signed by the person making the correction.
- The laboratory's procedures for checking data transfers and calculations are being complied with.
- Vertical audits on random samples have not highlighted any problems (i.e., checks made on a sample, examining all procedures associated with its testing from receipt through to the issue of a report).
- Proof-reading of the final data report has been made.

REFERENCE

ANNEX 11

THE BRITISH NATURAL HISTORY MUSEUM SCHEME ON IDENTIFICATION QUALIFICATION

AIMS

The Natural History Museum’s Identification Qualification (IdQ) scheme was introduced in 1993 with the aim of improving standards in environmental work in the UK by awarding certificates of competence in animal and plant identification to participating biologists and ecologists. Qualification is by examination, and the Natural History Museum (NHM) is the Awarding Body. No similar accreditation scheme exists that specifically addresses identification skills, but the need for quality control in the rapidly growing field of ecological consultancy is widely recognised. Accuracy of identification is of fundamental importance in ecological monitoring, assessment, impact and conservation work as it often underpins the data from which subsequent analyses and interpretations are made.

The NHM IdQ is a vocational qualification. Much thought has gone into developing examination Units which link into the real requirements of the workplace. Since identification skills typically relate to either a particular type of habitat or to a particular systematic group, IdQs have been devised that cover both options. At present, there are about 20 examination Units, with others under active consideration (see below for a selection).

IdQ POLICY GROUP

Within the NHM the IdQ Policy Group has overall responsibility for the development and implementation of the examination project in all its aspects. The team comprises Dr Roger Lincoln (Chairman, Zoology), Dr Peter Barnard (Entomology) and Ian Tittley (Botany).

ADVISORY BOARD

The external Advisory Board is an important feature of the IdQ scheme, and serves to build a strong link between the Museum, as the examining body, and the various outside user groups. The following organisations are represented on the Board, all members having been nominated by their professional institutions: Confederation of British Industry (CBI), Environment Agency (EA), Joint Nature Conservation Committee (JNCC), Institute of Freshwater Ecology (IFE), Field Studies Council (FSC), Institute of Biology (IoB), Institute of Ecology and Environmental Management (IEEM), Institute of Environmental Assessment (IEA) and the Botanical Society of the British Isles. The Advisory Board is chaired by Professor David Bellamy. As the name suggests, the role of the Board is to make recommendations to the Policy Group on all aspects of IdQs – structure, operation and standards.

EXAMINATIONS

The precise structure of the examination varies a good deal depending on the types of animal and plant groups covered by the Unit. Typically, the test is a laboratory-based practical lasting from 3–6 hours, and is held at the NHM in London. Other venues will be offered in future as the scheme develops. Candidates may be given a variety of fresh, preserved, prepared, photographed, videotaped or figured material to identify to species, genus or other taxonomic group as required. The emphasis is on accurate identification and competence in the use of handbooks and keys. Candidates are encouraged to consult keys and other field guides, except where the examination specifically states that they should not be used. Since the time factor is most important, all examination Units are piloted in the first instance to ensure that an appropriate quantity of material is given. The cost of the examination ranges from £200–£250.

IdQ CERTIFICATE

The pass mark for the examination is 90 per cent; successful candidates are awarded an NHM IdQ certificate endorsed by the Museum and the Advisory Board, and have the details entered into the IdQ database. As a further guide, each candidate who completes the examination is notified of the actual percentage mark achieved. The database is the formal register of IdQ certification, and will be accessible to contractors and employers who are seeking confirmation of these awards.
To encourage training in animal and plant identification and the progressive acquisition of skills, an intermediate standard of 70 per cent is also recognised within the examination. Candidates who do not achieve the 90 per cent pass mark but who reach the 70 per cent level receive an Intermediate Standard certificate. This is not the full IdQ qualification but indicates significant progress in that direction.

**IdQ UNITs**

Vascular plants (Ref B011)
Aquatic macrophytes (Ref B012)
Bryophytes (Ref B012)
Bryophytes (Ref B061)
Freshwater macro-invertebrate groups (Ref E061)
Freshwater algae (Ref B051)
British Birds (Ref Z131)
Seaweeds (Ref B021)
Marine diatoms (Ref B032)
Marine and brackish water harpacticoid copepods (Z101)
Rocky shore fauna (Ref Z083)
Estuarine macrofauna (Ref Z084)
Marine meiofauna groups (Ref Z082)
Marine nematodes (Ref Z091)

For further details and application forms please contact the Science Marketing Office.

Roger Lincoln
IdQ Chairman
Examination Information

NAME OF UNIT: MARINE BENTHIC MACRO-INVERTEBRATE GROUPS
REFERENCE NUMBER: Z081
COST OF EXAMINATION: £250
DATE OF EXAMINATION: To be advised

SYNOPSIS

The aim of this examination is to test the application of skills in identifying British benthic marine and brackish water invertebrate groups from a variety of coastal, inshore habitats. Identification will not be required to species-level, but to a higher taxonomic group such as family, order and perhaps class. The emphasis is on breadth of identification skill across taxa rather than depth of knowledge within taxa. The level of difficulty has been matched to the quality standards required for sorting and identifying biological material as part of environmental impact assessments, habitat evaluations and ecological surveys.

Candidates will be expected to demonstrate proficiency in handling and dissecting small invertebrates, and proficiency in the use of microscopes. The examination will cover a wide range of taxonomic groups, with specimens selected to represent the following taxa; Porifera, Cnidaria (Hydrozoa, Anthozoa), Nemertea, sipuncula, Annelida (Oligochaeta, Polychaeta – Polyplacophora, Eunicidae, Hesionidae, Syllidae, Orbinidae, Spionidae, Cirratulidae, Maldanidae, Ampharetidae, Terebellidae, Sabellidae), Pycnogonida (Ectopodidae), Ostracoda, Amphipoda (Lysianassidae, Ampeliscidae, Corophiidae, Gammaridae, Phoxocephalidae, Melitidae, Ischyroceridae), Caprellidea, Isopoda (Gnathiidae, Flabellifera, Janiroidea, Anthuridea), Tanaidacea (Tanaidomorpha, Apsidomorpha), Cumacea, Euphausiacea, Decapoda (Callianassidae, Porcellanidae, Majidae), Mollusca (Caudofoveata, Polyplacophora, Gastropoda – Turritella, Hydrobiidae, Calyptraeidae, Naticidae, Buccinidae, Pyramidellidae, Philinidae; Nudibranchia, Scaphopoda, Pelycypoda – Nuculidae, Mytilidae, Carnidae, Montacutidae, Tellinidae, Veneridae, Hiattellidae) Brachiopoda, Bryozoa, Phoronida, Echinodermata (Crinoidea, Ophiuroidea, Holothuroidea, Echinoidea), Hemichordata (Enteropneusta), Chordata (Asciidiacea).

Most of the examination material will be in the form of alcohol preserved specimens, but may also include slide preparations.

A time element has also been taken into account so that the examination is a realistic test of efficiency of practical work as well as accuracy of identification. There is no restriction on the use of keys, handbooks or other identification manuals.

CANDIDATE GROUPS

Marine biologists and ecologists working for the EA, Water Companies, Water Purification Boards, and Environmental Consultancies; conservation biologists, environmentalists, and taxonomists engaged in assessing, monitoring or evaluating marine habitats and estuaries; also experienced amateurs.

EXAMINATION FORMAT

The examination comprises a practical test lasting about 3 hours and will comprise about 50 specimens which have to be identified to the taxonomic level specified on the examination paper. This material may comprise adult males, females or juveniles, and may be presented as single specimens or small, mixed samples. Familiarity with relevant keys and other identification guides will be essential. One or more specimens from the plankton or from adjacent terrestrial habitats may be included; these need only be recorded as ‘not marine benthos’.

EQUIPMENT

Candidates are encouraged to bring their own microscopes and dissecting equipment. Where this is not possible a binocular dissecting microscope and a compound microscope will be provided for each candidate as appropriate. Facilities for making temporary slide mounts will be available, and standard items such as forceps, mounted needles, slides and cavity blocks will be provided.
Candidates will be expected to bring their own identification keys, handbooks, and other identification aids, although single copies of relevant key works will be provided. Reference collections will not be available, nor can they be brought into the examination room. Any problems over the availability of equipment and literature should be referred to the Museum well in advance of the examination data.

MARKING

The pass mark for the examination is 90 per cent. Candidates achieving the pass mark will receive the full IdQ Certificate. As well as being informed in writing of their result, each candidate will also be given the actual percentage mark achieved.

To encourage training in the identification marine invertebrates and the progressive acquisition of skills, candidates who fail to achieve the 90 per cent pass but who reach the intermediate standard of 70 per cent will be awarded an Intermediate Certificate.

VENUE

The examination will be held at the Natural History Museum, South Kensington, London.

REFERENCE LIST

Familiarity with the following keys will generally be desirable for successful completion of the examination, but in some cases candidates may prefer to use alternatives. The list is intended as a guide only.


ANNEX 12

ACTION LIST

1) **Members** to further refine draft QA guidelines intersessionally and locate specific examples of good practice for inclusion. Further suggestions and amendments are to be sent to the Chairman by the end of December 1999.

2) **Hubert Rees** to write to the Chairs of the Working Group on Phytoplankton Ecology and Benthos Ecology Working Group requesting initial consideration of the draft ICES/OSPAR QA guidelines for biological measures during 1999, and requesting time for formal consideration of the final draft at their respective meetings in 2000.

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

4) **Members** to review the new ICES biological data reporting format intersessionally.

5) **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.

6) **ICES Secretariat** to ensure that there is reciprocal exchange of SGQAB, SGQAC, and SGQAE reports among members, and that the Chairs of the WGPE and BEWG also receive copies.

7) **Heye Rumohr and Hubert Rees** to report on QA-related issues arising from the 1999 ICES Benthos Ecology Working Group meeting.

8) **Franciscus Colijn** to report on QA-related issues arising from the 1999 meeting of the ICES Working Group on Phytoplankton Ecology, especially concerning chlorophyll a.

9) **Heye Rumohr and Torgeir Bakke** to forward benthos SOPs to Dr Rees by mid-March 1999 for contributions to a non-attributable review for BEWG in April 1999.

10) **Heye Rumohr and Franciscus Colijn** to report on BEQUALM activities.

11) **Torgeir Bakke** to review the implications, from a QA standpoint, of a Norwegian assessment of eutrophication along the southwest coastline of Norway using historical data.
ANNEX 13

RECOMMENDATIONS

The ICES/OSPAR Steering Group on Quality Assurance of Biological Measurements Related to Eutrophication Effects [SGQAE] (Chair: Dr H. Rees, UK) recommends that it meet at ICES Headquarters from 15-18 February 2000 to:

a) produce a final draft of OSPAR/ICES QA guidelines for biological measures, for review by the relevant specialist groups;

b) in joint session with SGQAB, review the performance of the biological reporting format produced by the ICES Environmental Data Centre, and the latest draft of the OSPAR/ICES QA guidelines;

c) 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;

d) review progress in the application of JAMP guidelines and associated QA activities, especially the outcome of workshops/intercomparison exercises, within OSPAR Member Countries;

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

f) compile a programme of planned biological workshops/intercalibration exercises/ring tests, etc., relevant to ICES/OSPAR activity, covering the years 2000 and 2001;

g) review the outcome of activities of SGPHYT, and of other comparable efforts in compilation of species lists, with emphasis on QA aspects;

h) discuss the scientific and QA merits for inclusion of additional parameters (especially zooplankton and primary production) in monitoring the effects of eutrophication, in consultation with the relevant working groups;

i) review the outcome of an evaluation, by BEWG, of benthos SOPs and make appropriate recommendations, including the possibility of extending the exercise to other biological measures;

j) follow up results obtained within the BEQUALM project, with the aim of producing recommendations relevant to JAMP guidelines;

k) review QA aspects of a standard method for chlorophyll a determination to be finalised by WGPE.

Justification

a) this will meet the needs of laboratories seeking guidance in evolving new schemes for QA of biological data;

b) joint sessions with SGQAB are an ideal opportunity to discuss matters of common interest and to ensure harmonisation in approaches to QA;

c) this recognises the importance to QA of biological data of decisions made at the programme planning stage;

d) a review of national activities greatly assists in evaluating progress in the development and implementation of QA schemes within OSPAR member countries;

e) progress in this area is essential to facilitate decision-making at the data compilation stage;

f) this is intended to be a helpful reference source for member countries/individual laboratories who wish to participate or organise their own activities. It is also a means for SGQAE to identify gaps in coverage and to recommend appropriate action;

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g) this arises from an earlier ICES request, and is considered to be an important goal related to improvements in QA of biological data;

h) in view of the relevance of these measures to eutrophication studies and, where incorporated into current national programmes, the importance of sound QA, such considerations are considered appropriate for SGQAE, in liaison with the relevant working groups;

i) this task arose from a recommendation of the 1998 SGQAE meeting, and has promise as a means to improve the quality of data;

j) the BEQUALM project includes a benthos component and progress will therefore be highly relevant to SGQAE interests;

k) chlorophyll a falls within the interests of SGQAE and such a review is therefore considered essential.