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Report of the

Working Group on Phytoplankton Ecology

The Hague, The Netherlands
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International Council for the Exploration of the Sea

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1 OPENING OF THE MEETING

The host, Dr Peter Bot opened the meeting at 9 am on the 14 March. He welcomed the participants to the Working Group meeting; being held at National Institute for Coastal and Marine Management (RIKZ), The Hague, The Netherlands. The meeting took place in The Hague instead of Middelburg, as it had been found more practical to continue after the workshop on eutrophication in this place. The Chair Dr Lars Edler started the Working Group on Phytoplankton Ecology, as many interesting scientific and applied problems are discussed within the group e.g., eutrophication, growth rates, food web structures, global change, operational monitoring strategies, global change.

The task of acting as rapporteur was shared among the participants, with the main responsibility by Dr David Mills.

2 TERMS OF REFERENCES AND AVAILABLE PAPERS

The Terms of Reference (Annex 2) were considered and the Chair presented the Available Papers for the meeting (Annex 3).

3 DISCUSSION OF TERMS OF REFERENCE

3.1 Review of the reports of ICES/HELCOM Steering Group on Quality Assurance of Biological Measurements in the Baltic (SGQAB)/ICES/OSPAR Steering Group on Quality Assurance of Biological Measurements in the Northeast Atlantic (SGQAE) (TOR a)

The work of SGQAB and SGQAE continues to be of relevance to the members of the WGPE. Feedback to and from these study groups plays an important role in ensuring relevant expertise is available to the steering groups and that WG members are well informed of developments.

Quality assurance issues being addressed represent major interests of the Baltic and North Sea communities. It was noted that a combined 3-day meeting was held for HELCOM QA combined with the OSPAR QA meeting.

3.1.1 SGQAB

The two Quality assurance groups had parallel meetings, including a joint session in Copenhagen 19–22 February 2002. At the time of the WGPE meeting their reports were not available. At a later stage the report of SGQAB was available. The main outcome was that the comments on the ICES Biological Data Reporting Format should be submitted to the ICES Marine Data Centre via the discussion forum on the ICES website. ICES Marine Data Centre then decides if comments are of a scientific nature and need consideration by SGQAB. The group was informed about the current status of ICES Marine Databases and SGQAB members reported on the use of ICES Biological Data Reporting Formats in their countries and data submission. At the moment only Sweden has reported data.

At the third HELCOM MONAS meeting it was made clear that MONAS does not approved the merging of the ICES/HELCOM SGQAB and ICES/OSPAR SGQAE, but has strongly recommended the Groups to have back-to-back meeting and joint sessions in order to guarantee the harmonisation between HELCOM and OSPAR.

SGQAB was informed that Guy Hällfors has almost completed the preparation of phytoplankton taxonomical checklist for Baltic area and that it is available on the Algaline website and the publishing of the checklist is also planned at the nearest future.

The meeting was also informed that national checklists on macrozoobenthos and phytoplankton are compiled covering German marine monitoring areas. At present the checklists are under revision and the availability through Internet is planned for the next year.

ICES/HELCOM Steering Group on Quality Assurance of Chemical Measurements in the Baltic Sea had produced comments on the QA procedures for chlorophyll a and primary production measurements and concluded that it is sufficient for general guidance and is not controversial to quality assurance requirements. The QA document on primary production measurements should consider also the waste handling according to international requirements.

Reports of the Phytoplankton Expert Group meetings were presented. The meetings have training in identification, estimation of biomass by measuring the algae from natural samples and creation of Baltic phytoplankton checklist.

Every meeting has considered the development of the ICES Biological Data Reporting Format and the comments have been prepared and submitted.

Concerning the HELCOM COMBINE Manual, SGQAB realised that differences exist between ISO standard and Manual Annex C-4 on chlorophyll a determination and decided to ask the Working Group on Phytoplankton Ecology to consider the differences and prepare a harmonised draft of the Annex. The new draft will be distributed to experts intersessionaly. SGQAB will review the comments at the next meeting and suggest the changes for COMBINE Manual. Lars Edler will update the Phytoplankton Primary Production manual by the end of April 2002. The new version will be discussed at the next meeting of SGQAB.

Reports from ring tests and the workshop conducted in Germany was presented. The main conclusions from the phytoplankton ring test was that a unified species list, including all synonyms, is needed; exact definitions should be used; regular training courses for all staff involved in routine monitoring should be organised. Future workshops of 2002–2003, organised by Federal Environmental Agency of Germany, will be open for the experts of HELCOM countries.

3.1.2 Joint meeting of SGQAB and SGQAE

Progress in the work of the Study Group on a ICES/IOC Checklist of Phytoplankton and other Protists and Working Groups on Phytoplankton Ecology, Benthos Ecology and Zooplankton Ecology was discussed and it was concluded that Phytoplankton checklist for the Baltic Sea is almost finished and will be published 2002. It was also reported that the Dutch have developed software to demonstrate a checklist (Encyclopaedia Taxonomica. Currently the database contains diatoms, zooplankton, macrofauna and birds. The North Sea Information System, an ICES-KIS funded project, is set up in combination with ETI Amsterdam. The Taxonomica system is now live. WWW.taxonomica.com. Jon Davies reported on National Biodiversity Network, UK. Marine species checklist is being developed by JNCC using Recorder www.nbn.org.uk. There was also report of the current status of the European Register of Marine Species (ERMS). This was a MAST programme funded project to produce a web-based register of marine species. The web site is live (http://erms.biol.soton.ac.uk), but has not been updated since February 2000. Several of the links are dead and communication with the web manager has proven futile.

In the joint session the advantages and limitations of measurements of primary production and of zooplankton communities in monitoring programmes were further considered, noting that these were not requirements under the OSPAR Joint Assessment and Monitoring Programme. It was also noted that these were not mandatory targets for evaluations of ecological status under the EU Water Framework Directive. Measurements of primary production, and of zooplankton communities, are established tools within the Baltic marine monitoring programme, and methodology for field sampling and laboratory analysis, together with relevant QA considerations, are contained in the HELCOM COMBINE monitoring manual. This document provides a rationale for such measurements as follows: 'Primary production is the only regular rate measurement in the Baltic Monitoring Programme. From these measurements it is possible to calculate the amount of organic material formed from light, carbon dioxide and nutrients. Primary production has important links to eutrophication and sedimentation and, consequently, to deep-water oxygen concentrations'.

SGQAE recognised the potential value of determination of primary production, which, as a 'rate' variable (see above), was directly relevant to evaluations of ecosystem function, and a necessary component in the modelling of energy flow.

Experiences with the employment of primary production measures in national monitoring programmes within the OSPAR area were briefly reviewed. Reference was made to the relatively demanding nature of the work (both in time and resources), which was necessary in order to generate credible outcomes, and difficulties associated with the lack of standardisation in approaches to sampling and analysis. As a result, some considered that measures of species composition, densities and biomass provided more dependable alternative means to evaluate environmental status. The scope and limitations of estimating primary production from chlorophyll a determinations was also discussed, leading to the conclusion that it may be locally acceptable but could not be advocated for wider application.

Measurement of primary production continues to have an important role in a number of research programmes, including assessments of responses to chemical contaminants. Note was made of a forthcoming ICES-sponsored meeting on Contrasting Approaches to Understanding Eutrophication Effects on Phytoplankton, 11–13 March 2002, which should provide further relevant guidance.

It was concluded that, for both primary production measurements and zooplankton studies, further critical evaluation of their advantages and limitations in environmental monitoring programmes was required. Such an evaluation should

combine considerations of practicality (including QA/AQC aspects) with those of scientific merit. ICES Working Groups on Phytoplankton and Zooplankton Ecology are the appropriate sources of advice.

The questionnaire on Primary Productivity QA practices produced by SGQAB and circulated to HELCOM countries, was re-worded to encourage laboratory participation. SGQAE also proposed that the questionnaire be circulated through the OSPAR network since the information gathered would be mutually beneficial. The results will be analysed during the next SGQAB/SGQAE meeting in 2003.

A list of planned workshops, training courses, intercalibrations and other relevant QA activities was composed jointly with SGQAE to get an overview of planned QA activities in convention areas. Compilation of similar lists was thought to be one of the future joint activities during future back-to-back meetings.

The work of SGQAB and SGQAE continues to be of relevance to the members of the WGPE. Feedback to and from these study groups plays an important role in ensuring relevant expertise is available to the study groups and that WG member are well informed of developments.

3.1.3 SGQAE

It was noted from the OSPAR SIME meeting (2001) that 'ICES had therefore recommended that the work of SGQAE should continue, that its remit should be extended to cover QA of all biological community measures used in marine monitoring in the Northeast Atlantic, and that it should collaborate more closely with the related ICES/HELCOM Steering Group on Quality Assurance of Biological Measurements in the Baltic Sea (SGQAB)'.

At the 2002 SIME meeting a proposal had been prepared for consideration by ASMO 2002 for inclusion of SGQAE activity on the draft 2003 ICES Work Programme. Janet Pawlak outlined the options available for consideration at ASMO 2002, namely:

a) continuation of the group, or
b) delegation of QA matters to the relevant ICES working groups.

In April 2002, ASMO will decide on the future inclusion of SGQAE on the ICES work programme, based on the revised Terms of Reference and taking into account its strategic importance relative to other bids for future work.

SGQAE reviewed relevant biological studies and related QA activities in member countries. The review shows the considerable activity in Germany, The Netherlands, United Kingdom and Norway, where ring tests, workshops and national standards for phytoplankton, macrophytes, epifauna and macrozoobenthos have been held and been prepared.

It was evident from the views of ACME (ICES) and ASMO/SIME (OSPAR) that there was recognition of the ongoing importance of QA activity in international monitoring programmes, in response to established demand for strategic environmental evaluations at this level (see item 5). OSPAR, HELCOM and ICES are currently engaged in the development of an 'ecosystem approach' to marine environmental management. This will have profound implications for future assessment strategies and, is likely to require closer integration of data sets from disciplines which have conventionally been gathered and reported separately, and therefore have little in common with regard to QA/AQC approaches. Further, the EU 'Water Framework' Directive presently provides another strong stimulus for the harmonisation of monitoring methods among member states, and the quality control of the resulting data.

The utility of accreditation schemes for QA of biological work was discussed and it was found that one of the main problems of the application of accreditation to biology is the lack of national and international standards on which to assess compliance. SGQAE and SGQAB recognise this may be addressed through increased involvement with ISO/CEN.

Within Europe CEN Standard EN4500 regulates accreditation.

In the general discussion, widespread deficiencies in the amount of effort devoted to the teaching of taxonomy and identification skills in academic establishments were highlighted. The need for such skills was evidenced (in the UK) by the fact that all nationally organised taxonomic workshops were oversubscribed. In Norway, the issue is to be discussed at governmental level.

3.2 Elaborate the outcome of the work of the Study Group on an ICES/IOC Checklist of Phytoplankton and other Protists (ToR b)

Inter-sessional work by Guy Hällfors was not possible due to illness and as a result no progress had taken place since last years report. Nevertheless discussion by WGPE members ensued. It was noted that the checklist was published on the web site ALGALINE. Discussion highlighted the importance of ensuring links with other checklists were identified. The WGPE felt that it should make strong recommendations to the appropriate bodies to ensure commonality in approach. Peter Bot noted that Europe wants a different system to the USA. Confusion exists about taxonomic codes and there is general lack of agreement. WGPE may identify approaches to improve communication. Gene Turner noted that two or three schemes existed to identify HABs but there was a need for mutually agreeable schemes that are comparable. Francisco Rey suggested that there was a need to complete the ICES/IOC list as a matter of urgency and to get list into the public domain now and to continuously update. By taking such an approach it would then give the opportunity for experts to reconcile differences and arrive at common checklist.

Gene Turner suggested that the perceived incompatibility between lists might only account for 10 % of the material. Ted Smayda noted that Guy Hällfors has carried out a difficult task well and agreed that an important way forward was to identify differences between the check lists and for problems to be resolved by experts. Paul Harrison suggested that lists should be merged where they match and then work on the problems of compatibility where they fail to merge. Specific problems that were anticipated by the WG members included problems in format. Peter Bot provided an example of RIKZ database, as example of a "first base" checklist. A preliminary ICES checklist of phytoplankton should be circulated and expert response should be sought. Lars Edler was asked to screen names to produce final list of lists. As SGPHYT is a combined ICES/IOC group both organisations need to be contacted.

Ted Smayda proposed that we refer the problem back to ICES. Solely taxonomic experts do not populate the WGPE. There was a need to consider all available and relevant checklists and set up another group to address this. The problem was twofold – format and different identifications. There is a need for a master list.

Lars Edler suggested the first step is to make a list of all species and then ask taxonomists to check it. Francisco Rey agreed and proposed forwarding such a list to Guy Hällfors.

In order to bring this task to termination Ted Smayda asked how long would it take to complete the task of reconciliation between checklists. Lars Edler responded that he could produce lists for Guy Hällfors within 1 month but was not able to indicate when this task could start but that he could try to meet with Hällfors prior to ICES science meeting in September 2002.

Ted Smayda recommended to distribute the preliminary ICES checklists of phytoplankton and seek expert response. Give experts veto power return of amended list to be considered by the next meeting of WGPE. Lars Edler will screen names intersessionally in order to produce final list of lists and report back to the next meeting.

Recommendation

Form Study Group to resolve outstanding problems/issues in the Preliminary European Phytoplankton Checklists and to integrate information from molecular taxonomists. Therefore the working group should be composed of taxonomists and molecular taxonomists.

Phytoplankton checklist to be compiled by DATE from the ICES/IOC, ICES WGHAB and other checklists available on European waters, including those in identified in previous reports from ICES WGPE.

Deliverable is checklist with suitable nomenclature for database inclusion. The combined merged checklist for phytoplankton will be handed over to the ICES Marine DataBase Manager for the control of the format.

3.3 Organise a specialised session for the 2004 meeting of the Working Group, on non-traditional and automated analysis techniques for phytoplankton field sample analysis with invited speakers (ToR c)

WGPE noted the convening of a workshop focussing on automated *in situ* technology held in Germany in April 2002. This workshop undermined the purpose of this specialised session. However, a presentation by Thomas Rutten of the RIKZ was given on the use of flow cytometry for routine analysis of live field samples of phytoplankton. The technique is used for analysis of samples collected during the monthly survey carried out in The Netherlands coastal waters, as part of The Netherlands National Marine Monitoring programme.

WGPE concluded that it is no longer relevant to hold a specialised session at a WGPE meeting. Instead WGPE will recommend having a Theme Session at the ICES Annual Science Meeting in 2004. The group will revisit this ToR at next year's meeting and then draft a suggestion to be presented at the ICES Annual Science Meeting in 2003.

3.4 Re-evaluate the proposed mesocosm experiment, dependent upon the outcome from the proposed Workshop on anthropogenic nutrient input (C.Res. 2001/2CWS) (ToR d)

Ted Smayda introduced the discussion on this topic and pointed out that there does not appear to be a mesocosm facility available. It also seems to be difficult to find funding for a mesocosm experiment and without special funding participation in the experiment is not possible. It has been found that there is not a critical mass of interdisciplinary scientists available, who are prepared to undertake such a study at this time. A discussion followed, which ended with the decision that, WGPE agreed to cancel the plans for such an experiment for the immediate future. For year 2004, WGPE will adopt the ToR to reconsider these issues.

3.5 Evaluate the proposed mesocosm facilities at RIKZ in Middleburg, The Netherlands (ToR e)

Due to the outcome of the discussion of ToR d the mesocosm facilities in Middelburg were not visited. Despite the present conclusion of cancelling the mesocosm experiment at this time, the interest of the WGPE remains considerable. However, difficulties including manpower concerns and funding are likely to prevent any possibility fulfilling this ToR. After the ICES workshop on nutrient effects immediately preceding the working group meeting there was recognition of the need to incorporate different trophic levels in any mesocosm study. It was agreed that such a study creates a need for a multi-disciplinary approach that is beyond the capability of a single WG.

A presentation by Theo Prins from RIKZ on the mesocosm facilities of RIKZ at Middleburg was given. Based on the MERL design implemented originally at the University of Rhode Island work has been conducted over a 10-year period. A paper was presented by Prins at the Nutrient Effects Workshop preceding the WGPE meeting and the abstract is included in Appendix 3 of the Workshop Report (ICES CM 2002/C:05).

Following the presentation the WGPE recognises the problem of appropriately simulating physical processes e.g., mixing and turbulence that will lead to questions regarding the extrapolation of mesocosm results to the marine ecosystem. Based on the perceived problems and the progress of mesocosm work carried out elsewhere the view of WGPE is that that the plans for a mesocosm study should be abandoned at present.

Subsequent discussion identified a possible role for modelling in exploring some of the questions originally identified for testing within a mesocosm. This idea will be explored further at the proposed modelling workshop proposed to be held jointly with WGZE.

3.6 Integrate the contributions on phytoplankton monitoring in the ICES area into the Summary Status Report on zooplankton monitoring results in the ICES area (ToR f)

During the joint meeting between WGPE and WGZE in 2001 links between the two groups were combined. The discussion resulted in the identification of an obvious area of collaboration, i.e., the annual status reports on standard sections and time series stations of phyto- and zooplankton in the ICES area. At the present meeting some WGPE members provided examples of reports from their countries. Peter Bot presented a type of national report in use in The Netherlands, which may be adapted for inclusion in the Summary report. Cluas Dürselan also presented an example of the monitoring reporting procedure in use in Germany that could form the basis of a contribution to the Summary report (Annex 4) (http://www.bsh.de/Meeresumweltschutz/Mursys/1517.htm). Using these examples WGPE will continue developing the standard reporting protocols for use in this effort intersessionally.

The WGPE noted the need to consider the implication of the new OSPAR assessment procedures (see ToR g) and potentially other policy drivers (e.g., Water Framework Directive) requirements. As a result the action will be addressed in greater detail in 2003.

3.7 Provide the scientific merits and operational possibilities to include primary production measurements in environmental programmes as e.g., OSPAR/JAMP with full coverage of QA and standardisation (ToR g)

The group discussed this topic, using the available information from HELCOM and specific ICES countries. Lars Edler told that measurements of Primary Production used to be mandatory in the HELCOM Baltic Monitoring Programme and one of the strongest arguments to include it was that this was the only rate measurement in the monitoring

programme. When the programme was changed into HELCOM COMBINE some years ago Primary Production was no longer a mandatory, but a supplementary variable. Today only three countries among the 9 HELCOM countries measure Primary Production; Estonia, 7 stations, Poland, 15 stations and Sweden, 2 stations. Francisco Rey continued saying that in Norway they have stopped measuring Primary Production, because of difficulty in intercomparisons. This is due to differences in methodology and calculation, which then questions the value of the measurement.

It was stated that a measure of Primary Production is needed for ecological assessment, but that there is a need for agreed standard methodology. Lars Edler pointed out that there is an ICES standard procedure, which has been adopted by HELCOM Combine. The dominating opinion in the group was that the use of models to calculate the production would be the most successful way to continue.

New direct methods (bio-optical) for measurement of the physiological (nutrient) status of phytoplankton and their photosynthetic response are becoming available (e.g., FRRF, PAM). Simple models can be used to estimate primary productivity column productivity from these new measurements (and traditional ^{14}C or O_2 measures) when coupled with appropriate additional environmental data (e.g., sub-surface irradiance profiles) and more complex models can subsequently be used to scale discrete and small scale measures to regional or basin scale estimates of primary productivity (and nutrient status). New measurements and improved models have the potential to meet the need for improved information on primary production – a fundamental measure of ecosystem functioning.

A major goal in the study of all aquatic ecosystems is the accurate and precise measurement of primary production. Organic production by phytoplankton provides food for higher trophic levels and acts as a sink for atmospheric CO_2. The biomass resulting from high levels of primary production may cause water quality problems, and eutrophication is defined by the EU as including "accelerated growth of algae" following nutrient enrichment. Net primary production is phytoplankton growth rate multiplied by biomass; however the chlorophyll component of biomass is easy to measure routinely, and growth rate depends on phytoplankton photosynthetic rate and internal nutrient status. Conventional methods for estimating primary production by uptake of $H^{14}CO_3$ or release of O_2 are labour intensive and apply only to the small volumes enclosed in bottles and are contentious in interpretation. The modelling of production using photosynthesis-irradiance (P-E) curves requires a theoretical understanding of the causes of variability in these curves. New instruments such as the natural fluorometer and the FRRF and PAM open up the possibility of direct *in situ* estimates of these parameters, especially the photosynthetic quantum yield ϕ. They have been successfully used in oceanic (optical class I) waters but their use in coastal (optical class II) waters can be complicated by the presence of abundant yellow substance and inorganic suspended particulates. The operational status of the new generation of bio-optical instrumentation needs to be determined before recommendations concerning their wider use for 'routine' assessment of primary productivity. The outcome of current research programmes needs to be reviewed and evaluated as a step towards this goal.

3.8 Prepare a summary report listing relevant marine bio-ecological variables and indicators suitable for operational use (ToR h)

Job Baretta gave an introduction to the EuroGOOS Publication No 15 "Bio-ecological Observations in Operational Oceanography" The WGPE had received the publication relatively briefly before the meeting. The WGPE members felt the publication was highly relevant and would be of great value in assessing operational readiness of bio-ecological variables. It was noted that some examples of the bio-ecological variables e.g., primary productivity were addressed elsewhere in this report (ToR g). The late arrival of the key document did not assist the working group in meeting this ToR. The meeting was of the opinion that further effort was required in order to move this ToR to a satisfactory conclusion. It was proposed that this ToR be carried forward till next years meeting.

The group recognised the need to urge the monitoring agencies and the remote sensing community to look for rate variables in addition to state variables, e.g., O_2 saturation as indirect indicator of rate measurements, as well as FRRF, PAM, methods that are not yet operationally ready. It was also noted that observations on benthic activity and its influence on pelagic communities are highly needed

3.9 Review studies underway in OSPAR on ecological quality objectives for the North Sea with regard to nutrients and eutrophication effects (ToR i)

Robert Jak gave a presentation supported by Wanda Zevenboom, who joined the WGPE during discussion of this ToR. The presentation was an extract of the OSPAR Meeting of the Eutrophication Committee (EUC), entitled Current status of Elaborated Ecological Quality Objectives for the Greater North Sea with regard to Nutrients and Eutrophication Effects (EcoQOs-eutro). The paper presented, included in Annex 5, was discussed by the WG members.

Jak and Zevenboom explained that through them OSPAR was seeking expert feedback on the procedures identified in the document. ICES is regarded as an independent check on OSPAR with a specific role for WGPE in the application of agreed procedures and further development of assessment criteria. They elaborated on the development of EcoQO's in regard to OSPAR and in particular highlighted those elements related to planktonic communities. They drew attention to the OSPAR definition of eutrophication that includes reference to accelerated growth of algae and shifts in the balance of organisms. In particular, reference to chlorophyll-a concentration, species composition and the role of 'indicator' species were mentioned.

Four issues related to nutrients and eutrophication effects (nutrients, phytoplankton, oxygen, benthic communities) were extracted by EUC from the proposed ten issues of EcoQOs by the biodiversity committee (BDC). They became the EUC assessment criteria: winter DIN and DIP, phytoplankton chlorophyll a and indicator species, oxygen, benthos kills. These criteria were classified into four categories: degree of nutrient enrichment, direct effects of nutrient enrichment, indirect effects of nutrient enrichment, and other possible effects of nutrient enrichment. This allows a classification of an area in problem, potential problem or non-problem area dependent whether there are increased trends, elevated levels, shifts or changes in the respective assessment parameters or not.

The overall general ecological objective is to achieve by the year 2010 a healthy marine environment where eutrophication does not occur.

The report also includes tables for each assessment parameter and different regions, which give the ranges during former years, the historical background concentration, and numbers for the elevated level. In this study the elevated levels of the EcoQOs are defined as the concentration > 50 % above the natural spatial/historical background. For example the background for German coastal waters is 10 $\mu g\ l^{-1}$ Chl a, that means for the elevated level > 15 $\mu g\ l^{-1}$ Chl a.

Jak and Zevenboom noted a need for the WGPE members to help contracting parties to aggregate information into the assessment scheme. Based on assessment criteria and monitoring programme outcome contracting parties will report all information requested in a standardised form. National reports will lead to contracting parties own conclusions as to how to classify their waters. However, they must assess in a manner that enables a clear indication of whether the assessment indicated that the EcoQO was met as specified. The timetable currently will require reports to be delivered in September 2002 to co-lead countries (The Netherlands and Germany) for assessment and to Norway and The Netherlands for quality objectives.

OSPAR will require help to analyse reports when they are submitted and proposes that WGPE should assist in this task. In addition, help is sought from the ICES WGPE to advise on the current status of the assessment procedures. Ted Smayda expressed concern about this and suggested that this assessment procedure may be difficult to endorse.

The group noted the summary record EUC 01/11/1-E, Table 9, on chlorophyll and in particular the absence of information for Belgium, France, Iceland, Spain, Wadden Sea and UK. This should be attached as a footnote to Table 9 page 17 in EUC doc. 01/5/3- Rev.1.

Some suggestions and remarks during the following discussion in WGPE concerning the Ecological Quality Objectives are listed here. ICES should be involved in the future process with reference to the quality assurance.. There is the need to help the contracting parties to aggregate the information into the assessment scheme. Based on Working Group assessment criteria and monitoring programmes, the contracting parties will report all information requested in a standardised form. The national reports lead to conclusions as to how to classify their waters.

Important for the classification of water masses are the region specific characteristics, like the coastal salinity gradient, the degree of stratification or the type of sediment. Chlorophyll is a problematic parameter due to different species composition and diurnal changes. The species abundance limits have to be considered, e.g., the cell number of HAB species depends on a lot of conditions like currents.

There is a huge contrast between monitoring programs of different countries. All countries should work together when collecting the samples and data. A co-ordinated programme is necessary. For the North Sea such a co-operation already works well. The sampling has to be adapted to the local situation.

4 ANY OTHER BUSINESS

4.1 Outcome of Actions from 2001

a) WGPE will urge ICES to promote more regionally focussed taxonomic training courses of phytoplankton.

It was noted by USA delegates that there was strong reliance on the Naples course within the USA and that attendance was assisted with financial contribution from US agencies. Other courses were offered in the USA at the Bigelow laboratory in Boothbay harbour. Attention was drawn to a Japanese based course run by Fukuyo that had trained some 300–400 students in response to a pressing need and had trained sufficient people in taxonomy to meet local needs. The different levels of training offered by different courses were regarded as important in order to ensure appropriate provision for training from beginners through intermediate to advanced.

The WGPE expressed some concern over loss of the loss of expertise in taxonomy in general and in the knock on effect in terms of future trainers for advance courses.

The potential for new technologies to enable sharing of taxonomic resources internationally was discussed. There is a need to identify key reference sources, for example, employing an image database for all species with identification agreed by current recognised experts. Such an approach could be web based providing wide access. The use of molecular and chemical approaches to taxonomy was discussed by the WG. Species-specific probes are now available and the group recognised a need for a more detailed discussion on the likely impact on taxonomy would be. Other approaches e.g., HPLC for chemical taxonomy were also noted.

The question of what value are regional courses held was discussed by the working group. Specific regional differences in populations were a strong reason for different types of courses with regional focus.

The work of the EU funded programme BEQUALM as drawn to the attention of the WG and it was noted that it will report on ring tests for phytoplankton analysis. A need for ICES to take note of the outcome of this EU programme was identified and specifically any implications concerning the needs for improved training for phytoplankton taxonomists in the ICES region. It was also noted that ICES needs to be aware of other related initiatives and especially to learn from the Baltic experience.

b) WGPE will recommend ICES to make a selectable site from ICES homepage on the web, where appropriate links, showing the different national of the various institutions, performing monitoring programmes, are stated.

Lars Edler introduced this topic and indicated that the ICES Webmaster had agreed to allow links referred to in the justification. These were to be presented under WGPE banner. Edler drew attention to his involvement with the production of AlgAware (www.smhi.se/ then follow link via algal report). This site provides update on information concerning phytoplankton distribution at particular sites in Swedish coastal waters.

Francisco Rey drew attention to a compilation of monitoring results for phytoplankton based on weekly sampling that includes information on where species are found and whether they are harmful. (www.imr.no/ALGEINFO). Paul Harrison noted a relevant link to monitoring in Hong Kong (www.info.gov.hk/afcd) that includes HAB updates, weekly reports on distribution and data on toxicity. Many relevant links were to be found in the USA and these were best pursued via the NOAA web site. The UK has a site incorporating general information on the UK National Marine Monitoring programme as well as real-time monitoring data from the CEFAS Smart Buoy programme (www.cefas.co.uk/monitoring). Rey also presented the following list of interesting web sites:

Ioc.unesco.org/oceanportal
/glodir
/iode
/goos
/hab

c) Outcome and future work of the Workshop on "Contrasting Approaches to Understanding Eutrophication Effects in Phytoplankton (WKNUPE)"

The Workshop objective was to evaluate the mass balance versus organismic approaches to quantify phytoplankton responses to coastal nutrient enrichment. In this evaluation, observational and experimental studies, both field and laboratory, were of interest, including regional ecology, population dynamics, cellular nutrient physiology and

modelling. Elements that fell within the objective were the identification of the underlying mechanisms that limit understanding and hinder robust predictions of phytoplankton responses to nutrient inputs, considering selected case histories from around the world to identify the range of responses exhibited by phytoplankton communities to nutrient inputs and the evaluation the potential importance of cellular level responses to nutrient inputs, as opposed to population and community level responses.

The WGPE agreed that the Workshop was successfully accomplished and especially **thanked RIKZ, The Netherlands and CEFAS/DEFRA, United Kingdom for their complete financing of the Workshop**. In attendance were 43 delegates from 15 countries who presented 33 papers. Informed presentations and spirited interdisciplinary discussions took place. The Workshop is the first known assembly of biologists, chemists, modellers and representatives of regulatory agencies ever gathered to focus on the important issues of the nature of coastal water eutrophication and its role in altering ecosystem processes, particularly at the plankton level. Both the material presented and the professional channels that were newly opened up should henceforth greatly facilitate the missions of social scientists and regulatory agencies in their need to incorporate "hard science" into their efforts and, in reciprocal fashion, the Workshop helped to "sensitise" marine scientists to the needs of social scientists. A dialogue has been established. One measure of the success of the Workshop is that the participants agreed to publication of the Workshop presentations in a dedicated volume to appear in the Journal of Sea Research, with the editorial board consisting of Ted Smayda, Paul Harrison, David Mills and Peter Bot.

WGPE discussed if it is meaningful to give a quantitative definition of eutrophication: during the spring bloom biomass of phytoplankton is high, but during summer there is a high primary production at low biomass. The chlorophyll is more active in summer due to the higher light intensity. The basic conditions are always the same: chlorophyll – nutrients – grazer. But the response of the species is different.

Case studies are very well suited to show the necessity for monitoring programmes. From these studies an optimal adapted sampling programme can be developed for specific conditions. There is a clear need for long-term series.

Data sets of historical case studies could be run with ecosystem models. In this way specific hypothesis could be tested and possibly replace samplings. An intensive exchange of views with the mathematicians is demanded.

The organization, programme, Abstracts and results of the Workshop (WKNUPE) are presented in a separate report submitted to ICES, identifiable as “Workshop on Contrasting Approaches to Understanding Eutrophication Effects on Phytoplankton (ICES CM 2002/C:05)”.

d) WGPE to plea for the rescue of the long-term time series run for 37 years by Dr Smayda

Lars Edler told the WG that he had spoken directly to senior ICES officials. ICES responded that it was not in a position to make any statement or formerly respond. Wider discussion by Edler with others has taken place and every opportunity was taken to publicise the plight of this time series. Ted Smayda indicated that Chris Reid director of SAHFOS wrote to the Dean of Programme at University of Rhode Island and that the WGZE through Peter Wiebe was also pursuing the matter.

In a related discussion Peter Bot noted the retirement of Gerhard Cadee and the potential threat to the Marsdiep time series in The Netherlands. Ted Smayda suggested that WGPE should recommend the continuance of this time series. The WGPE noted that OSPAR has a requirement for information from its contracting parties to comply with monitoring of nutrients and eutrophication effects. The 30 years Marsdiep time series is a unique long term programme, one of only 2 for the North Sea, of phytoplankton and nutrients and is a key reference site for continental coastal waters in the North Sea. The WGPE would wish to alert OSPAR and NIOZ (as the key institute) to the importance in maintenance of this long-term time series.

e) WGPE to outline a plan for the discussion of the mesocosm experiment at the next meeting of WGPE

See ToRs d) and e)

f) WGPE to consider and review plans for a workshop on modelling phytoplankton-zooplankton interactions in 2003.

A modelling workshop auspiced by the WGPE and the WGZE was proposed during the 2001 discussions. In the contacts with WGZE we have agreed the workshop on modelling phytoplankton-zooplankton interactions should be postponed since there will be a similar workshop during the Zooplankton Symposium in Gijón 2003. It was agreed that

WGPE and WGZE keep in close contact for the planning of a suitable time and place for a joint meeting, including the workshop to be held in 2004. The Workshop on Grazing-Phytoplankton Relationships is of great concern for WGPE and WGZE and in part also for WGHABD.

g) *WGPE to develop standard reporting protocols for an annual status report on standard sections and time series stations of phytoplankton in the ICES area based on the report produced annually by the WGZE with the first status report to be a product of the year 2002 meeting of the WGPE.*

See ToR f)

5 ACTIONS, RECOMMENDATIONS AND DRAFT RESOLUTIONS

Actions for the WGPE

Action I To prepare a draft ICES/IOC checklist of Phytoplankton and other protist to be compiled from the ICES / IOC, ICES WGHAB and other checklists available on European waters, including those identified in previous reports from ICES WGPE. The draft checklist will independently be reviewed by taxonomic experts (Lars Edler).

Justification: The checklists of Phytoplankton and other protist are urgently needed and the WGPE is prepared to help in accomplishing this without delay.

Action II To review the progress of the EU programme BEQUALM and the implication concerning needs for improved training for phytoplankton taxonomists in the ICES region (Claus Dürselen).

Justification: OSPAR requirements for assessment in relation to eutrophication will require information on the taxonomic composition of phytoplankton. There is concern that suitably trained staff is becoming in short supply to meet anticipated future demand.

Action III To publish the outcome from the workshop in a peer reviewed journal (Edler, Bot, Smayda, Mills)

Justification: The workshop attracted an international group of 43 experts to present and discuss material under the theme of the workshop. The outcome of the workshop was a timely review of the driving forces and responses to eutrophication. A published account will be of great value in aiding the refinement of OSPAR eutrophication assessment criteria and be international significance in improving the understanding of ecosystem response to nutrient enrichment.

Recommendations to the Oceanography Committee

The Working Group on Phytoplankton Ecology recommends the support of the following Theme Session at the ICES Annual Science Meeting 2004:

AUTOMATED BIOLOGICAL IN SITU MEASUREMENT TECHNIQUES

Drafts of the proposed time sessions, convenors and other logistic details will be prepared for discussion during the Oceanography Committee Meeting at the 2003 ICES Annual Science Meeting

Draft resolution

The Working Group on Phytoplankton Ecology (Chair: Dr Lars Edler, Sweden) will have its annual meeting 11–14 March 2003 (second alternative: 4–7 March 2003) in Villefranche sur mer, France, with the following Terms of Reference:

a) Review the reports of the ICES/HELCOM Steering Group on Quality Assurance of Biological Measurements in the Baltic and the ICES/OSPAR Steering Group on Quality Assurance of Biological Measurements related to Eutrophication Effects;

b) Elaborate the outcome of the work of the Study Group on a ICES/IOC Checklist of Phytoplankton and other Protists;

c) Organise the mini-symposium at the ICES Annual Science Meeting 2004:on AUTOMATED BIOLOGICAL IN SITU MEASUREMENT TECHNIQUES;

d) To alert ICES to the potential termination of a unique North Sea phytoplankton 30 year time series from the Marsdiep of increasing value with relevance to OSPAR assessments and urge ICES to make representation to the appropriate bodies in order to ensure its future support

e) To proceed with organisation of a workshop in collaboration with WGZE on modelling phytoplankton-zooplankton interactions.

f) To continue to integrate the contributions of the WGPE on phytoplankton monitoring in the ICES area into the Summary Status Report on zooplankton monitoring results in the ICES area

g) To receive the reports from OSPAR/EUC regarding eutrophication status of greater North Sea and advise on current status of OSPAR assessment procedures

h) To consider the HELCOM experience with respect to the use of measures of primary production in environmental monitoring programmes

Supporting information

Priority:	The activities of this group are fundamental to the work of the Oceanography Committee. They are critical in understanding links between physics and Living Marine Resources and play an important role in identifying environmental change. The work of this group is regarded as high priority.
Scientific Justification:	a) The work of SQGAB and SGQAE continues to be of relevance to WGPE. Feedback to and from these Steering Groups plays an important role in ensuring relevant expertise is available to the groups and that WGPE is kept informed of developments. b) The work of SGPHYT in developing a Checklist of Phytoplankton and other Protists is of direct interest to the work of WGPE and benefits from its attention and feedback. c) The introduction of new techniques to supplement the traditional ship and shore-based approach has revealed even greater complexity in plankton distributions, cycles and processes than previously measured. Data are showing strong coupling between plankton composition, abundance, dynamics and ecophysiological diversity and long-term weather patterns. Growing evidence are showing the need to consider species level dynamics, rather than the traditional reliance on biomass only. These newer insights indicate that the classical working definition of needs to be revised. Given these newer insights, the WGPE recognise the need to address automated sampling techniques for *in situ* measurements of biological variables. d) There has been a strong condemnation and notice taken of the problems caused by breaks in monitoring datasets. Such breaks seriously affect the data analysis and explanatory power of time series. Last year there was great concern noted by all of the WG members when they learned that the 37-year time series of sampling in Narragansett had been suspended. This year the WG learned that North Sea phytoplankton 30-year time series from the Marsdiep is in danger. This is felt to be serious losses since these series were some of the very few continuous plankton monitoring datasets in the world. There is, it was felt, a near crisis in data management, in maintaining continuity, in the investment in practical methods and in developing agreed approaches internationally. e) The difficulties in modelling the ecosystem functioning imposed by our limits to understand the phytoplankton-zooplankton interactions is recognised in recent literature. There is a need to communicate with modellers to review the advances in integrating ecosystem models. A modelling workshop auspiced by the WGPE and the WGZE was proposed during the 2001 discussions. The WGZE wants to be proactive in this practical initiative and prepare activities

	for this workshop programmed in 2003. f) The WGPE recognises the need for disseminating information of the phytoplankton status in a timely manner. The material presented will be used to prepare the annual Summary Status Report on Phytoplankton in the ICES area. Reporting results must be supported by significant observations and trends based on time series sampling programmes. g) The WGPE ICES as independent of OSPAR is asked to review the reports from OSPAR/EUC regarding eutrophication status of greater North Sea, application and further development of assessment criteria. There is a need to help contracting parties to aggregate info into assessment schemes. Based on assess criteria and monitoring programme content parties will report all info requested in standardised form. h) OSPAR is in need to learn from HELCOM about Primary Production experience with regard to spatial and temporal resolution of state and rate variables as well as biogeographic provinces. Primary Production measurements are important as they are coupled with key site process measurements through collaborative efforts with research community.
Relation to Strategic Plan:	These working groups activities embrace all elements of the scientific objective of understanding the physical, chemical, and biological functioning of marine ecosystems.
Resource Requirements:	None required
Participants:	WGPE continues to see the need to encourage wider participation and especially to draw in relevant experts in areas of specific interest as required.
Secretariat Facilities:	None required
Financial:	None, apart from report's reproduction cost
Linkages to Advisory Committees:	The Group reports to ACME, mainly for the provision of scientific information on phytoplankton and their role in ecosystem function.
Linkages to Other Committees or Groups	Members of the WGPE are active participants in range of other committees and groups including SGQAB, SGQAE and SGPHYT
Linkages to Other Organisations	Members of this group are active in HELCOM, EuroGOOS and OSPAR

ANNEX 1: LIST OF PARTICIPANTS

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ANNEX 2: TERMS OF REFERENCE

ToR a	Review the reports of the ICES/HELCOM Steering Group on Quality Assurance of Biological Measurements in the Baltic and the ICES/OSPAR Steering Group on Quality Assurance of Biological Measurements related to Eutrophication Effects;
ToR b	Elaborate the outcome of the work of the Study Group on a ICES/IOC Checklist of Phytoplankton and other Protists;
ToR c	Organise a specialised session for the 2003 meeting of the Working Group, on non-traditional and automated analysis techniques for phytoplankton field sample analysis with invited speakers;
ToR d	Re-evaluate the proposed mesocosm experiment, dependant upon the outcome from the proposed Workshop on anthropogenic nutrient input (C.Res. 2001/2CWS)
ToR e	Evaluate the mesocosm facilities at the RIKZ in Middleburg, The Netherlands;
ToR f	Integrate the contributions on phytoplankton monitoring in the ICES area into the Summary Status Report on zooplankton monitoring results in the ICES area;
ToR g	Provide the scientific merits and operational possibilities to include primary production measurements in environmental programmes as e.g., OSPAR /JAMP with full coverage of QA and standardisation;
ToR h	Prepare a summary report listing relevant marine bio-ecological variables and indicators suitable for operational use;
ToR i	Review studies underway in OSPAR on ecological quality objectives for the North Sea with regard to nutrients and eutrophication effects.

ANNEX 3: AVAILABLE PAPERS FOR THE MEETING

EuroGOOS Publication No 15 “Bio-ecological Observations in Operational Oceanography”

Geannoteerde soortenlijst Biomonitoring 1990–1999. Bijlage 3 bij AquaSense (2000). Biomonitoring van fytoplankton in de Nederlandse zoute en brakke wateren 1999. Rapportnummer: T0017–4a.

Synthesis and new conception of North Sea Research (SYCON). Working Group 5: Fluxes of matter / D.H. Topcu and U. Brockmann. –2001. Berichte aus dem Zentrum für Meeres- und Klimatforschung.

Synthesis and new conception of North Sea Research (SYCON). Working Group 7: Phytoplankton/ U. Tillmann and H.-J. Rick. –2001. Berichte aus dem Zentrum für Meeres- und Klimatforschung.

Current status of Elaborated Ecological Quality Objectived for the Greater North Sea with regard to Nutrients and Eutrophication Effects (EcoQOs-eutro). EUC 01/5/3-Rev.1. OSPAR Convention for the Protection of the Marine Environment of the North-East Atlantic. Meeting of the Eutrophication Committee (EUC). Berlin: 26–30 November 2001.

ANNEX 4: GERMAN PLANKTON MONITORING PROGRAMMES

(Claus Dürselen)

Different marine plankton monitoring series are currently running in the German North Sea and Baltic Sea parts. But until now there is no general overview of all these programs as it is available for other countries for example as a special web portal. For this reason last fall a questionnaire was send to research institutes and governmental agencies in Germany to collect detailed information about the existing monitoring series. Most of the institutes are presenting their programs (station grid, frequency of sampling, parameter, etc.) and very few of the data on special web pages some other only in reports. But unfortunately most of these presentations are in German. In future all these information around all of the German plankton monitoring series should be easily available via an English web site.

Phytoplankton is a standard parameter for all the plankton monitoring series; zooplankton is only measured in two programs and bacterioplankton only at the Helgoland Road series. Marine fungi and viruses are not yet routinely integrated in monitoring programs in Germany.

Useful addresses are:

BLMP http://www.bsh.de/Meeresumweltschutz/BLMP/2295.htm

For different sampling parameter maps can be found with the exact sampling positions of most of the programs. In addition the time of sampling and the sampling frequency is given. Also the state of analysis can be found. This web site is still in German as well as the downloadable quality status reports from recent years.

MURSYS **http://www.bsh.de/Meeresumweltschutz/Mursys/1517.htm**

This is a marine environmental report system for the North Sea and the Baltic Sea, in which institutes and agencies give a quarterly summary report of physical, chemical and biological (including plankton) parameter. The reports are downloadable but are in German as well as the total web site.

MUDAB **http://www1.bsh.de/Oceanography/DOD/MUDAB.htm**

The Marine Environmental Data Base (MUDAB) serves as the central German database for marine data. At present the database covers about 5,500 cruises, with the data from some 250,000 stations - altogether more than 13 million records. Data can be requested electronically with a special form. This web site is in English.

SEE ATTACHED WORD FILE entitled: Annex 4. German plankton monitoring programmes (Claus Dürselen)

Contact Address

	Name of organisation	Institute or department	Working group
BAH	Alfred Wegener Institute for Polar and Marine Research	Biological Institute on Helgoland (BAH)	Dept. of Biological Oceanography
FTZ	University of Kiel	Research and Technology Centre	Coastal Ecology
IFB		Institut für Frischwasser- und Brackwasserbiologie	Phytoplankton
IOW	Baltic Sea Research Institute (IOW)	Sektion Biologische Meereskunde	
NLON	Niedersächsisches Landesamt für Ökologie	Forschungsstelle Küste	Dezernat Ökologie der Küstengewässer
NLOW	Niedersächsisches Landesamt für Ökologie	Forschungsstelle Küste	Dezernat Terrestrische Ökologie
ARGE	Arbeitsgemeinschaft für die Reinhaltung der Elbe	Wassergütestelle Elbe	

Contact Address

	Person to contact	Street or post-office box	Postal code	Town	Phone	Fax
BAH	Dr Karen Wiltshire	P.O. Box 180	D-27483	Helgoland	0049 4725 819238	0049 4725 819283
FTZ	Dr Karl-Jürgen Hesse	Hafentörn	D-25761	Büsum	0049 4834 604–0	0049 4834 604–299
IFB	Dr Jeannette-Cornelie Riedel-Lorjé	Rainvilleterrasse 9	D-22765	Hamburg	0049 40 396288	0049 40 39054 66
IOW	Dr Norbert Wasmund	Seestrasse 15	D-18119	Rostock-Warnemünde	0049 381 5197–212	0049 381 5197–440
NLON	Dr Hermann Michaelis	An der Mühle 5	D-26548	Norderney	0049 4932 916–0	0049 4932 1394
NLOW	Dr Wilfried Heiber	Am Fliegerdeich 1	D-26382	Wilhelmshaven	0049 4421 9471–0	0049 4421 9471–10
ARGE	Dipl.-Biol. Thomas Gaumert	Neßdeich 120/121	D-21129	Hamburg	0049 40 42854–7774	0049 40 42854–7778

	Contact Address		Which plankton organisms are included in the monitoring program?				
	e-mail	www address	phytoplankton	zooplankton	bacterioplankton	mycoplankton	virioplankton
BAH	kwiltshire@awi-bremerhaven.de	http://www.awi-bremerhaven.de	x	x	x		
FTZ	office@ftz-west.uni-kiel.de	http://www.uni-kiel.de/ftzwest	x				
IFB	riedel-lorjé@t-online.de		x				
IOW	norbert.wasmund@io-warnemuende.de	http://www.io-warnemuende.de	x	x			
NLON	info.crs@t-online.de	http://www.nloe.de	x				
NLOW	nloe-fsk.whv@t-online.de	http://www.nloe.de	x				
ARGE	wge@arge-elbe.de	http://www.arge-elbe.de	x				

	Which parameter are determined for phytoplankton?			
	chlorophyll		other pigments	
BAH	x	HPLC, Flouroprobe	x	HPLC
FTZ	x	Jeffrey and Humphrey (1975), Lorenzen (1967)	x	Mantoura, R. F. C. and Llewellyn, C. A. (1983)
IFB				
IOW	x	acetone extraction, fluorometric measurement, phaeopigment corrector according to Lorenzen		
NLON	x	Strickland & Parsons, Lorenzen (1967)	x	Lorenzen (1967)
NLOW				
ARGE	x	DIN 38 412-L16	x	DIN 38 412-L16

Which parameter are determined for phytoplankton?

	total abundance		abundance on species level		total biomass		biomass on species level	
BAH	x	Utermöhl (1958)	x	Utermöhl (1958)	x		x	190 different Algae
FTZ	x	Utermöhl (1958)	x	Utermöhl (1958)	x	Hillebrand, H. *et al.* (1999)	x	stereom. vol. calc. and conv. to C, Edler (1979) and others
IFB	x	Utermöhl (1958)	x	Utermöhl (1958)			x	if recommended, geometric shape, sp. formula
IOW	x	Utermöhl (1958)	x	Utermöhl (1958)	x	Utermöhl (1958)	x	Utermöhl (1958)
NLON	x	Utermöhl (1958)	x	Utermöhl (1958)				
NLOW	x	Utermöhl (1958)	x	Utermöhl (1958)				
ARGE	x	Utermöhl (1958)	x	Utermöhl (1958)				

Which parameter are determined for phytoplankton?

	primary production	
BAH	x	Fo activity Multialgal Fluorometer
FTZ		
IFB		
IOW		
NLON		
NLOW		
ARGE		

Which parameter are determined for zooplankton?

	total abundance		abundance on species level	
BAH	x		x	
FTZ				
IFB				
IOW	x	microscopical counting	x	microscopical counting
NLON				
NLOW				
ARGE				

	Which parameter are determined for bacterioplankton?	Which additional parameter relevant for plankton ecology are determined?		
	total abundance	meteorology	hydrography	physics
BAH	x	sunshine hours	temperature, salinity	Secchi depth
FTZ		wind, temperature, clouds, overcast, precipitation	temperature, salinity	Secchi depth
IFB		wind with force, direction and time	salinity, waves: upwelling, depth	
IOW			temperature, salinity	Secchi depth
NLON			temperature, salinity, seston	pH
NLOW			temperature, salinity, seston	pH
ARGE			temperature, conductivity	pH

	Which additional parameter relevant for plankton ecology are determined?		
	chemistry	biology	other parameter
BAH	nitrate, nitrite, ammonium, phosphate		
FTZ	nitrate, nitrite, ammonium, phosphate, silicate		
IFB	nutrients	consumers	turbidity
IOW	nitrate, nitrite, ammonium, phosphate, silicate, oxygen		
NLON	nutrients		
NLOW	nutrients		
ARGE	nitrate, nitrite, ammonium, phosphate, silicate, oxygen, total N, total P		surface water outflow, anions, cations

Where is the sampling area?

	description of the area	geographical position (decimal)					
		longitude	latitude	western longitude	eastern longitude	southern latitude	northern latitude
BAH	German Bight	7,9000 E	45,1880 N				
FTZ	Büsum Ostmole	8,8617 E	54,1200 N				
IFB	German Bight, Norderney						
IOW	Baltic Sea: Kiel Bight, Arkona Sea, Bornholm Sea, Eastern Gotland Sea			10,4000 E	20,1000 E	54,1000 N	57,3000 N
NLON	East Frisian Coast, Norderney, Fähranleger (landing-place of ferry)	7,1658 E	53,6987 N				
NLOW	East Frisian Coast, Wilhelmshaven, Mole Nassauhafen (pier Nassau harbour)	8,1467 E	53,5139 N				
ARGE	German part of the river Elbe incl. outer Elbe estuary (km 0 - 757)						

	How much stations are sampled?	In which frequency are the stations sampled?	When did the long-term series start?
	number of stations	frequency of sampling	
BAH	1	work daily	1962
FTZ	1	weekly to monthly	1991
IFB	10	monthly, weekly	1987
IOW	8	5–10 times per year	1979
NLON	1	weekly	1985
NLOW	1	twoweekly	1994
ARGE	17	weekly, two weekly	1982

	In which project / framework are the data sampled?	Are the data available? yes	no	if yes, in which form
BAH	Helgoland Roads		x	website
FTZ	reference station for other projects, contribution to the Trilateral Waddensea Monitoring		x	after consultation for joint publication
IFB	BLMP monitoring		x	database
IOW	HELCOM monitoring		x	database and published in HELCOM assessments
NLON	Phaeocystis-blooms, Bund-Länder-Messprogramm (BLMP)		x	reports
NLOW	Bund-Länder-Messprogramm (BLMP), Trilateral Monitoring and Assessment Programme (TMAP)		x	reports
ARGE	program of ARGE ELBE		x	reports, database

	Are the data available? if public or published	person / institution to contact
BAH	http://www.pangaea.de	Dr Karen Wiltshire, Biologische Anstalt Helgoland
FTZ	partly submitted	Dr Karl-Jürgen Hesse, FTZ Büsum
IFB		Dr Michael Hanslik, Niedersächsisches Landesamt für Ökologie
IOW	Database MUDAB in Bundesamt für Seeschiffahrt and Hydrography Hamburg	Dr Sunhild Wilhelms, Bundesamt für Seeschiffahrt und Hydrographie
NLON	UBA-Text 3/98; Forschungsstelle Küste 26/1995, 11/1996, 1/1998, 3/1999, 17/1999	Dr Hermann Michaelis, Niedersächsisches Landesamt für Ökologie
NLOW	Forschungsstelle Küste 26/1995, 11/1996, 1/1998, 3/1999, 17/1999	Dr Wilfried Heiber, Niedersächsisches Landesamt für Ökologie
ARGE	Berichte der Wassergütestelle Elbe	Michael Bergemann, ARGE Elbe

Are the data available?

	Street or post-office box	Postal code	Town	Phone	Fax	e-mail
BAH	P.O. Box 180	D-27483	Helgoland	0049 4725 819238	0049 4725 819382	kwiltshire@awi-bremerhaven.de
FTZ	Hafentörn	D-25761	Büsum	0049 4834 604–203	0049 4834 604–299	hesse@ftz.west.uni-kiel.de
IFB	An der Mühle 5	D-26448	Norderney	0049 4932 916–102		
IOW	P.O. Box 30 12 20	D-20305	Hamburg	0049 40 3190–3537		sunhild.wilhelms@m5.hamburg.bsh.d400.de
NLON	An der Mühle 5	D-26548	Norderney	0049 4932 916–0	0049 4932 1394	hanslik.crs@t-online.de
NLOW	Am Fliegerdeich 1	D-26382	Wilhelmshaven	0049 4421 9471–0	0049 4421 9471–10	nloe-fsk.whv@t-online.de
ARGE	Neßdeich 120/121	D-21129	Hamburg	0049 40 42854–7776	0049 40 42854–7778	michael.bergemann@arge-elbe.de

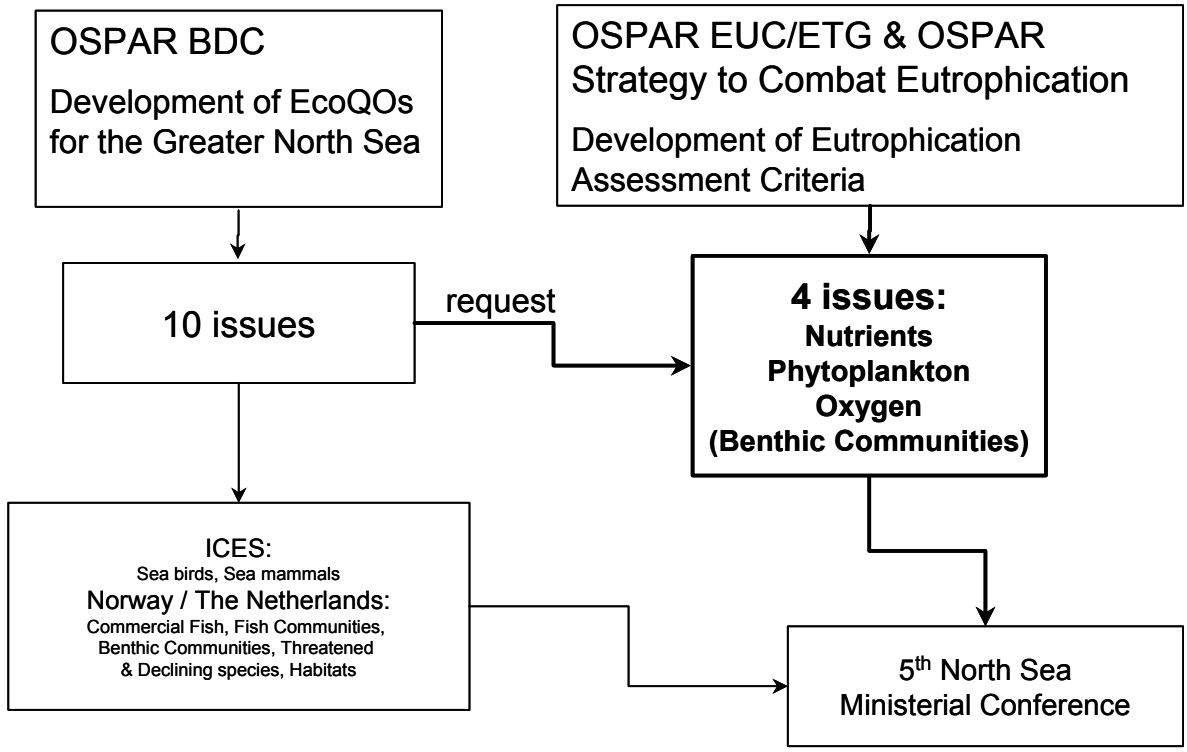
ANNEX 5: CURRENT STATUS OF ELABORATED ECOLOGICAL QUALITY OBJECTIVES FOR THE GREATER NORTH SEA WITH REGARD TO NUTRIENTS AND EUTROPHICATION EFFECTS (ECOQOS-EUTRO) EUC 01/5/3-REV.1

MEETING OF THE EUTROPHICATION COMMITTEE (EUC), BERLIN: 26–30 NOVEMBER 2001

Wanda Zevenboom (North Sea Directorate, NL) & Robbert Jak (TNO, NL)

SEE ATTACHED POWER POINT FILE entitled: Ecological Quality Objectives

EcoQOs within OSPAR



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Relationship
BDC issues / EUC criteria (integrated set)

- Nutrient budgets and production
- Plankton Communities
- Winter DIN and DIP
- Phytoplankton
  - Chlorophyll a,
  - Indicator species
- Oxygen Consumption
- Benthic Communities
- Oxygen depletion
- Benthos kills
  - (affected by eutrophication)
- (organic matter)

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ICES involvement

- Quality Assurance
  - Data taken from ICES database
- OSPAR Guidelines
  - For Nutrients and Eutrophication effects
- Further advice
  - 4-8 March, Berlin:
    Marine Chemistry Working Group
  - 14-15 March, The Haque:
    Working group on Phytoplankton Ecology
  - 25-27 April, Tromsø:
    Benthos Ecology Working Group

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EcoQOs for Nutrients and Eutrophication effects for the Greater North Sea

- Elaborated by **EUC** (Eutrophication Committee) & **ETG** (Eutrophication Task Group (see EUC 01/11/1, Annex 6)
- EcoQOs are developed in parallel with the **Harmonization of Assessment Criteria** (see EUC 01/11/1, Annex 5)
- Provide guidance on (regional) assessment of the Eutrophication status (**Classification**) (see EUC 01/11/1, Annex 5)

- On the basis of **submitted info** from Contracting Parties (from OSPAR Nutrient Monitoring Programme & **ICES database**)
- Provide a **classification** into Problem Area, Potential Problem Area, and Non-Problem Area
- Make an extensive **update of 'OSPAR 1992' Assessment**

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Current Status

- EUC
- CONSSO
- 5th NSC
- OSPAR MMC 2003

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Figure 2 (EUC 01/5/3-Rev.1)

Causal-Effect relationships

Integrated set

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Supporting factors

- **Region specific characteristics**
  - (physical and hydrodynamical aspects, and weather/climate conditions): explaining the results of the classification.
- Types of areas :
  - **Coastal/salinity gradient**
    (riverine influenced) waters (salinity £ 34.5) vs. offshore waters (salinity > 34.5);
  - **Stratified waters**
    (may be both coastal and offshore, e.g. Oyster Grounds) vs. mixed waters;
  - **Sedimentation areas**
    (may both be coastal, e.g. Wadden Sea, and offshore, e.g. Oyster Grounds, ancient Elbe river valley (short-term sedimentation), Skagerrak (long-term sedimentation) vs. 'high energy' areas (e.g. offshore part of Southern North Sea);

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Assessment parameters

Category II **Direct Effects of Nutrient Enrichment**

(during growing season)

1 Maximum and mean Chlorophyll a concentration

Elevated level (defined as concentration > 50 % above spatial (offshore) / historical background concentrations)

2 Region/area specific phytoplankton indicator species (nuisance, toxic)

Elevated levels (and increased duration) + algal toxins

3 Macrophytes including macroalgae (region specific)

Shift from long-lived to short-lived nuisance species (e.g. Ulva)

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Classification

Category I Causative factors	**Category II** Direct effects	**Category III and IV**; Indirect & other possible effects	**Classification**
+	+ and /or +		Problem Area
-	+ and /or +		Problem Area (caused by transboundary transport
+	-	-	Potential Problem Area
-	-	-	Non-Problem Area

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Agreed EcoQOs-eutro

- The overall general ecological objective is to achieve by the year 2010 a healthy marine environment where eutrophication does not occur
- (see also para 4.1 of the OSPAR Strategy to Combat Eutrophication)
- 50% reduction target for N&P (1985 as reference year) sufficient?
- (Regular evaluation to be performed, starting this year)
- Integrated set (winter DIP & DIN; Phytoplankton; Oxygen; Benthos kills)

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Phytoplankton

- Considered:
  - OSPAR Holistic list Comprehensive Procedure
    - **Increased phytoplankton** (chlorophyll a)
    - **Increased frequency and duration of blooms** (cell numbers)
    - Increased annual primary production
    - Shifts in species composition
  - BDC "plankton communities"
    - Non-indigeneous species
    - Indirect effects (via food web)
    - Zooplankton

- OSPAR Nutrient Monitoring Programme &
- ICES database

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Info

Chl-a (µg/l)

Country	Area	Range < 1985, 1985-1990 (average)	Range 1990-1997 (average)	Spatial/ historical background concentration	Elevated level
Belgium *	Coast		14-45	NAY	
Denmark *	Fjords/Estuaries		> 10		
	Kattegat		1-48		
	Offshore Skagerrak		<1.25	1-2	
	Coast Skagerrak		1.25-2.5		
	Coast North Sea		2-10	10	> 15
France *	Coast		NAY	NAY	> 20
Germany *	Helgoland Roads (spring)	4-26	4-23	2-4	
	Helgoland Roads (summer)	5-22	5-28		
Iceland			NAY	NAY	
Ireland			5-12	NAY	> 10
The Netherlands *	Coast	20-50	20-50	10	> 15
	Offshore	2-7	2-8	2-4	
Norway			4-22	1-3	
Portugal	Offshore		NAY	10	
Spain			NAY	NAY	
Sweden	Skagerrak spring		1.5-14	1.5	
	Skagerrak late summer		0.8-8		
	Kattegat spring		3-17		
	Kattegat late summer		2-13		
Trilateral Wadden Sea **	Marsdiep	(9.15)	(7.15)**		
	Norderney	(6.5-7.8)	(6.5-7.8)**		
	Sylt	(7.4-6.5)	(7.4-6.5)**		
United Kingdom	Coast		NAY	NAY	> 15

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EcoQO Chlorophyll a

Maximum and mean Chlorophyll a concentration during the growing season, should remain below elevated levels, defined as the concentration >50% above the natural spatial (offshore) / historical background concentration

CP	Area	Chl. a µg/l background	Chl. a µg/l elevated
Denmark	Offshore Skagerrak	<1.25	
	North Sea coast	2-10	
Germany	Offshore	2-4	
	Coast	10	>15
France	Atlantic coast		>20
Ireland	Full salinity waters		>10
Netherlands	Offshore	2-4	
	North Sea coast	10	>15
Norway		1-3.5	
Portugal		10	
Sweden		1.5	

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EcoQO eutrophication indicator species

Region/area specific phytoplankton eutrophication indicator species should remain below respective nuisance and/or toxic elevated levels (and increased duration)

Type	Species #	Effect	Elevated "nuisance bloom"/toxic level level	Addition
Diatom/flagellates ratio				
Nuisance	*Phaeocystis* spp.	Nuisance, foam	> 10^6	and > 30 days
	Noctiluca scintilans	Nuisance, oxygen depletion	> 10^4	or > 5 km^2
(Potentially) toxic	*Chrysochromulina polylepis*	Potentially toxic; fish and benthos	> 10^6	
	Gymnodinium mikimotoi	Fish killing, PSP	> 10^5	
	Alexandrium spp.	Toxic, PSP	> 10^2	
	Dinophysis (spp.)	DSP mussel infecting	> 10^2	
	Prorocentrum spp.	DSP mussel infecting	> 10^4	

List of species is not exhaustive!

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Example map for *Phaeocystis*, from OSPAR 1992

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Future work

- Implementation of agreed current set of EcoQOs eutro (OSPAR, NSMC)
- Application in entire OSPAR area

- Development additional parameters into assessment criteria / EcoQOs
  - **Depends on available monitoring data**
  - **Depeneds on development of the respective assessment levels**
- Could be (for phytoplankton):
  - Indigeneous species (ballast water)
  - Primary production
  - …

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Assessment parameters (I)

Category I **Degree of Nutrient Enrichment**

1 Riverine total N and total P inputs and direct discharges (RID)

Elevated inputs and/or increased trends (compared with previous years)

2 Winter DIN- and/or DIP concentrations

Elevated level(s) (defined as concentration >50 % above salinity related and/or region specific background concentration)

3 Increased winter N/P ratio (Redfield N/P = 16)

Elevated cf. Redfield (>25)

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Assessment parameters (III / IV)

Category III **Indirect Effects of Nutrient Enrichment (during growing season)**

1 Degree of oxygen deficiency

Decreased levels (< 2 mg/l: acute toxicity; 2 - 6 mg/l: deficiency)

2 Changes/kills in Zoobenthos and fish kills

Kills (in relation to oxygen deficiency and/or toxic algae)

Long term changes in zoobenthos biomass and species composition

3 Organic Carbon/Organic Matter

Elevated levels (in relation to III.1) (relevant in sedimentation areas)

Category IV **Other possible Effects of Nutrient Enrichment (during growing season)**

1 Algal toxins (DSP/PSP mussel infection events)

19 Incidence (related to II.2)

Winter DIN and/or DIP concentrations should remain below elevated level(s), defined as the concentration > 50% above salinity related and/or region specific natural background concentration.

EcoQO <

Background concentration (salinity related and/or region specific)		Elevated winter levels (roughly set at > 50 % above salinity related and/or region specific background concentration)		
DIN	**DIP**	**DIN**	**DIP**	**Area#**
10 mmol/l	0.6 mmol/l	> 15 mmol/l	> 0.8 mmol/l	Offshore North Sea, its coastal waters; Skagerrak*
9 mmol/l	0.4 mmol/l	> 15 mmol/l	> 0.8 mmol/l	Channel
4 - 5 mmol/l	0.4 mmol/l	> 6 mmol/l	> 0.7 mmol/l	Kattegat (offshore)
				Skagerrak*
6.5 mmol/l	0.5 mmol/l	> 7 mmol/l	> 0.7 mmol/l	Wadden Sea (autumn data, needs verification)
12 mmol/l	0.8 mmol/l	> 18 mmol/l	> 1.25 mmol/l	Irish Sea (saline waters)

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Map
DIP 1991-1997

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Oxygen concentration

The oxygen concentration, decreased as an indirect effect of nutrient enrichment, should remain above region specific oxygen deficiency levels, ranging from 4-6 mg O_2/l

- Vulnerable or sensitive areas
  - Morphology, hydrography, transboundary transport, …
- Severity
  - < 2 mg/l acute toxic
  - < 4-6 mg/l deficiency

- US-EPA
  - 4.8 mg/l chronic protective value
  - 2.3 mg/l limit for survival

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Benthic Communities (eutrophication)

There should be no kills in benthic species as a result of low oxygen concentrations and/or toxic phytoplankton species in the OSPAR Maritime Area

- Criteria used to assess the indirect effects upon benthos are:
  - Kills
    - in relation to low oxygen concentrations and/or toxic algal species
  - Long term
    - changes in zoobenthos biomass and species composition
    - May also be caused by other factors (e.g. fisheries)

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