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REPORT OF THE

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

ICES Headquarters
18–21 February 1997

International Council for the Exploration of the Sea

Conseil International pour l'Exploration de la Mer

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1 OPENING OF MEETING

The Chairman, Dr H. Rees, opened the meeting of the ICES/OSPAR Steering Group on Quality Assurance of Biological Measurements Related to Eutrophication Effects (SGQAE) at ICES Headquarters in Copenhagen at 10.00 hrs on 18 February 1997. A list of participants at the meeting is given in Annex 1.

The creation of this Steering Group parallels activity on the revision of the old Joint Monitoring Programme (JMP) guidelines for a range of monitoring activities in the Oslo and Paris Commissions area. These new Joint Assessment and Monitoring Programme (JAMP) guidelines have a much stronger emphasis on quality assurance (QA) procedures, reflecting earlier problems in this area, especially with regard to synthesising data from different countries for international assessments. The need for proper QA procedures from the point of field collection of samples to the submission of data for international reporting purposes is now well appreciated.

The terms of reference for the 1997 meeting of the Steering Group [ICES C.Res.1996/3:9] are specified below.

> An **ICES/OSPAR Steering Group on Quality Assurance of Biological Measurements Related to Eutrophication Effects** [SGQAE] will be established under the chairmanship of Dr H. Rees (UK) and meet at ICES Headquarters from 18–21 February 1997 to:
>
> a) develop a programme with the aim of establishing quality assurance procedures for measurements of chlorophyll *a*, phytoplankton, macrozoobenthos, and macrophytobenthos [OSPAR 1997/2.1];
>
> b) develop a means for the preparation of appropriate taxonomic lists of species [OSPAR 1997/2.1];
>
> c) in the above work, cooperate with SGQAB so that, to the extent possible, common procedures may be used. To begin this cooperation a half-day joint meeting between the two groups should be held.
>
> The Steering Group will report to ACME before its June 1997 meeting.

The primary concern of the Steering Group is with work aimed at assessing eutrophication effects, thus reflecting the international importance attached to this problem. However, it is clear that QA activity, especially in relation to benthos studies, will have equal relevance to other monitoring objectives (e.g., assessments of contaminant effects; long-term 'baseline' studies: see Sections 4 and 12, below).

The development of coordinated QA procedures is viewed as a relatively long-term programme (about five years), reflecting the time that will be required to ensure that 'best practice' is widely adopted and, just as importantly, demonstrated to be effective.

The role of the Steering Group is therefore to define a QA programme for the OSPAR area, and then decide what must be done, and in what order of priority, in order to implement the programme. It will be necessary to identify conveners for various activities and, if (or, more likely, when) necessary, to explore and coordinate funding opportunities to support these activities. It will also be essential to be aware of, and seek to encourage, participation in relevant QA initiatives (such as workshops and intercalibration exercises) pursued by other organisations and, conversely, to involve outside parties in SGQAE-sponsored activities, where practicable.

It is understood that the first priority for action is in the field of benthic sampling and analysis. Both for benthic and water-column studies, the Steering Group will be able to call upon the expertise of the Benthos Ecology Working Group (BEWG) and the Working Group on Phytoplankton Ecology (WGPE) later this year. One objective of the present meeting was therefore to frame appropriate questions for consideration by these groups after communication to their respective Chairmen.

The Steering Group also had an opportunity to gain a valuable insight into the requirements of an international QA programme through interaction with the ICES/HELCOM Steering Groups on QA of biological and chemical measurements in the Baltic Sea, both of which were also meeting at the same time at ICES Headquarters.

2 APPOINTMENT OF RAPPORTEUR

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

3 ADOPTION OF AGENDA

The revised agenda, as shown in Annex 2, was adopted for the meeting.

4 PROGRESS IN THE PLANNING AND CONDUCT OF OSPAR STUDIES RELATING TO EUTROPHICATION BY COUNTRY AND BY DISCIPLINE

SGQAE took note of a description of the OSPAR Nutrient Monitoring Programme (attached as Annex 3), that was adopted by the Oslo and Paris Commissions (OSPAR) in June 1995. In particular, SGQAE noted that its work will primarily be concerned with the development of QA procedures for the biological parameters contained in Table 2 of this programme description (chlorophyll *a*, phytoplankton species composition, macrophyte biomass and species composition, and benthic community biomass and species composition). In addition, however, J. Pawlak informed the group that the recent meeting of the OSPAR Working Group on Concentrations, Trends and Effects of Substances in the Marine Environment (SIME) (Ostend, 3–7 February 1997) had agreed that SGQAE should handle all aspects of the QA of benthic community measurements, including those conducted in relation to studies of the biological effects of contaminants (SIME Summary Record 97/15/1, Item 4.9). For the latter, Norway had earlier agreed to serve as the lead country in coordinating QA and intercomparison activities under SIME, but this commitment would be transferred to SGQAE.

Concerning the actual implementation of the Nutrient Monitoring Programme, it was noted that after the programme was accepted by all OSPAR Contracting Parties in June 1995, the conduct of this monitoring has been a mandatory obligation. Each OSPAR Contracting Party is expected to decide on the locations at which this monitoring should be conducted. However, the guidelines for monitoring the various parameters have been under development for the past two years and are still in the final stages of review and approval within the OSPAR system, with approval anticipated later this year. Thus, countries may be waiting to begin monitoring until the guidelines have been finalized.

The Nutrient Monitoring Programme is also related to the Common Procedure for the Identification of the Eutrophication Status of the Maritime Area of the Oslo and Paris Commissions, which is presently being drafted. Under the Common Procedure, definitions will be made of areas according to the categories 'non-problem areas, problem areas and potential problem areas with regard to eutrophication'. After the Common Procedure becomes effective, the Nutrient Monitoring Programme will need to be conducted in problem areas and potential problem areas, in addition to monitoring locations previously identified.

In addition, J. Pawlak reported that studies of benthic community responses to point-source discharges (e.g., offshore oil platforms) and contamination gradients (e.g., estuaries) had been one of four biological effects measurements accepted by the North Sea Task Force (NSTF) for inclusion in its Monitoring Master Plan. The results of these benthos measurements had been compiled, at the request of ICES and using Norwegian money donated for this purpose, by the Netherlands Institute of Ecology/Centre for Estuarine and Coastal Ecology at Yerseke, the Netherlands, but they had not been assessed owing to a lack of comparability of methodology among the institutes submitting data. This source of data still remains, and should be able to be used by SGQAE members if they so wish.

The recently drafted OSPAR/JAMP guidelines for chlorophyll *a*, phytoplankton species, and benthos were considered. These are more prescriptive in some areas than in others. All make explicit reference to the need for adequate QA procedures.

The intention of SGQAE was to review summaries of existing studies, or those planned under the JAMP guidelines, with a view to obtaining an essential perspective on the likely scope and geographical extent of related QA needs. However, owing to the small number of participants at the meeting, information was only available from Germany, Norway and the United Kingdom, and this is presented below.

In view of the importance attached to information relevant to this item and to Section 5, below, it was resolved that OSPAR representatives from countries not represented here should be contacted intersessionally with a request for summary details of their relevant studies and programmes (see Annex 4).

4.1 Eutrophication-related Work: Germany

The German monitoring programme is under revision. The draft outline of the programme was reported to SIME 1996. Monitoring locations were reported to the one-day workshop prior to SIME 1997. With regard to eutrophication, several projects have been funded by the ministry of environment (BMU) during recent years.

A study of nutrient concentrations in the North Sea (*Distribution maps on nutrient concentrations in the central part of the North Sea*) presents comprehensive information on nutrient concentrations in the North Sea based on data from 1985 to 1995 in the form of isopleths, depth profiles, TS-diagrams, etc.

Another study (*Evaluation of long-term investigations of nutrients and phytoplankton in the German Bight*) deals with the development of nutrient concentrations and their effects in the German Bight. This evaluation is based on long-term data sets from 1962 to 1994.

Furthermore, there are studies on the dynamics of phytoplankton (*Seasonal dynamics of bloom-forming and toxic algae along the coast of Lower Saxonia*) and the distribution of macroalgae (*Distribution of macroalgae (e.g., Enteromorpha) in the Wadden Sea*).

With regard to eutrophication, there is also ongoing research into the phenomenon of 'black spots' in the Wadden Sea area.

Additional projects have been financed by the ministry of research and development (BMFT) with regard to the issue of eutrophication.

4.2 Eutrophication-related Work: Norway

A National Coastal Monitoring Programme was initiated in 1990 in response to the North Sea Task Force. The programme was founded and is financed by the State Pollution Control Authority (SFT). Its duration is expected to be at least 10–20 years. The geographical range is from the Swedish border to the Norwegian west coast at Bergen. The programme conducts long-term monitoring of the regional environmental status of the coastline, with special emphasis on eutrophication. The aims are:

- establishment of the environmental quality status with respect to nutrients and their effects;
- identification of sources for nutrient inputs to the Norwegian coast;
- detection of possible long-term changes in nutrient concentrations;
- detection of possible effects of nutrients on hard and soft bottom communities.

The programme includes the four biological components which are to be treated by SGQAE: chlorophyll *a*, phytoplankton, macrozoobenthos, and macrophytobenthos.

Some other relevant monitoring programmes covering these components include:

- Modelling of nutrient inputs and effects on production and oxygen development in several fjord basins, e.g., to assess potential problem areas with respect to eutrophication.
- Monthly transect surveys across the Skagerrak (Arendal – Hirtshals), operated since 1951. Nutrients, chlorophyll *a*, and aspects of phytoplankton have been included since 1980.
- Local monitoring of potentially harmful species of phytoplankton since the early 1980s. The programme has been successively extended and since 1992 covers the complete Norwegian coast.
- Several short-term monitoring programmes related to eutrophication are conducted in the vicinity of point-source nutrient discharges (sewage outfalls, fish farms, etc.).
- Comprehensive annual soft bottom monitoring around offshore petroleum sites; from 1996 this has been extended into a regional offshore monitoring scheme.

4.3 Eutrophication-related Work: United Kingdom

The UK is active in a number of studies concerned with nutrient fluxes in estuaries and coastal waters, and the consequences for local ecosystems. Localised effects of nutrient enrichment, such as excessive growth of benthic algae, have been identified, e.g., in Langstone Harbour (south coast of England) and the Ythan estuary, Scotland. However, no major eutrophication-related phenomena, such as the widespread proliferation of toxic algae or de-oxygenation of UK coastal waters, have been identified.

Examples of current programmes include:

JONUS: the 'Joint Nutrient Study'. This ongoing project (a joint initiative between the regulatory agencies) has addressed the fate and behaviour of nutrients through the establishment of nutrient budgets for major east coast estuaries and surrounding coastal areas. Much of the work has been done in the Humber/Wash area; more recently, attention has focused on the Thames area. A comprehensive programme of water-column and sediment sampling (extending into offshore areas of the southern North Sea) has been carried out, and the latter medium has been identified as having an especially important controlling influence. The consequences of nutrient inputs for primary production and phytoplankton ecology are being considered. A summary report on earlier work under this programme was made available to members.

National Monitoring Programme (NMP): this is a cooperative UK-wide survey by the regulatory agencies, involving (*inter alia*) the determination of nutrient and chlorophyll *a* concentrations at selected stations within estuaries, coastal and offshore waters (see map at Annex 5). The benthic macrofauna are also sampled at these stations.

Estuarine and coastal surveys of nutrients and phytoplankton are conducted by the Environment Agency (and its Scottish and Northern Irish counterparts) as part of a wider 'water quality' monitoring programme.

Water companies are engaged in several modelling and monitoring exercises relating to nutrient inputs and phytoplankton growth, in connection with the EC Urban Waste Water Treatment Directive. Again, benthos studies form a significant part of these programmes.

There are numerous ongoing studies of benthic communities in estuaries and coastal waters around the UK which are principally concerned with assessments of anthropogenically induced change, especially arising from point-source inputs of organic matter and chemical contaminants, but also from physical disturbances of the seabed. In many cases, such studies may also have an incidental role in the identification of any adverse consequences that might arise from water-column nutrient enrichment.

A future increase in sampling and analytical effort for chlorophyll *a*/phytoplankton species is likely, especially since changes in concentrations or species composition may provide the first tangible evidence of effects arising from increased nutrient inputs. The JAMP guidelines will provide a stimulus to harmonise methodological approaches, and hence ensure that regular monitoring programmes (such as the NMP) will be able to contribute effectively to wider international assessments.

5 REVIEW OF RELATED QA ACTIVITIES BY COUNTRY AND DISCIPLINE

The intention of this agenda item was to present summaries of existing QA activities, or those planned under the JAMP guidelines, with a view to obtaining an essential perspective on the likely scope and geographical extent of the QA requirements. However, owing to the small number of participants, information was only available from Germany, Norway and the United Kingdom, and this is presented below.

In view of the importance attached to information relevant to this item and to Section 4, above, it was resolved that OSPAR representatives from countries not represented here should be contacted intersessionally with a request for summary details on relevant QA activities (see Annex 4).

5.1 QA Activities: Germany

In the framework of the National Monitoring Programme (Bund/Länder-Messprogramm, BLMP), a special working group on QA exists. Within the QA group a subgroup on chemical QA and biological QA was established. To support the work of the QA group, a two-year research project for the development and implementation of QA in the BLMP was established in 1997.

5.2 QA Activities: Norway

Norway has participated in a Nordic intiative to prepare a set of general QA guidelines for monitoring surveys (atmospheric, terrestrial, freshwater and marine systems). A draft Guidance on QA has been prepared under the coordination of the Swedish Environmental Protection Agency (May 1996). In association with this, a set of guidelines for QA planning and documentation of field surveys has been prepared (Annex 6).

QA guidelines have been implemented in a revised manual prepared by the State Pollution Control Authority (SFT) for the local and regional environmental monitoring around Norwegian offshore fields. The manual contains detailed QA/QC procedures for soft bottom macrozoobenthos studies, as well as criteria for the selecton of laboratories to perform the surveys.

For the National Coastal Monitoring Programme, the cooperating institutions (NIVA and IMR) perform annual intercomparisons (parallel analyses) on chlorophyll *a*. In addition, both institutes perform instrument calibrations with certified reference materials on chlorophyll *a*. NIVA holds a national accreditation certificate on chlorophyll *a* analysis.

National accreditation certificate requirements have been established for monitoring macrozoobenthos on soft bottoms. One consultant is at present accredited and several others will receive accreditation in the near future.

For monitoring of phytoplankton and hard bottom communities, no coordinated QA activities or requirements exist, but some institutions are presently developing and documenting internal QA systems.

5.3 QA Activities: United Kingdom

There has been little effort to develop coordinated QA activity in the areas of chlorophyll *a* determinations or phytoplankton species composition within the UK. However, individual laboratories can be expected to operate to standard procedures (e.g., drafts are available for CEFAS, Lowestoft). In the case of chlorophyll *a*, the aim of establishing interlaboratory consistency will be complicated by the range of methods available for determining concentrations.

The establishment of a 'National Monitoring Programme', involving the coordinated sampling of several estuarine, coastal and offshore stations by the UK regulatory agencies (see Section 4.3, above), has stimulated QA effort, especially for chemical determinands. Recently, a 'National Marine Biological AQC Scheme' was set up to improve inter-laboratory consistency in the analysis of soft-bottom benthos samples. Standards determining the suitability of the data for inclusion in the NMP are being devised (see also Section 8). About 25 laboratories have participated; the Scheme is funded through an annual fee charged to each participant.

The structure of the Scheme is shown in Annex 7A. So far, most of the effort has been directed at the proficiency of laboratory processing of samples. Several 'ring tests' have been carried out to determine the proficiency of species identification (see Annex 7B for an example of relative performance for three ring tests per laboratory, each involving the identification of 25 benthic species). Whole samples taken locally by individual laboratories have also been re-analysed to assess proficiency in all aspects of sample processing.

Comparisons have also been made of the performance of laboratories in particle size analyses. Systematic (though relatively small) differences arise according to the method used (i.e., manual sieving versus laser-sizing). This is to be expected, as the methods are measuring particle size in different ways (see Annex 7C for the output from a well-sorted fine sand). Between-laboratory error is greater for poorly sorted (see Annex 7D) than for well sorted sediments. The biological group is seeking advice from geologists regarding the best means to proceed in defining criteria for acceptable performance.

A Workshop aimed at improving consistency in field sampling is planned for March 1997. Output will include a training video identifying 'best practice'.

To date, this Scheme has proved to be an efficient way of addressing QA issues for the benthos. It may therefore be a useful model for wider activity. There may also be scope to extend the remit of this Scheme to involve other coastal states, if funding from individual laboratories or countries is available. Further information on this scheme is given in Annex 8.

6 REVIEW OF HELCOM ACTIVITIES AND DEFINITION OF THE SCOPE FOR INTERACTION AND CONDUCT OF JOINT OR PARALLEL ACTIVITIES

Earlier reports from meetings of the ICES/HELCOM Steering Group on Quality Assurance of Biological Measurements in the Baltic Sea (SGQAB) and several workshops it coordinated were reviewed, and they were recognised as being very useful as a contribution to the development of a work programme for SGQAE.

A joint session between SGQAE and SGQAB was held in the afternoon of 19 February 1997. The HELCOM Baltic Monitoring Programme (BMP) has been running for about seventeen years with data assessments every five years.

Detailed procedural guidelines have been prepared for most parameters monitored and SGQAB has taken the strategy not to prepare detailed QA procedures until such guidelines have been agreed upon by the relevant HELCOM body. However, based on negative experience with substantial amounts of non-comparable data within the BMP, SGQAB strongly emphasized the importance of reaching early consensus on the methodology and accompanying QA standards. Furthermore, overall and/or regional workshops were strongly recommended to harmonize procedures as much as possible. Where harmonization is not achievable, partly due to several methods being of equally high standard, efforts should be made to formulate QA standards in such a way that the data from different methods are comparable in overall assessments.

The session acknowledged the advantage that SGQAE has, compared to SGQAB, in starting the work before a monitoring programme on eutrophicaton has been agreed upon within OSPAR. This should enable important QA principles to be implemented at the appropriate stages in the procedural development.

It was agreed that all reports from the two groups should be exchanged among the members of the groups. SGQAB further informed SGQAE that all its workshops and other scientific arrangements are open for external participation.

As a matter of principle, the general approaches adopted in SGQAB activities should be followed by SGQAE. Clearly, some divergence in approach can be expected, as a natural consequence of geographical differences and regional variability in the levels of expertise currently available. However, the benefits of continued interaction were clearly recognised by both Steering Groups.

7 DEVELOPMENT OF A PRACTICAL STRATEGY FOR SGQAE APPROACHES TO THE FOUR SPECIFIED BIOLOGICAL STUDY AREAS

7.1 Definitions

SGQAE began by considering a range of QA definitions (see Annex 9). Whether widely or narrowly defined, all were consistent in the overall objective of ensuring the submission of data of adequate quality, and all were, in effect, statements of good intent. The following combination of aims derived from Annex 9, numbers 3-5, appeared to provide a satisfactory working framework for the Steering Group:

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—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.*

7.2 SGQAE Strategy for Practical Implementation of QA Programmes

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 Lusitanean.

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.

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.

It is essential that support at the national level is firmly established for the principle of sound QA of biological measurements. Strong support can also be given to the ICES/HELCOM SGQAB view that, in the application of this principle, emphasis should be placed upon the performance of the individual at the laboratory bench. Central to a successful outcome is a sound laboratory QA system, and this must be encouraged as a starting point. Also, along the path of developing effective QA procedures, the aim should be to persuade and assist, rather than simply to dismiss poor performance when measured against agreed standards of acceptability. SGQAE also endorses the view that the aims of the science programme should be carefully considered, in order to derive realistic QA targets. Such a pragmatic approach to the issue is permissible, given the early stages of development both of a coordinated monitoring programme and a supporting QA strategy.

These deliberations must be translated into a practical programme for the various subject areas. A consideration of the entire history of a sample provides a framework for identifying priority areas, i.e., from field sampling through laboratory analysis to the final analysis and then archiving the resulting data and analysed material.

The task is therefore:

a) to acknowledge the fact that the different steps in a monitoring exercise have variable influence on the accuracy and precision of the resulting data, and to develop a priority list with attention to the most important field and laboratory stages with respect to their influence on data quality. Common sense dictates that the list will be biased towards the more intractable problems, such as laboratory taxonomic issues, and quality control of key areas of field sampling activity;

b) to assess the variability in methodology of these stages as reflected in the draft JAMP guidelines for the relevant monitoring components;

c) in view of Task b), to identify the most critical QA elements in each step of the methodology;

d) to propose a set of priority QA areas and to identify the best means to address them (field/laboratory workshops; intercalibrations, including data analysis techniques as well as sample processing; the drafting and adoption of Standard Operating Procedures (SOPs) and the associated production of 'quality manuals'; pursuit of formal accreditation, etc.). For SOPs/quality manual production, the Steering Group could offer basic guidance on 'best practice'. Examples of SOPs covering specified topics will be requested from a range of laboratories for review at the next meeting, as well as examples of actions to be taken to ensure a quality which is fit for the purpose;

e) to consider organisational aspects and realistic time scales. (Depending on the topic, tiers of activity may be identified, ranging from intralaboratory work to between-laboratory comparisons within and across some or all countries.) These will then determine the appropriate level of participation, i.e., local, national, 'regional' (groups of countries), or 'global' (all countries);

f) to consider practical implementation (including numbers that are likely to be involved in different activities, and realistic workshop sizes to aim for); also likely funding opportunities (see Agenda Item 10);

g) to identify 'secondary' (supplementary) variables relevant to the interpretation of biological data (e.g., particle size analyses, redox determinations, etc., for macroinfauna; see Annex 10), and to seek guidance on which ICES/OSPAR groups are best placed to deal with them.

The Steering Group approached this task, with particular attention to items a) to d) and g), above, by constructing a set of tables for the four types of measurements: chlorophyll *a*, phytoplankton, macrozoobenthos and macrophytobenthos. These tables are attached as Annex 10.

8 APPROACHES TO SETTING QA STANDARDS FOR ACCEPTABLE DATA

The consequences of between-worker variability in the output from analyses of benthos and phytoplankton samples are not as straightforward to assess as with many other measures because of the number of variables (species) involved. Clearly, mistaken identification of several rare species in a sample does not inspire confidence and indicates the need for positive action through, e.g., enhanced training. Despite this, the data on not-so-rare (and common) species from the same sample may be sound, and for some programmes involving the synthesis of data from several sources, this may still make an important contribution to assessment. Also, it is possible that (again, for the same sample) poor identification may contrast with sound biomass determinations which may thus provide useful information.

The multivariate nature of the output from phytoplankton or benthos sample analysis thus represents a fundamental difference between these and many other laboratory activities and, for the reasons outlined above, it is difficult to devise schemes to score such output other than against a somewhat arbitrary, relative scale of 'competency'. However, although arbitrary, any such scale may be justified if it succeeds in providing a motivating force to improve the quality of scientific output.

At an early stage in the implementation of new QA procedures, draft standards may be used in a positive way to encourage better performance. However, for formal international assessments, and when confidence in the utility of standards has been fully established, laboratories which demonstrably do not meet the requirements may have to accept the exclusion of data or, at least, accept the need for re-analysis of a sample batch.

An example of draft criteria for assessing the quality of analytical output against an independant re-analysis of the same sample is given in Annex 11, arising from a UK QA programme (see Section 4, above). These criteria are purely illustrative: it must be emphasized that they have yet to be applied in earnest, and so may be modified by experience. (It should also be borne in mind that, operationally, the required precision and accuracy of the data may vary according to the aims of different scientific programmes.)

Note was also taken of information on a wide-ranging QA programme that has been developed for monitoring activities along the Californian coast (the 'Southern California Bight Pilot Project'). Further information on the progress of this Project would significantly benefit the future work of the Steering Group.

9 PREPARATION OF APPROPRIATE TAXONOMIC LISTS OF SPECIES

The Steering Group noted that the ICES/HELCOM SGQAB had identified the use of improper and inconsistent nomenclature for phytoplankton species as a significant problem affecting the quality of data. The extent to which such a problem might apply throughout the OSPAR area with respect to phytoplankton and benthos studies was uncertain. However, at least for northern areas, significant advances have been made in recent years. For example, a Norwegian compilation of North Sea soft bottom macrofauna species is annexed to the revised Guidelines for monitoring around offshore petroleum fields (SFT, in press). Also various annotated species lists for groups of marine organisms have been published. The UK published a directory of marine species in 1987, and an up-dated version will appear shortly (see Annex 12). This has become a widely used source of authoritative information concerning taxonomic nomenclature and species occurrences for both flora and fauna (although not including phytoplankton), with wider application than just to UK coastal seas.

In view of the emphasis by SGQAB on problems regarding phytoplankton nomenclature, SGQAE considered it appropriate to give priority to this topic. Accordingly, it was agreed that the Chairman should inquire about the availability of relevant information sources in a letter to the Chairman of the Working Group on Phytoplankton Ecology (see Annex 4).

SGQAE also took note of the comment in the report of a ICES/HELCOM Workshop on Quality Assurance of Pelagic Biological Measurements in the Baltic Sea (ICES CM 1996/E:1) that *'finalising the complete (phytoplankton) checklist including Quality Assurance is ... a workload of such magnitude that external funds must be found to finance it'*.

10 FUTURE PLANS: WORKSHOPS/GUIDELINES

SGQAE devoted a significant amount of time to drafting a priority list for future work aimed at improving QA procedures for a range of biological variables (see Section 7, above). However, the small number of participants at the meeting precluded the establishment of a wider perspective on the degree of support (both material and financial) which might be available for the conduct of workshops or intercalibration exercises on various geographical scales.

Accordingly, a series of questions aimed at ICES WGs and OSPAR representatives was framed (see Annex 4), among which the issue of external funding for certain activities was raised.

As pursuit of external funding could only further enhance the ultimate objective of improved data quality, a number of options were considered in outline, including EU funding via the COST and MAST programmes, and alternative sources at the national level. A significant development was the prospect of a funding proposal being developed for consideration under the EU Standards, Methods, and Testing programme: at the March 1997 meeting of the ICES Working Group on Biological Effects of Contaminants (WGBEC), it was understood that the Chairman (Dr R. Stagg) intended to discuss the development of a proposal for a biological equivalent to the EU-sponsored QUASIMEME programme, to encompass biological effects measurements. There may be scope to include phytoplankton and benthos studies in this QA scheme, and it was agreed that the Chairman should explore this matter intersessionally. However, it was recognised that any outline structure for such involvement must be compatible with SGQAE objectives for the OSPAR area and, hence, would need to be considered at the 1998 SGQAE meeting.

11 DATE/VENUE FOR NEXT STEERING GROUP MEETING

A list of intersessional activities to be performed by Steering Group members was adopted (Annex 13).

The Steering Group further recommends that it meets in Copenhagen on 17–20 February 1998 in order to address the topics given in Annex 14.

12 ANY OTHER BUSINESS

12.1 Functioning of the SGQAE

The small number of participants at the first Steering Group meeting had certain advantages in identifying how to proceed with the Terms of Reference. However, in the view of the Group, continuation at this low level of participation was not a sustainable prospect, and action of an appropriate nature was required in order to ensure a healthy level of representation across OSPAR countries at future meetings.

Available evidence suggests that significant eutrophication-related (or other) monitoring effort, following JAMP guidelines, has yet to commence (see Section 4, above). This offers a unique opportunity for OSPAR Contracting Parties to contribute to QA developments before the commencement of new monitoring programmes. Many of the problems that became apparent following the conduct of past international monitoring exercises could, therefore, be avoided through active participation at this stage.

12.2 Proposed Name Change for SGQAE

Under Section 4, above, it was noted that SIME had agreed that the Steering Group should handle all aspects of the QA of benthic community measurements, including those conducted in relation to studies of the biological effects of contaminants. Given this, explicit reference to eutrophication in the title of the Steering Group might inhibit wider involvement in its activities. The Group therefore recommends removing '... related to eutrophication effects' from the title. (This might be replaced with, e.g., '... in the Northeast Atlantic area').

ANNEX 1

LIST OF PARTICIPANTS

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ANNEX 2

AGENDA

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

1) Opening of meeting (Chairman).

2) Appointment of Rapporteur.

3) Adoption of Agenda.

4) Progress in the planning and conduct of OSPAR studies relating to eutrophication by country and by discipline*.

5) Review of related QA activities by country and by discipline.

6) Review of HELCOM activities and definition of the scope for interaction and conduct of joint or parallel activities*.

7) Development of a practical strategy for SGQAE approaches to the four specified biological study areas.

8) Approaches to setting QA standards for acceptable data.

9) Preparation of appropriate taxonomic lists of species.

10) Future plans : workshops/guidelines.

This must take account of guidance from future meetings of the Benthos and Phytoplankton Ecology Working Groups. The issue of sources of funding forvarious activities must also be addressed.

12) Date/venue for next Steering Group meeting.

13) Any other business.

**(Summary guidelines for the conduct of surveys for the Joint Assessment and Monitoring Programme of OSPAR are still being finalised and therefore it is unlikely that many new studies directly geared to addressing the eutrophication issue will have been initiated. However, it is to be hoped that some ongoing studies in critical areas may be adapted to meet the new requirements with relatively little effort. The current status of eutrophication-related work need not inhibit progress on QA matters.)*

ANNEX 3

OSPAR NUTRIENT MONITORING PROGRAMME[10]

1. A satisfactory monitoring programme needs clear objectives and should comply with the basic recommendations issued by OSPAR 1993 and ASMO March 1994.

2. Since the monitoring and assessment procedures associated with a nutrient monitoring programme will address maritime areas with different levels of priority (i.e. problem areas, potential problem areas and non-problem areas with regard to eutrophication) and different characteristics (stratified/non-stratified water bodies, rocky/non-rocky shores etc.), a high degree of flexibility should be incorporated into the design of the monitoring programme.

3. The minimum requirements for a nutrient monitoring programme should therefore be as follows:

   a. Non-problem areas with regard to eutrophication. In non-problem areas with regard to eutrophication the monitoring programme has the function of detecting change in eutrophication status or confirming the status of particular areas as non-problem areas. This should be done with respect to thresholds defined in the common procedure for the identification of the eutrophication status of the maritime area of the Oslo and Paris Conventions. Clearly, monitoring effort should be limited to a limited number of parameters and a limited frequency of measurements, although spatial coverage should not be neglected;

   b. Problem areas with regard to eutrophication. In problem areas with regard to eutrophication the monitoring programme should focus on long-term trends in nutrient concentration and on a selection of related eutrophication effect parameters, taking into account corresponding long-term trends in nutrient inputs. A larger number of parameters and a higher sampling frequency should be considered than is the case for non-problem areas, so as to satisfy statistical requirements. The spatial coverage should also be more focused than for non-problem areas. Monitoring should continue until non-problem area status is achieved;

   c. Potential problem areas with regard to eutrophication. With regard to their unknown status, potential problem areas with regard to eutrophication should be monitored in the same manner as problem areas, for a trial period not exceeding five years. This should enable the area to be classified as either a problem area with regard to eutrophication or a non-problem area with regard to eutrophication.

4. In implementing these minimum monitoring requirements Contracting Parties should focus on those eutrophication effects that are sufficiently closely linked to nutrient enrichment to be of value in indicating the eutrophication status of an area. The eutrophication effects should be selected on the basis of the assessment criteria listed in the draft common procedure for the identification of the eutrophication status of the maritime area of the Oslo and Paris Commissions.

5. If, following the classification of the maritime area in terms eutrophication status, sub-regions (based for example on hydrographic characteristics) are identified within an area of particular eutrophication status (i.e. a problem area, a potential problem area or a non-problem area with regard to eutrophication) then the minimum monitoring requirements specified under paragraph 3 should be applied to each of the subregions.

6. The spatial distribution of the monitoring stations should, prior to the establishment of the eutrophication status of the maritime area using the common procedure, be commensurate with the anticipated extent of eutrophication in the area under consideration as well as its hydrographic characteristics. Consequently, each Contracting Party should determine the optimum locations for its monitoring stations. Where appropriate Regional Task Teams should coordinate effort between Contracting Parties.

7. The minimum requirements for a nutrient monitoring programme are specified in Tables 1 and 2. Contracting Parties should increase the scope and frequency of monitoring as they consider appropriate.

8. Contracting Parties shall report at appropriate intervals to SIME on the results for the parameters listed in Tables 1 and 2, and on any assessment or classification of areas within its waters.

---

10 The nutrient programme was adopted by OSPAR 1995 (cf OSPAR 95/15/1, Annex 12).

Table 1. Nutrient enrichment

	Non-problem areas[1]	Potential problem areas	Problem areas
NH_4-N	+	+	+
NO_2-N	+[2]	+	+
NO_3-N	+[2]	+	+
PO_4-P	+	+	+
SiO_4-Si	-	+	+
Salinity	+	+	+
Temperature	+	+	+
Frequency[3]	About every three years during winter[4]	Annually during winter and during direct and indirect effects monitoring	

+ action required

- action discretionary

1 Where obvious non-problem areas exist it should be left to the discretion of the Contracting Parties to determine the frequency and range of any analyses which they consider desirable and to report as necessary.

2 For non-problem areas with regard to eutrophication the sum of NO_2 and NO_3 can be reported.

3 Each monitoring event should include sufficient samples to confirm that the maximum winter nutrient concentration has been determined. Winter is defined as the period with lowest algal activity and maximum remineralisation.

4 Reporting should be based on the results of monitoring and/or research programmes and/or current literature.

Table 2. Direct and indirect eutrophication effects

	Non-problem areas	Potential problem areas	Problem areas
Phytoplankton chlorophyll	-	+	+
Phytoplankton species composition	-	+ composition: (genera and nuisance/potentially toxic species)	+ composition: (genera and nuisance/potentially toxic species) + TOC and POC[1]
Macrophytes (in shallow areas, primarily in estuaries and coastal waters)	-	+ biomass	+ biomass + species composition and reduced depth distribution
O_2 (including % saturation)	-	+	+
Benthic communities	-	+ biomass and species composition (if time series already exist)	+ biomass and species composition
Frequency	-	annually at times of maximum growth/activity	

+ action required

- action discretionary

1 TOC: Total Organic Carbon; POC: Particulate Organic Carbon

ASMO 97/2/7-E

Appendix 2

Additional assessment parameters

The additional assessment parameters may include the following:

- total nitrogen
- organic nitrogen
- organic phosphorous
- dissolved organic carbon
- dissolved organic nitrogen
- dissolved organic phosphorous
- sedimentation rate
- nutrients in sediments
- microphytobenthos (biomass and primary production)
- zoobenthos mortality
- fish mortality
- ecosystem structure
- algal toxins.

Appendix 3

Quantification of the selected criteria according to the comprehensive procedure

The methodologies for deriving the necessary database have to be developed. The derived database should be the starting point on the development of threshold values which are used in a follow-up holistic assessment for the classification of the non-problem, potential problem and problem area.

List of items which may be included in the "Terms of Reference"

- Description of the various criteria (e.g. typical ranges, variability for each assessment including reference to their origin and how they are derived);
- Description of methods to be used: only references, to OSPAR Monitoring guidelines:
- How to evaluate the data (median/average values, ranges: including statistical aspects, surface figures, deep water figures, origin of the water mass sampled);
- Mixing diagrams for nutrients; examples to be provided. How to derive reference/background concentrations;
- How to assess quantitative data (e.g. NO_3, PO_4 concentrations) together with semi-quantitative data (e.g. biological information on species, distributions, number of cells/l);
- Considering regional differences
- How to derive threshold values on a Convention-wide, regional, or sub-regional basis as appropriate for :

  background/non problem areas

  potential problem areas

  problem areas
- Consider background/reference and elevated concentrations under the aspects of natural variability and that overlapping of possible threshold values to be avoided.

Appendix 4

Compilation and overview about typical data

A compilation of selected background/reference concentrations, monitoring data on direct and indirect effects with regard to eutrophication and supplementary information will be given by this Annex.
This database should serve together with the quantification of the selected criteria (Appendix 3) as the basis for the comprehensive assessment.

List of items which may be included in the "Terms of Reference"

- Compilation of selected background/reference concentrations which are based on the assessment methodology as described in Appendix 3;
- Excerpt from the OSPAR/ICES workshop on background/reference concentrations, EUT(1) 97/3/2 as an example

Norwegian coastal waters as parts of OSPAR Regions I and II			
Criteria:	Nutrients	Background (µmol/l)	Natural variation (µmol/l)
	Total - P	0,58	0,23 - 0,68
	Total - N	15,7	8,6 - 21,1
	NO_3^-	5,6	2,3 - 6,4

- Description/list of the individual areas/zones and the respective database which are taken for the classification according to the Common Procedure

Appendix 5

Methods for the comprehensive assessment

The methodology for a holistic assessment method has to be developed. Case studies should be performed in order to gain experiences on the possible combination of the quantified criteria, a possible grouping of criteria, and the possible use of weighting factors for the different criteria and upon the combined use of models and monitoring results.

List of items which may be included in the "Terms of Reference"

- Development of a holistic assessment method
- Limitations of the assessment method(s)
- Use of weighting factors in the overall assessment
- The combined use of models and monitoring results
- Selection of relevant criteria for the assessment
- Reporting formats (e.g. graphical illustrations, tables, maps)
- Combination of the quantified criteria, grouping of criteria

ANNEX 4

QUESTIONS RAISED AT THE MEETING

1. To OSPAR representatives regarding agenda items 4 and 5

Please would you :

a) provide a short summary (maximum 2 pages) of eutrophication-related studies in your country, including any details of those planned under OSPAR and following the recently revised JAMP guidelines;

b) provide a short summary of quality assurance activities (maximum 2 pages) related to the above studies, which are being pursued in your country. We would also appreciate any written descriptions of sampling or analytical methodology relevant to the topics listed in our Terms of Reference (e.g., in the form of Standard Operating Procedures), for information and review at our next meeting;

c) Would you support, in principle, any initiative to obtain external funding (e.g., through the EU) for an international QA programme for relevant biological measures referred to in the terms of reference of the ICES/OSPAR SGQAE?

A response to the Steering Group Chairman is requested by 1 July 1997.

2. To ICES Benthos Ecology Working Group

Please would you :

a) briefly review the experiences in collaborative NSTF benthos work, especially problems revealed during attempts to synthesise data from separate countries, and to identify the main QA issues which, in the opinion of your group, would minimise future problems;

b) review and, if necessary, up-date the basic soft-bottom sampling recommendations for NSTF, given in the 1990 Benthos Ecology Working Group report, and provide comparable basic recommendations for hard-bottom substrates/biota. (In both cases, reference should first be made to the draft JAMP guidelines.)

With regard to requests under b), in both cases, it must be emphasised that detailed guidance is not sought (this is already available elsewhere, including the JAMP guidelines). Rather, attention should be directed at fundamental issues such as mesh size, and timing of annual surveys. You will appreciate that no amount of effort directed at QA of sample analysis will make up for disparities in the use of, e.g., mesh sizes, when it comes to synthesising data from different sources.

It would be appreciated if initial consideration could be given to these topics at the 1997 meeting with (as necessary) a more detailed appraisal in 1998.

3. To ICES Working Group on Phytoplankton Ecology

Please would you :

a) review progress in quality assurance activities related to phytoplankton studies, highlighting areas which deserve special attention. We are particularly interested in the implications for international collaborative programmes such as OSPAR eutrophication-related studies. Reference should be made to the recently-produced draft JAMP guidelines;

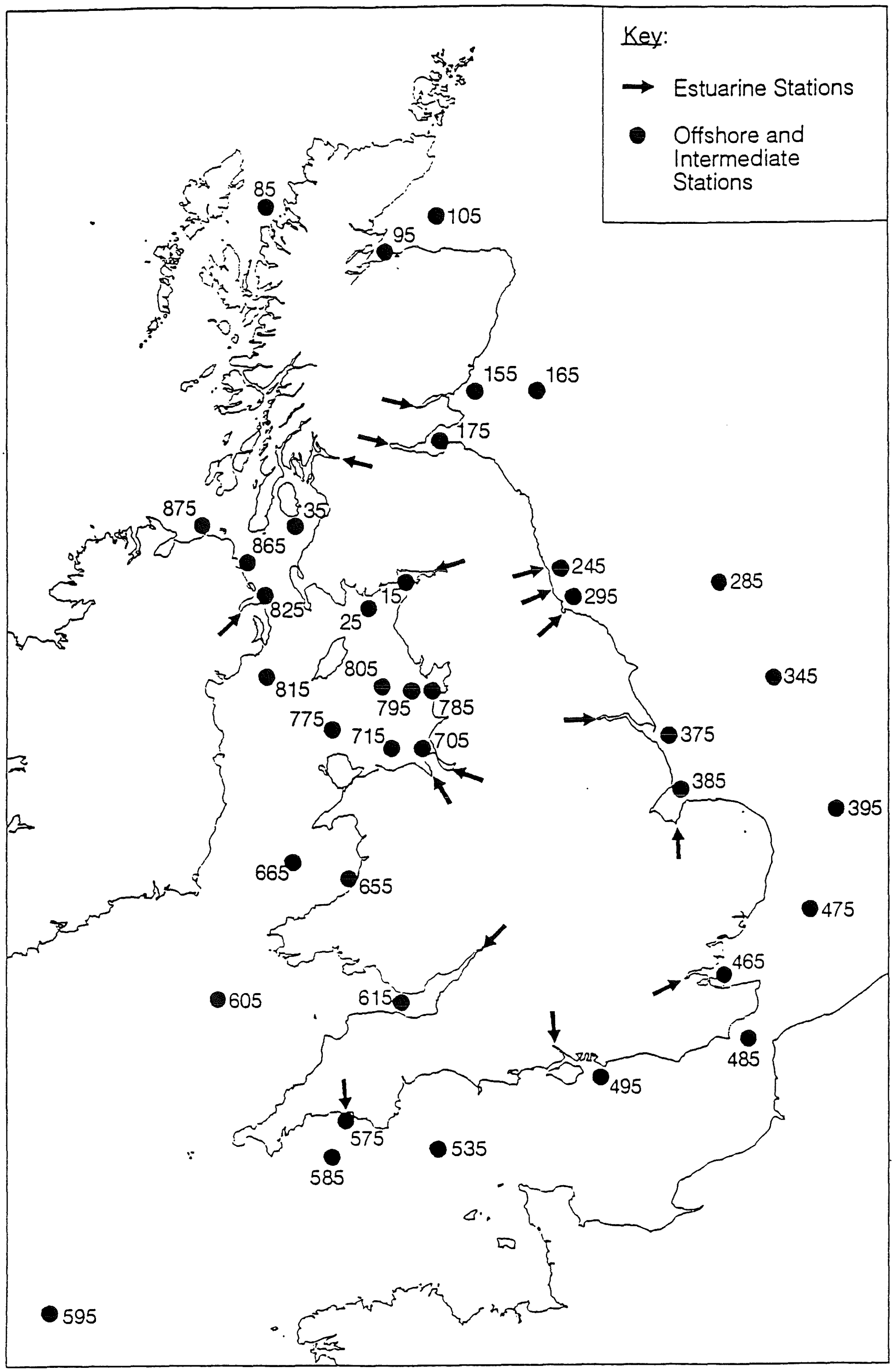
b) identify sources of information which would allow the compilation of an authoritative list of the majority of phytoplankton species likely to be encountered throughout the OSPAR area or, perhaps more realistically, to cover more local geographical scales.

It would be appreciated if initial consideration could be given to these topics at the 1997 meeting with (as necessary) a more detailed appraisal in 1998.

ANNEX 5

STATION POSITIONS FOR THE UNITED KINGDOM NATIONAL MONITORING PLAN

Arrows represent, in each case, at least three stations within major estuaries.



ANNEX 6

NORDIC GUIDELINES FOR PREPARING QA ROUTINES IN FIELD MONITORING SURVEYS

A Subproject Under a Nordic Council Initiative on QA of Environmental Monitoring Activities

This document has been prepared to provide guidelines on what should be included in a complete QA manual for a specific field survey procedure. The document is general in nature and intends to cover deployment and running of automatic instruments and loggers, on site biological and other registration, as well as sampling of various media for later analysis; in atmospheric, terrestrial, freshwater and marine surveys.

Contents

ANNEX 7A

STRUCTURE OF THE UNITED KINGDOM 'NATIONAL MARINE BIOLOGICAL AQC SCHEME'

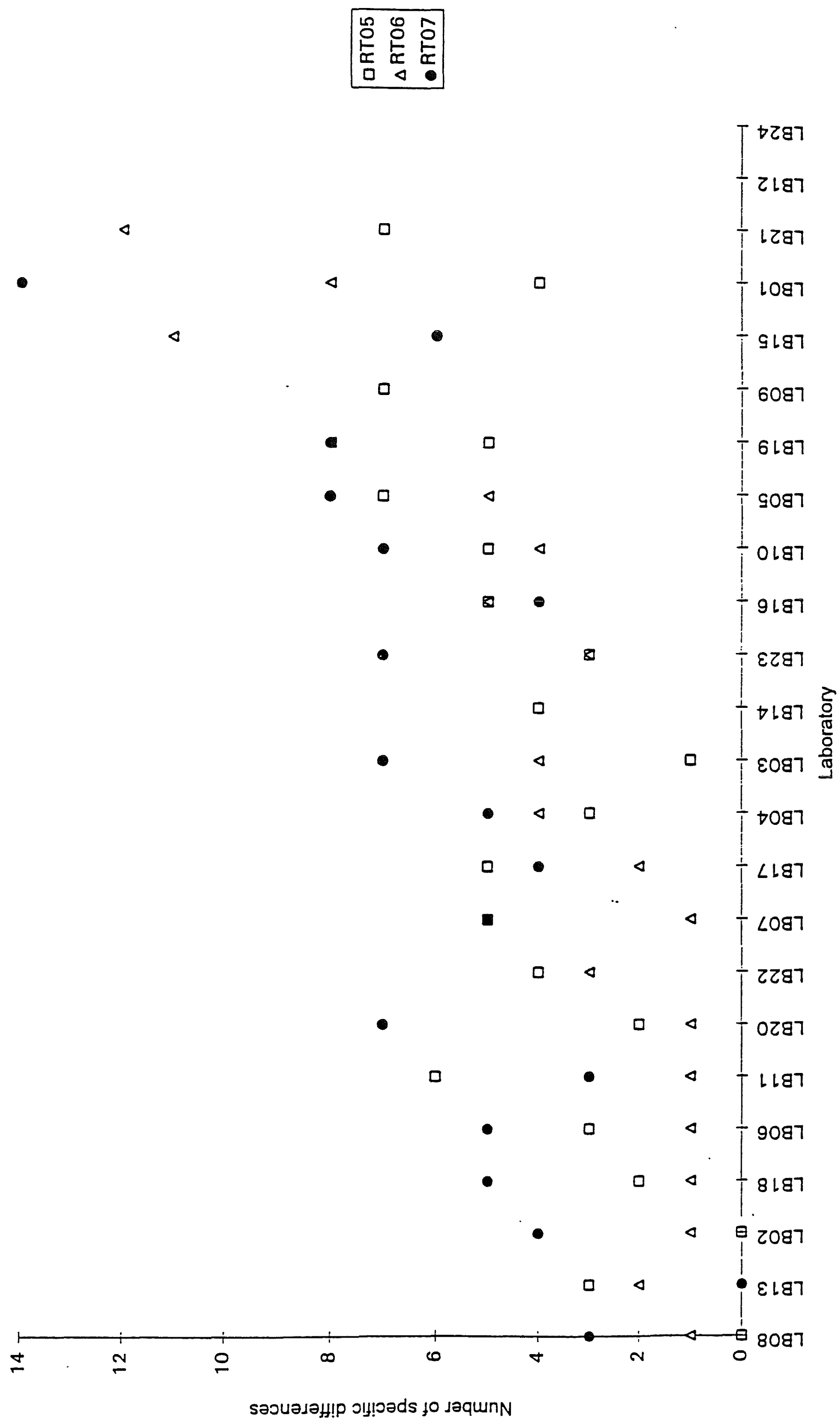
NMBAQC COMMITTEE: Overall responsibility for the scheme; defines the QA work programme (presently macrobenthos and particle size analyses only).

MANAGER: Liaises with participants and contractor to ensure that the QA exercises run smoothly; ensures that annual fees are paid; reports on progress and accounts to the NMBAQC Committee.

CONTRACTOR: Supplies sample material to participants and reports on results to the NMBAQC Committee.

ANNEX 7B

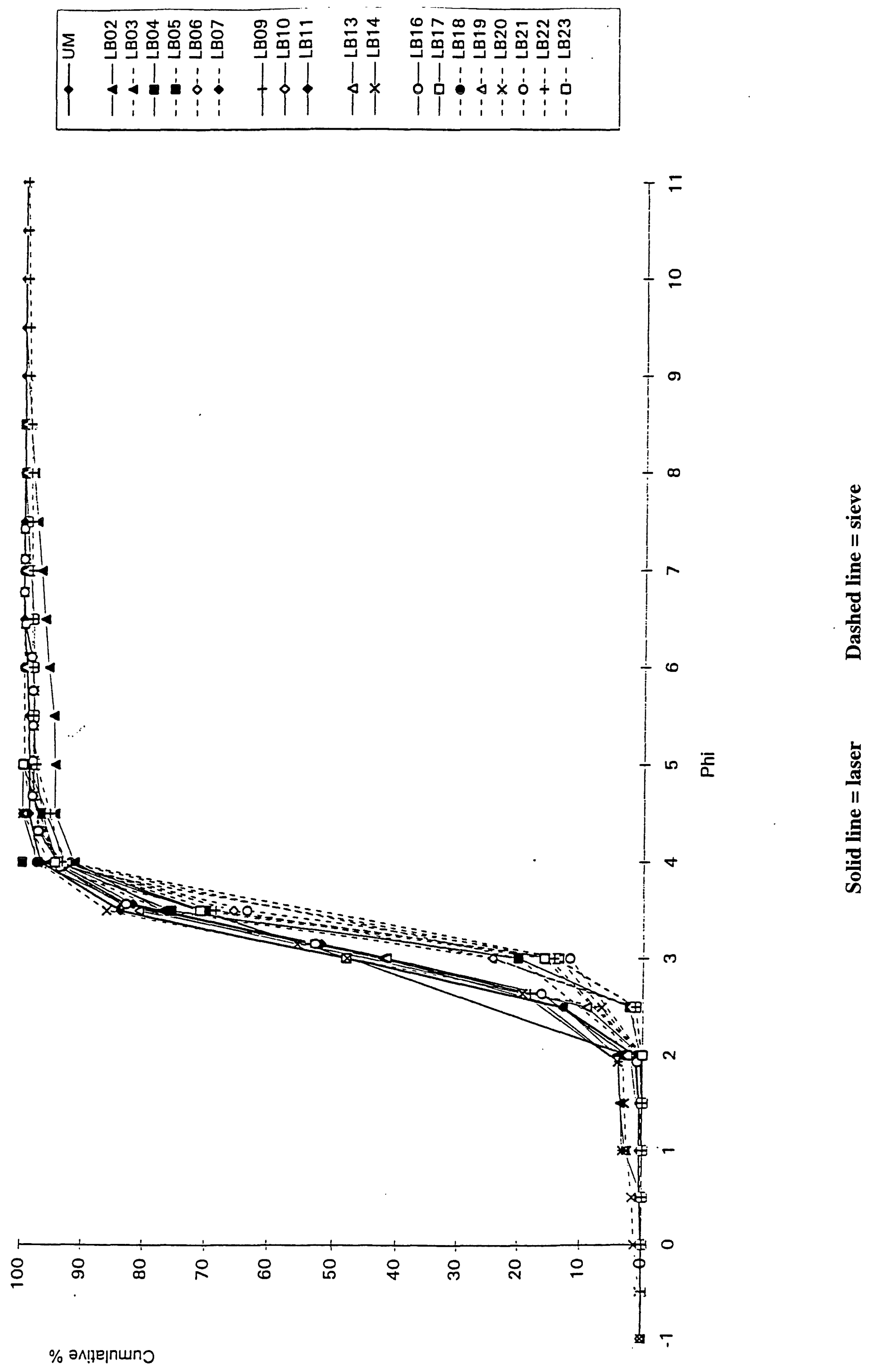
RELATIVE PERFORMANCE OF UNITED KINGDOM LABORATORIES IN THREE 'RING TESTS'



Each test involves the identification of twenty-five benthic species. The y axis shows the number of mis-identifications at the species level.

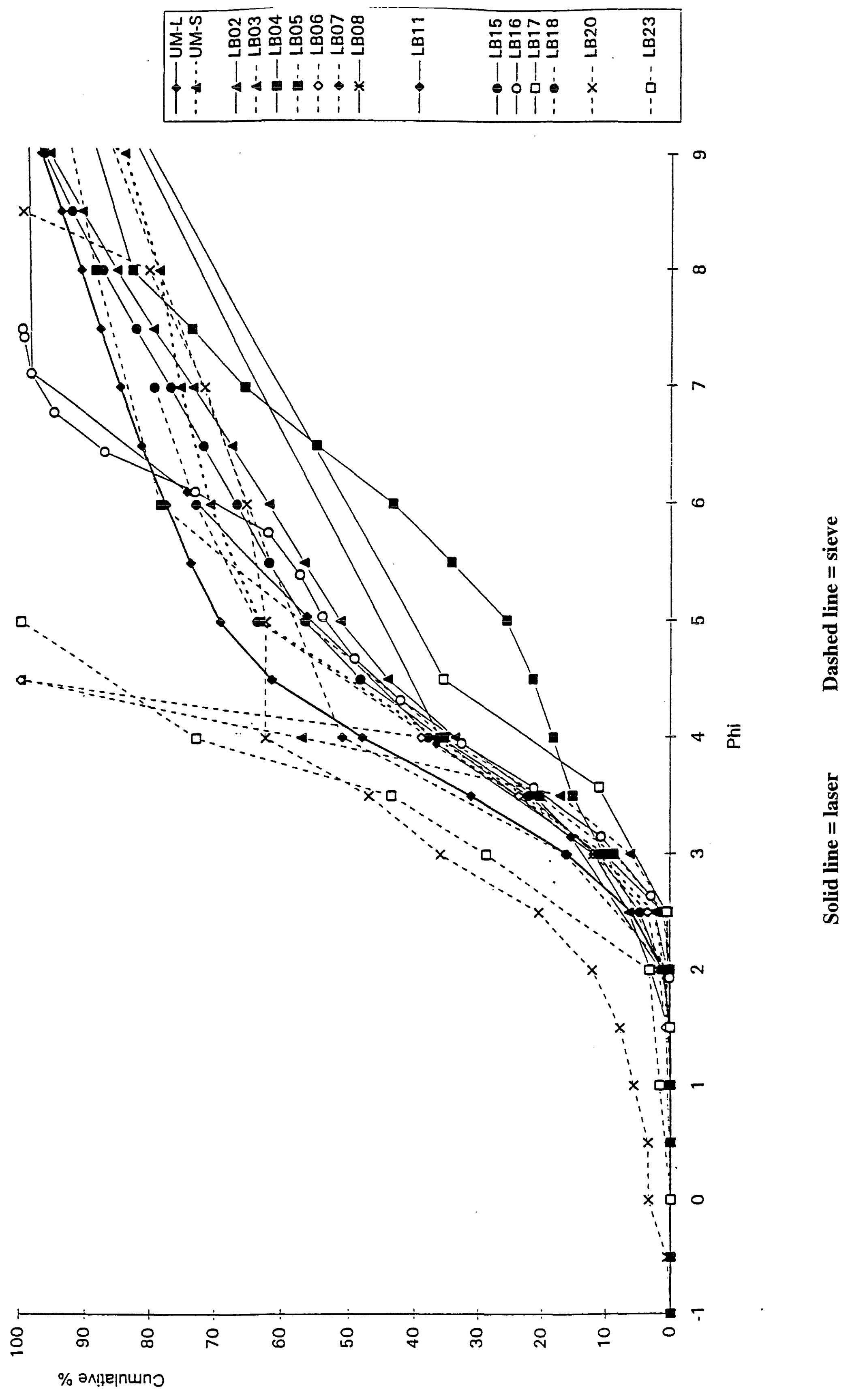
ANNEX 7C

RELATIVE PERFORMANCE OF UNITED KINGDOM LABORATORIES IN THE ANALYSIS OF A WELL-SORTED SANDY SEDIMENT



ANNEX 7D

RELATIVE PERFORMANCE OF UNITED KINGDOM LABORATORIES IN THE ANALYSIS OF A POORLY-SORTED MUDDY SEDIMENT



ANNEX 8

UNITED KINGDOM'S NATIONAL MARINE BIOLOGY ANALYTICAL QUALITY CONTROL SCHEME

National Marine Biology Analytical Quality Control Scheme

It has been increasingly recognised by biologists working in coastal waters that there is a pressing need to standardise methods of analysis and move towards developing and managing a control system ensuring uniformly high quality data. Reliance on benthic infaunal data in terms of its ability to describe in quantitative terms, the quality of the ecosystem and sedimentary environment and any impact thereon has been increasing and the development of Environmental Quality Standards based on biological determinands has further reinforced this need.

Following the establishment of the National Marine AQC scheme in 1992 it became clear that the biological components of the National Monitoring Plan (NMP) would not be covered by the scope of the original scheme. The National Marine Biology AQC scheme (NMBAQC) was therefore established at the request of the UK Marine Pollution Monitoring Management Group (MPMMG) and is designed to assess the performance of those laboratories submitting benthic biological and associated data to the NMP.

The scheme is the overall responsibility of a Co-ordinating Committee under the chairmanship of Dr Matthew Service, of the Department of Agriculture, Northern Ireland (DANI). Dr Steve Hull of SEPA (East) acts as Secretary. This committee clearly sets out the nature of the material to be circulated and the conditions for collection of the samples. The day-to-day running of the scheme is managed by Anne Henderson of SEPA (West) and the contractors to the scheme, supplying the materials and reporting back to the Co-ordinating Committee, are UnicoMarine.

During the first year of operation 25 laboratories participated in the scheme which consisted of three components; analysis of two macrobenthic samples, particle size analysis of four sediment samples and identification of four sets of twenty animal specimens. The results of this exercise were presented in the form of a report to MPMMG in which the various laboratories remained anonymous.

The scheme has successfully completed its second year and is now entering its third.

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ANNEX 9

QUALITY ASSURANCE DEFINITIONS

1) Quality assurance is generally defined as *'all those planned and systematic activities necessary to guarantee the achievement of the required quality'.*

2) Quality may equal:
   a) *'the assurance of systems of data production'* (many existing accreditation systems work to this aim); or
   b) *'the need to demonstrate good precision'* (many existing AQC procedures will meet this).

   But *'if quality is taken to be synonymous with accuracy of the data, we have a considerable way to go'.*

   The author proposes that quality is *'the consistent production of accurate analytical results'* (Source: A.H. Brown. 1992. Water Bulletin, 10 July 1992.).

3) *'Quality assurance is defined as the procedures carried out by laboratory staff which ensure that data of the appropriate quality are obtained to meet the defined aims of the respective laboratory project. The two principal components of quality assurance are:*

   a) ***quality control*** *— the procedures which maintain the measurements within an acceptable level of accuracy and precision;*

   b) ***quality assessment*** *— the procedures which provide documented evidence that the quality control is being achieved'.*

   (Source: ICES. 1994. Report of the ICES/HELCOM Workshop on Quality Assurance of Pelagic Measurements in the Baltic Sea. ICES CM 1994/E:9.)

4) *'Quality assurance is the total management scheme required to ensure the consistent delivery of quality controlled information'* (Source: draft JAMP benthos monitoring guidelines, 1996).

5) The QA programme *'should ensure that the data are fit for the purpose for which they have been collected'. '... 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'* (Source: draft JAMP benthos monitoring guidelines, 1996).

   The draft JAMP phytoplankton and chlorophyll *a* guidelines adopt a comparable *'... fit for the purpose...'* definition, conforming with a 1990 Oslo and Paris Commissions policy statement on QA.

6) *'The primary objective of a laboratory's quality system is to improve the precision and accuracy of the laboratory's product'* (source: J.A. Ratcliff. The laboratory quality assurance system. 2nd edition, p. 1).

7) In a broader, but very relevant context: *'Environmental assessment activities may be viewed as being comprised of four parts:*
   a) establishment of Data Quality Objectives;
   b) design of the Sampling and Analytical Plan;
   c) execution of the Sampling and analytical Plan; and
   d) Data Assessment' (source: Liabastre *et al.*, Quality assurance for environmental assessment activities. I Methods of environmental data analysis, pp. 259–299. Ed. by C.N. Hewitt. Elsevier, London and New York.)

CONCLUSIONS

1) Definitions may be narrowly or widely focused but all are, in effect, statements of good intent.

2) QA covers all aspects of a laboratory's activities from sample collection to final analysis and archiving of the data and sorted material.

3) Most would agree on the need for consistent accuracy and precision. The simple challenge is: how to achieve this?

ANNEX 10

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

TABLE 1. CHLOROPHYLL *a*.

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

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 2. PHYTOPLANKTON.

Steps	Method diversity	Critical QA factors	Priority QA actions
Sampling procedures	High (4) - water bottles - hose - pumps - nets	Large variability in accuracy between methods especially among nets.	• Intercomparison of methods
Treatment and storage of samples	High (4-6) - different fixatives - living samples	Algae may be impossible to identify as a result of group-specific fixation damage.	• Intercomparison of fixative effects
Concentration of samples	High (4) - sedimentation - centrifugation - filtration - no concentration	Large variability in accuracy between methods (species dependent).	• Intercomparison of methods
Sample analysis	Use of light microscope offers different techniques such as: - brightfield - darkfield - phase-contrast - epifluorescence	Magnification. Quality of optics (resolution).	• Intercomparison exercises • Control of optical quality
	Species identification	Taxonomic expertise. Change of species names. (Synonyms)	• Training and intercomparison exercises. • Ring tests • Common check list including synonyms
Biomass transformation	Two main methods: - cell measurements - use of standard volumes	Large variability in size for the same species.	• Use of standard geometric cell shapes • Establish lists of standard volumes
Data treatment	Use of 'control charts' with relevant information accompanying the data.	Simplicity and uniformity of control charts.	• Develop and maintain control charts

Footnote. Supplementary variables essential for interpretation of phytoplankton results include: particulate and total organic carbon, particulate organic nitrogen, temperature, salinity, and light penetration.

TABLE 3. MACROPHYTOBENTHOS: HARD BOTTOM.

Steps	Method diversity	Critical QA factors	Priority QA actions
Sampling procedure	High. At least 3 different method principles recommended: - aerial surveillance, - shoreline and diving transects and frames, - photography or video.	Frame and transect work: representativity (accuracy) of stations. Taxonomic competence of field observers. Operation of photographic and video equipment. Photo/video resolution.	• Guidelines on assessment of representativity of stations • Taxonomic intercomparison workshops • Preparation of regional check lists of taxa • Internal assessment of observer precision (repeated registrations) • Training courses • Instrument intercalibration exercises
Sample analysis	Low for each of the above sampling procedures	Taxonomic competence. Precision in quantification of abundances from photo and video images.	• Taxonomic intercomparison workshops • Preparation of regional check lists of taxa • Intercalibration workshop on image analysis procedures
Data treatment	Low in OSPAR recommendations	None.	None

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. MACROZOOBENTHOS: HARD BOTTOM.

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

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 5. MACROZOOBENTHOS: SOFT BOTTOM.

Steps	Method diversity	Critical QA factors	Priority QA actions
Sampling procedure	Sample collection: Low: 2 main categories – grabbing and coring. A wide variety of sampler designs are available within these categories	Variability in sediment and faunal sampling efficiency according to sampler design and handling.	• Intercomparisons of sampling devices in the field • Agreement on minimum acceptable sample volumes and sample quality
	Field processing: Low: the aim is invariably to extract fauna from sediments, and to preserve the material. Approaches to processing can vary substantially in the details	Mesh design (round vs. square, plastic vs. metal), sieving procedures, especially hose pressure.	• Intercomparisons of methods for field sample processing • Recommendations on 'best practice'
Sample analysis	Low: manual counting, identifying and weighing of species. Variability is encountered in: 1) means to extract fauna from residual sediment; 2) use of magnification during sorting; 3) access to up-to-date taxonomic keys; 4) biomass determinations	Extraction and sorting efficiency.	• Independent (in-house or external) checks on sorting and identification efficiency
		Proficiency of species identification.	• Workshops on species identification • Access to up-to-date taxonomic keys • Standardised taxonomic lists • Ring tests (identification, counting, biomass)
		Precision/accuracy of biomass estimates (method-determined).	• Compilation of biomass conversion factors
Data treatment	High: numerous methods (and software packages) for univariate and multivariate analysis	Inconsistency in handling of uncertain identifications.	• Standard approaches to pooling/exclusions of species
		'Rounding' errors with different computer packages.	• Intercomparisons of analytical output from a standard data set
		Mistakes in data compilation.	

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. Epifauna 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.

ANNEX 11

PROPOSED CRITERIA FOR ASSESSING THE PERFORMANCE OF UK LABORATORIES IN THE PROCESSING OF MACROFAUNA SAMPLES

N.B. These are in draft and are subject to review.

Total Taxa Target: ± 10 % or 2 taxa, whichever is greater. Based on comparison between lab and contractor value.

Total Abundance Target: ± 10 % or 2 individuals, whichever is greater. Based on comparison between lab and contractor value. A more relaxed standard of ± 20 % may be applied to samples requiring sub-sampling.

Total Biomass Target: ± 20 %. Based on comparison between lab and contractor value.

Bray-Curtis Similarity Target: ≥ 90 %. Based on comparison between lab and contractor value.

Taxa Correctly Identified Target: ± 5 % or 2 taxa, whichever is greater. Based on comparison between lab and contractor value.

ANNEX 12

MARINE SPECIES DIRECTORY

A landmark publication in marine studies in the British Isles

ULSTER MUSEUM

Marine Conservation Society

Marine Species Directory

The Definitive List of the Marine Fauna and Flora of the British Isles and Surrounding Seas

Edited by Bernard Picton and Christine Howson

The origins of the ***Marine Species Directory*** lie in the pioneering approach to data handling adopted by the Ulster Museum for work on the Northern Ireland Sublittoral Survey (1982-1986). The results, donated by the Museum to the Marine Conservation Society, formed the basis of the first edition published in 1987 (*Directory of the British Marine Fauna and Flora*, ed. Christine Howson). Due to great demand for the first edition, it was clear that a new edition would be necessary, with the addition of synonyms, new groups and a revision/update of existing groups. The publication will provide a useful reference source for ecologists and taxonomists alike as a summary of the state of knowledge of the flora and fauna of the region. This one volume assembles all the disparate lists of British and Irish marine species, incorporating all recent literature and taxonomic revisions, as well as individual records. It will also provide a standardised nomenclature as far as is currently feasible. Each chapter covers a different phylum, and comprises a short introduction, an outline classification and list of species with authority, date, a unique number, and brief notes with appropriate synonymy.

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If you would like further information about the **Marine Species Directory** please send the slip below to: Helena Chesney, Dept. of Zoology, Ulster Museum, Botanic Gardens, Belfast BT9 5AB.

Marine Species Directory

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Name ....

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ANNEX 13

ACTION LIST

1) Dr Rees to write to the chairmen of the ICES Benthos Ecology and Phytoplankton Ecology WGs requesting preliminary consideration of relevant QA matters at their 1997 meetings.

2) Dr Rees and Mrs Pawlak to ensure that representatives of OSPAR countries are contacted with a request for summary details of eutrophication-related (and other) studies involving specified biological measures and related QA activities.

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

4) Members to submit examples of SOPs covering the biological measurements of concern to SGQAE, and to report on progress with the development of 'in-house' quality manuals.

5) Dr Rees to report on a 1997 benthos sea-going workshop in the UK, and other developments in the UK National Marine Biological AQC Scheme.

6) Dr Dahl to report on any QA developments relating to phytoplankton and chlorophyll *a* studies in Norwegian waters.

7) Dr Bakke to report on any QA developments relating to benthos studies in Norwegian waters.

8) Dr Shwarzbach to report on any relevant QA developments in German waters not covered by ICES/HELCOM activity.

9) Dr Shwarzbach to report on intersessional activities of the ICES/HELCOM QA groups.

10) Dr Rees to discuss, with the Chairman of the ICES Working Group on Biological Effects of Contaminants, the scope for inclusion of benthos and phytoplankton studies in a proposed bid for EU funding of a biological QA scheme, and report back to the 1998 SGQAE meeting.

11) Dr Bakke to ensure (via the ICES Secretariat) that copies of the Steering Group report were also circulated to ICES/HELCOM SGQAB members.

ANNEX 14

RECOMMENDATIONS

The Steering Group on Quality Assurance of Biological Measurements Related to Eutrophication Effects recommends that it meet in Copenhagen on 17–20 February 1998 in order to:

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;

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;

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

e) work with the ICES Phytoplankton Ecology and Benthos Ecology Working Groups in order to ensure harmonisation in the future implementation of JAMP guidelines so that QA procedures are not compromised;

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

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

h) determine the scope for preparation of appropriate taxonomic lists of species, especially for phytoplankton.