Advisory Committee on the Marine Environment

ICES CM 1995/ENV:5
Ref.: E

ERRATA SHEET

FOR THE

REPORT OF THE WORKING GROUP ON ENVIRONMENTAL ASSESSMENT AND MONITORING STRATEGIES

Aberdeen, Scotland, United Kingdom
27–31 March 1995

PLEASE NOTE

Section 6, Page 3, Column 2, Paragraph 6

should read

There is a long history of the use of *Fucus* in monitoring radionuclides in sea water in the Baltic area, as well as in Norway and France. The concentration of some elements by algae make it possible to trace radionuclides, such as Cs-137, far distant from the primary source into areas where water analysis would have inadequate detection limits. Data on radionuclides are collated through the OSPARCOM RAD and HELCOM MORS working groups, but reliance is placed on the compilation of national reports (primarily concerning the size of discharges) rather than on internationally coordinated environmental monitoring. Indeed, radionuclides are not considered to pose a significant threat to marine life at the present time.

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International Council for the Exploration of the Sea

Conseil International pour l'Exploration de la Mer

Palægade 2–4 DK-1261 Copenhagen K Denmark

Table of Contents

Table of Contents

1 OPENING OF THE MEETING

The meeting of the Working Group on Environmental Assessment and Monitoring Strategies (WGEAMS) was held at the Marine Laboratory of the Scottish Office Agriculture and Fisheries Department in Aberdeen, UK, 27–31 March 1995. The meeting was opened at 10.00 hours on Monday 27 March by its Chairman, Dr I. Davies, who welcomed members to a rather chilly Aberdeen.

Representatives were present from Canada, France, Germany, Norway, Spain, Sweden and the UK. A list of participants is attached as Annex 1.

2 ADOPTION OF THE AGENDA

The draft agenda (Annex 2) was discussed and adopted without amendment. The Chairman did indicate that, with regard to agenda item 15, copies of a number of papers on the Global Ocean Observing System (GOOS) were available.

3 ARRANGEMENTS FOR THE PREPARATION OF THE WORKING GROUP REPORT

The Chairman reminded the Working Group that the ICES Secretariat had requested that the report of the meeting be drafted and approved in plenary by the end of the meeting. Sections of the report were therefore drafted throughout the course of the meeting and time was set aside on Friday for the approval of the various drafts, including recommendations.

Photocopying and typing services were kindly provided by the Marine Laboratory.

4 REPORTS OF ACTIVITIES IN OTHER FORA OF INTEREST TO THE MEETING

4.1 ACME

It was noted that ACME in its 1994 report incorporated several pieces of advice provided by WGEAMS, including sections on guidelines for predicting the effectiveness of monitoring programmes and on additional organisms for spatial monitoring of contaminants. Also, the WGEAMS comments on various papers prepared by ACME members concerning monitoring strategies were used as a starting point for the preparation of an ACME paper (ICES Role in Environmental Monitoring) which will be examined under items 11 and 12 of the agenda for the present meeting. It was also noted that a summary of the 1994 WGEAMS report was presented at a session of the Marine Environmental Quality Committee during the 1994 ICES Annual Science Conference in St. John's, Newfoundland, Canada, last September.

ACME will next meet in May 1995 and will then review the present WGEAMS report and its recommendations, along with those of all other relevant groups. Discussions will also be held at that time by ACME with representatives of the Oslo and Paris Commissions (OSPARCOM) and the Helsinki Commission (HELCOM) concerning ICES work with the Commissions, and with a representative from the Intergovernmental Oceanographic Commission (IOC) regarding possible ICES contributions to the Global Ocean Observing System (GOOS).

4.2 SIME

At the first meeting of the OSPARCOM Working Group on Concentrations, Trends and Effects of Substances in the Marine Environment (SIME), which took place in Delft, The Netherlands, from 6–10 February 1995, the main provisions of a new Joint Assessment and Monitoring Programme (JAMP) were decided. JAMP will replace the Joint Monitoring Programme effective 1 January 1996. The SIME meeting also proposed that a workshop to be held near the end of 1995 to review the Guidelines for the Joint Monitoring Programme and revise them in the light of new information. As ICES has a standing request from OSPARCOM to review monitoring guidelines and propose amendments when required, this is a useful opportunity to compile ACME/ACMP advice concerning monitoring guidelines from recent years as a contribution to the OSPARCOM Workshop. Accordingly, relevant excerpts from ACME/ACMP reports dating back to the last major monitoring advice in 1989 had been compiled to assist WGEAMS in this work.

The new JAMP will concentrate on the following major contaminants of interest:

a) mercury, cadmium and lead, which should be monitored in blue mussel and sediments for determination of temporal trends (existing programmes using fish should be continued); biological effects monitoring will be decided later in the year;

b) TBT distribution and effects, including in major shipping lanes;

c) for PCBs, trend monitoring using fish liver, with shellfish or the muscle of fatty fish as alternatives (the choice of species should be undertaken in accordance with the relevant ICES guidelines); more information is also required on PCBs in marine mammals, and on the distribution of non-*ortho* and mono-*ortho* substituted CBs in the marine environment; a programme for biological effects monitoring in fish and shellfish will be decided later this year;

d) for PAHs, spatial surveys in sediments will be mandatory, but biota (preferably mussels) can be used on a voluntary basis; for temporal trend studies on a voluntary basis, biota (preferably mussels) is the preferred matrix, but other matrices such as sediments in major deposition areas may also be appropriate.

In addition, SIME is interested in the distribution of other synthetic organic contaminants. Chlorinated dioxins and dibenzofurans have already been identified as of concern, and information on the spatial distribution of these compounds has been requested by the parent of SIME, the Environmental Assessment and Monitoring Committee (ASMO).

5 WGBEC STRATEGY PAPER ON THE USE OF BIOLOGICAL EFFECTS TECHNIQUES IN MONITORING AND RECOMMENDED POSSIBLE MEANS OF IMPLEMENTATION (OSPAR 1.3, HELCOM 9)

The Working Group was fortunate to have Dr R. Stagg, Chairman of the Working Group on Biological Effects of Contaminants (WGBEC), present the strategy paper that had been prepared at the WGBEC meeting held in Aberdeen in February 1995. Dr Stagg outlined the philosophy behind the paper, i.e., that biological concerns arising from alterations of the environment should be the primary targets for monitoring programmes. The strategy that has commonly been adopted previously of monitoring chemical parameters as indicators of possible biological change should be replaced by approaches that integrate biological and chemical measurements.

The strategy paper developed by the WGBEC indicates ways in which chemical and biological analyses could be combined in a variety of circumstances, e.g., in areas where the likely source (and hence nature of impact) is known (i.e., areas with specific recognized problems), or areas in which no particular type of impact is expected to be dominant and monitoring programmes would be directed at some expression of the general health of the ecosystem. Dr Stagg did not consider the paper to be in a final form, rather that it would evolve in response to both comments from other expert groups and scientific developments, and that its use in designing national and international programmes would be dependent on the objectives of such programmes. The paper can be found in the 1995 Report of WGBEC (CM 1995/ENV:3).

The WGBEC strategy paper generated considerable discussion, and WGEAMS agreed that the principle of improving links between chemical and biological approaches could only be beneficial to monitoring programmes, providing more information at similar or lower cost.

Dr Piuze noted that Canadian experience had indicated a need to create integrated monitoring programmes which included chemical, biological, and physical factors. Changes in ocean climate appeared to have been important factors in the recent evolution of some coastal commercial fish stocks in the Northwest Atlantic. The opportunity to achieve such integration on a large scale should be present in the GOOS programme, but the basic data must be gathered by more localized national or international programmes.

The strategy paper envisaged that an assessment of the health of the ecosystem would normally be approached through bioassays of water or sediment phases. At present, such assays normally have acute end points, and this might limit their usefulness in cases of sub-acute or chronic toxicity. Dr Stagg agreed that this is presently the case, and that more chronic assays are needed, perhaps addressing genotoxicity and precancerous conditions. Considerable effort is being expended towards the development of chronic sediment bioassays, for example, and it is quite possible to envisage the use of groups of sublethal effects (e.g., EROD induction, formation of DNA adducts with PAHs, and preneoplastic changes in liver histology) as methods of assessing response in bioassay tests, for example, in relation to PAH compounds. In relation to field surveys, the primary method of detecting effects of TBT exposure (i.e., imposex in *Neogastropods*) is not an acute assay.

There has been considerable interest over the years by the Commissions to produce maps that illustrate the degree of contamination in different areas, or at least to make comparisons between areas. The suitability of biological measures for such an application was questioned, however Dr Stagg did not consider it to be a fundamental problem, but rather a problem related to the precision of some techniques as currently employed. He felt that precision and accuracy, and greater understanding of confounding factors, would improve with time. EROD was used in the NSTF programme, but with limited success. It has now become more clear that there is considerable natural variability in EROD activity, and that factors such as age, sex, migration, maturation stage, and season (lipid status and metabolism) are all important influences on EROD activity. Future programmes need to take these factors into account when designing sampling and analytical work.

It was recognized that the paper dealt with a series of different circumstances, and that its application in specific programmes had yet to be worked out in detail. In cases where programmes were directed at defined causes for concern, such as the presence and effects of PAHs or CBs in the sea, then the strategy paper, used in parallel with other documents prepared within the ICES system, should lead to a well-structured combination of chemical and biological observations, concentrating chemical effort on the most relevant environmental compartments and tissues, and utilizing a group of biological observations at different levels of biological organization (e.g., from EROD induction to the presence of liver tumours in flatfish).

There was more concern expressed that the view taken of environmental health was too narrow, and that it concentrated on the relatively short-term effects of contaminants, such as could be assessed from bioassays, but omitted the longer-term true indicators of ecosystem health. The most important effects on fish populations are those which affect reproduction, growth, and mortality (of adults or juveniles). It is therefore necessary to develop a strategy that includes measurements of these vital processes. For example, measurements of growth rate, the time of sexual maturation (and impairment of gonad development), and fecundity should be included in the overall strategy. It would then be possible to include biomarkers as indicators of mechanisms (e.g., steroid hormones) and of exposure (e.g., EROD). In this way, it should be possible to separate effects of contaminants from those arising from other factors, such as changes in temperature regime or food supply.

An example was given of discussions that have been held over the years in relation to monitoring the effects of pulp and paper mill effluents in both Canada and the Baltic Sea area. Initially, there was a rather long list of possible approaches and assays that could be undertaken, and it was difficult to define an appropriate underlying strategy. After extensive review, it was decided to concentrate on whole organism responses and exposure studies supported by chemical analysis. As a result, the number of biological effects measurements made had been greatly reduced, but changes in the practices in the mills had led to clearly recognizable changes in the biology of the organisms. Dr Sandström emphasized the need to have a time series of observations to be able to interpret the monitoring data correctly.

Various other points were raised in relation to the incomplete nature of the strategy paper, such as various missing references and some ambiguities in table captions.

It was noted that an opportunity to try to utilize the general approaches described in the paper would arise at a proposed joint OSPARCOM/ICES Workshop to be held in Aberdeen later this year. The objective of the Workshop is to prepare detailed advice on the approaches to be taken for monitoring the SIME priority contaminants of concern, which so far are mercury, cadmium, and lead, PAHs, TBT compounds, and offshore chemicals (with the possible addition of CBs and dioxins). It is hoped that the combination of chemistry and biology as envisaged in the strategy paper will lead to a more effective utilization of resources and provide the information needed to assess the significance of these groups of contaminants. There is a continuing need for time series of chemical and physical measurements to provide information on natural variability in the environment and long-term changes.

WGEAMS therefore supported the conclusions of the WGBEC strategy paper and recommended that the comments contained within this report be taken into account in the preparation of the final document. WGEAMS encouraged greater integration of chemical and biological monitoring techniques, particularly since this leads to increased effectiveness and reduced costs of monitoring programmes.

6 THE USE OF SEAWEEDS IN MONITORING PROGRAMMES (OSPAR 1.2, HELCOM 4)

Dr Davies presented a short discussion paper prepared intersessionally on the role of chemical analyses of macroalgae in monitoring programmes. It was presented in the context of the discussions held at WGEAMS 1994, and from a predominantly UK perspective, and in particular considered what benefits would accrue to monitoring programmes by the inclusion of macroalgae. This paper is included as Annex 4 to this report. The following account of the discussions should be read together with the text in the WGEAMS 1994 report (CM 1994/ENV:4).

It was noted that some localized monitoring studies utilizing macroalgal analysis have been carried out, mainly in relation to trace metal contamination. These include spatial studies in the Humber estuary, UK. Other examples of isolated case studies were reported from Norway, Sweden, Greenland and Canada, but there was little or no activity reported in Germany and Spain.

There are a number of other circumstances where algae are utilized as foodstuff, and this has led to the monitoring of trace metal concentrations in several algal species (*Ulva lactuca*, *Chondris chrispus* and *Laminaria saccharina*) in locations in France where they are either harvested or cultivated for human consumption. It was noted that alginate extracted from kelp is used in human foodstuff, but it was not known whether metals or radionuclides present on the raw kelp were transferred to the alginate product.

There is a long history of the use of *Fucus* in monitoring radionuclides in sea water in the Baltic area, as well as in Norway and France. The concentration of some elements by algae make it possible to trace radionuclides, such as Cs-137, far distant from the primary source into areas where water analysis would are collated through the OSPARCOM RAD and HELCOM MORS working groups, but reliance is placed on the compilation of national reports (primarily concerning the size of discharges) rather than on internationally coordinated environmental monitoring. Indeed, radionuclides are not considered to pose a significant threat to marine life at the present time.

In discussion, it became clear that the two main concerns which limit the use of macroalgae as quantitative indicators of concentrations of contaminants (metals or radionuclides) in the water phase are the difficulty of obtaining samples free from epiphytes and epifauna, and the fact that the substances of interest are adsorbed onto the outer surface of the plant rather than incorporated into the tissues. This presents particular difficulties in preparing clean material for analysis. In addition, interpretation is complicated by the observed concentrations being dependent upon surface area rather than mass/volume of sample. As a consequence, macroalgae normally could provide an indication of the presence of substances in the sea water, but the high variance of the analyses greatly reduces the usefulness of the technique in temporal trend studies. Macroalgae are perhaps more useful in radionuclide monitoring, and can provide semiquantitative indications of the distribution of radionuclides away from point sources, residual circulation patterns, etc.

WGEAMS considered that macroalgae, while offering a different approach to contaminant monitoring than was available through mollusc or fish analysis, in practice would not add greatly to the power of monitoring programmes in general, such as a Commission-wide programme. However, for local monitoring of point sources it could be useful, as recommended by WGEAMS in 1994. In times of limited resources for monitoring activities, the group did not feel that a sufficiently powerful case could be made to replace an existing, mandatory, monitoring organism with macroalgae, but that macroalgae could be included as voluntary matrices for use in appropriate circumstances.

7 THE ROLE OF SEABIRD EGGS IN CONTAMINANT MONITORING PROGRAMMES (OSPAR 1.2)

In the context of a request by the Oslo and Paris Commissions to identify suitable additional organisms for the spatial monitoring of contaminants in biota, WGEAMS had examined the possible use of seabird eggs at its 1994 meeting. It had concluded that information was insufficient to make a balanced assessment of this question, and the ACME later endorsed the suggestion that an intersessional review be prepared on the use of seabird eggs in the monitoring of contaminants and their biological effects. This review paper (WGEAMS 1995/7/1) was prepared by Dr Olof Sandström and is attached as Annex 5.

In presenting his review, Dr Sandström pointed out that the main advantage of using seabird eggs is that eggs offer a stable, well-defined matrix with a high fat content, where many contaminants accumulate, especially organic substances. Thus, they can be used for detecting spatial, as well as temporal, variations. Also, as birds are top predators in the food chain, with a high rate of bioaccumulation, the monitoring of contaminants in birds can be combined with studies of biological effects on populations, such as egg-shell thinning or hatching failure. Among the drawbacks in using seabirds are their migratory habits, the non-uniform distribution of nests or colonies, the varied feeding patterns of some species—both spatially and temporally (often leading to an exposure which cannot be circumscribed precisely), the protected status of many species (e.g., birds of prey), and the lower efficiency of eggs in accumulating trace metals.

WGEAMS discussed the question of migration and felt that eggs would probably reflect uptake from the foraging area at the time of nesting, although this may depend on the mechanism for transferring lipids into the eggs. Since seabirds can forage over a fairly large area, it is expected that their eggs would act as good integrators to represent contamination over large areas rather than local ones. The question of clutch size was also raised and, although variability between eggs is not thought to be a problem if the sample size is sufficient, it was felt that the use of species laying only one or two eggs, such as guillemots, would minimize this problem.

WGEAMS then explained the situation with regard to the following possible species for contaminant monitoring in the eggs:

a) Oystercatcher (*Haematopus ostralegus*): A shorebird widely distributed along the coasts of the OSPARCOM and HELCOM areas. Could be chosen for monitoring contaminants in coastal areas, but is not strictly marine as it also nests and feeds inland.

b) Herring gull (*Larus argentatus*): A wide-ranging species covering the entire ICES area, both inland and on coasts; it is an opportunistic feeder whose diet is not representative of marine areas only.

c) Kittiwake (*Rissa tridactyla*): A truly pelagic bird, nesting on the northern European and Canadian Atlantic coasts. Not present in the Baltic Sea, in Spain or Portugal, or in the Atlantic off the USA. Will feed on fish offal offshore.

d) Common tern (*Sterna hirundo*): Wide distribution over the European and North American Atlantic coasts as well as in the Baltic Sea, but not in

Iceland. Feeds in marine, brackish, and fresh waters.

e) Guillemot (*Uria aalge*): Another truly pelagic species, nesting on the coasts of northern Europe, in the Baltic Sea, and on the North American Atlantic coast. Lays a small number of eggs (1–2). In the Baltic Sea, it feeds on a couple of species, namely herring and sprat.

f) Black guillemot (*Cepphus grylle*): A more coastal and more Nordic species than the guillemot.

Given the distribution as well as the migration and feeding patterns of the above species, it was felt that the guillemot seemed the best choice for monitoring wide marine areas. For coastal areas, the black guillemot could be a good choice, but it is not present in southern European countries. All other species examined present the problem that their feeding is not entirely marine, although in many situations the common tern may only be feeding in coastal marine waters.

In conclusion, seabird eggs can be useful in marine monitoring programmes on the condition that the species be chosen carefully, taking into account regional particularities. The study of biological effects on the same samples will not usually be possible, but effects studies will be possible at the population level. As for the use of other bird tissues, this may be quite limited because of the difficulty of obtaining permission to collect specimens, and because the use of dead birds would not really be acceptable for contaminant analyses.

8 REVIEW EXISTING GUIDELINES ON MONITORING CONTAMINANTS IN FISH AND SHELLFISH AND UPDATE THE TABLE ON SPAWNING PERIODS OF FISH AND SHELLFISH IN RELATION TO MONITORING OF CONTAMINANTS (OSPAR 1.4)

WGEAMS noted that the most concise expressions of the monitoring proposals by ASMO were those referred to in the covering note for the background papers WGEAMS 1995/8 prepared by the ICES Secretariat, and on pages 14–17 of the Summary Record of the SIME meeting held in February 1995. To some extent, the SIME meeting had already pointed out the areas in which they felt that the current guidelines on fish and shellfish monitoring required reconsideration and review. WGEAMS therefore used these two expressions of the proposals for future monitoring as the basis for its discussions.

a) Metals

SIME had noted that it was necessary to prepare detailed objectives for each contaminant in each matrix at each location in accordance with ICES advice, which also included the assessment of the statistical power of each item within national monitoring programmes. This was a substantial piece of work, which A. Franklin considered would be best undertaken following the meeting of the OSPARCOM Ad Hoc Working Group on Monitoring (AHWGM) proposed for November 1995, although some other members of the group saw some advantages in undertaking at least part of this work before November to provide a framework within which the November meeting could formulate an overall programme.

It was very likely that the statistical power of temporal trend programmes previously undertaken under JMG guidelines would differ between locations, laboratories, etc. The variance factors limiting the power of programmes include natural field variability, sampling variability, analytical variability, etc., which will not be constant between temporal trend studies. The variability of the inherent power of temporal trend programmes has not previously been taken into account in the assessment of temporal trend data, or in the design of OSPARCOM programmes. A decision will therefore need to be made to determine whether ASMO prefers to have a monitoring programme with fixed sampling and analytical guidelines, but varying power between sampling stations, or whether it would be better to have a programme in which all the temporal trend studies had similar power, but which varied in sampling or analytical strategy.

The current ICES advice on statistical power assessment contains sufficient information for a combined force of chemists and statisticians to make the necessary estimates of variance factors and power. There would be scientific logic in having an overall programme in which all temporal trend studies had at least some minimum statistical power. The interpretation of the presence or absence of apparent trends at different locations would then be simplified. However, this would tend to make the achievement of the agreed level of statistical power the dominant factor in planning sampling and analytical strategies. This would imply that there could well be an apparent relaxation of the sampling guidelines to allow different approaches to be taken, provided that the statistical power of each study was adequate.

To some extent, such procedures had already occurred in the design and implementation of the UK National Monitoring Plan. On the advice of statisticians, samples of 25 fish were now analysed in five pools of five fish in each pool, and sediment samples were collected in clusters of nine samples distributed regularly over a 500 x 500 m^2 area of seabed. Both of these changes resulted in additional analytical effort, but would provide valuable estimates of the variance associated with the programme at each location, to assist in the design of temporal trend programmes.

It was noted that OSPARCOM programmes would likely not include any spatial surveys for the next two years at least. The Regional QSRs would be based largely on the collation of existing data.

SIME had indicated the need for guidelines on quality assurance (QA) matters, and it was agreed that there would be benefit in the preparation of detailed guidelines on QA, including information on relevant certified reference materials (CRMs), and how to make and use laboratory reference materials (LRMs). It was noted that ASMO had already decided that Reporting Guidelines should emphasize the obligation for data to be accompanied by supporting QA information.

b) TBT

WGEAMS considered that the sampling of neogastropods (particularly *Nucella lapillus*) and their examination for imposex should be the subject of a new guideline. The guideline should also cover the chemical analysis of these samples for TBT compounds, and the necessary QA procedures to accompany both the chemical and biological effects measurements. It was anticipated that such a package could be prepared at the OSPARCOM/ICES Workshop planned for autumn 1995.

c) CBs

SIME had raised a number of concerns and issues regarding the occurrence and effects of CBs in the sea. These included the need for guidelines on trend assessment, which would include the concepts of statistical power, and therefore the comments above regarding statistical aspects of monitoring metals in biota also apply to CBs in biota.

i) SIME called for the revision of monitoring guidelines to take into account ICES advice on the determination of lipid concentrations. This area was under active examination through combined efforts by both the ICES Marine Chemistry Working Group (MCWG) and QUASIMEME. Lipid determination has been the subject of a QUASIMEME Workshop, and a comparison of methods of lipid extraction is included in the current QUASIMEME exercise. There was a problem, particularly in lean fish muscle, in which different extraction procedures extracted substantially different amounts of lipid, the phospholipids being rather more difficult to extract. The problem was much less significant in fatty fish muscle, and negligible in lipid-rich liver tissue. There was an additional problem that the most complete extraction methods used chlorinated solvents, the use of which would shortly be prohibited. [*There is a need for ICES to prepare a recommendation on the most appropriate method to determine lipid content of biota samples. However, it is premature to try to undertake this work until the results of current investigations have been assessed.*]

ii) The need stated by SIME for new guidelines concerning the requirement for data on size, sex and reproductive state of monitoring organisms to be included with CB data is partially met by the existing ICES Guidelines which stipulate size stratification of samples, and the time of year at which samples should be collected. (It was noted that recommendations from HELCOM did not follow ICES Guidelines, but indicated that small fish of a single size rather than a length-stratified sample should be used in HELCOM programmes.)

iii) SIME requested guidelines on sampling and analysis of non-*ortho* and mono-*ortho* CBs. ICES has previously undertaken an informal pilot intercomparison exercise on these compounds in fish oil. The full task, as stated in the SIME report, was part of the draft ICES work programme for 1996. In addition, a possible second phase of QUASIMEME would be in a position to provide a full QA scheme for these compounds, and a subsequent proficiency testing programme.

iv) The cover note prepared by the ICES Secretariat indicated that ASMO/SIME wished to obtain more information on CBs in marine mammals. Members of WGEAMS who attended SIME noted that marine mammals were unsuitable for spatial or temporal trend programmes because of their mobility and longevity. Countries were however encouraged to continue with national programmes, and to submit data for the planned Regional Assessments. Guidelines from ICES were not considered necessary.

d) PAHs

SIME comments on PAHs also implied a need for an assessment of the necessary power of monitoring programmes, as discussed for metals and CBs above. An additional factor was raised, namely, the need to use analytical methods with sufficient sensitivity to detect PAHs in typical environmental samples. It was noted that SIME had agreed to approach QUASIMEME on QA matters.

QUASIMEME had already started work on the QA of PAH determinations in standards and extracts, and hoped to move on to consider shellfish analyses during the current year. The QUASIMEME work will include the setting of analytical performance targets, either in response to needs expressed by the Commissions, or knowledge of the concentrations normally found in the environment. The training and proficiency elements of the QUASIMEME programme should ensure appropriate analytical performance.

e) Chlorinated dioxins and dibenzofurans

France had agreed to be the lead country for an initial assessment of the occurrence of these compounds in the OSPARCOM area, and it was too early to consider an ICES Guideline on the subject.

f) Selection of other compounds of concern

WGEAMS noted that its report from 1991 included a review of the methods in use at that time for the selection of priority contaminants, and that such advice could be passed to SIME to assist with their work. A. Franklin reported that The Netherlands had already indicated that they wished some pesticides to be considered in the OSPARCOM programme.

g) Spawning periods of fish and shellfish in relation to monitoring of contaminants

The table contained in the 1992 ACMP report has been revised and completed (OSPAR 1.4) with different proposals from members of WGEAMS. The main fish species of concern have been flounder, dab and lemon sole. Few changes have been included for shellfish in France. The revised table is included as Annex 6 to this report.

9 COASTAL MONITORING PROGRAMME (CMP) OF HELCOM (HELCOM 4)

Dr Ulf Grimås presented an account of the current stage of development of the HELCOM CMP, placing it in the context of the wider characteristics of the Baltic environment, and patterns of variation in bulk parameters of sea water quality, such as temperature and transmissivity. He also described the main issues arising from eutrophication processes, waste inputs, etc., and the causes for concern inherent in observations of concentrations of contaminants in biota (although CB levels in indicator organisms are falling), and large changes in both fish catches and the species composition of fish communities that have been observed in several separated areas leading to dominance, *inter alia,* by the stickleback to the detriment of more desirable species.

As described in the papers appended as Annexes 7 and 8 emphasis was placed on eutrophication processes and waste inputs, although the relative importance of these processes varied from area to area. Inputs were more important in the north, and eutrophication in the south, with a combination of the two in southeastern areas. Contracting Parties of HELCOM had also been asked to propose Reference Areas to reflect particular types of coastal environments. Detailed information was available on sampling locations.

Dr Grimås reported that in previous years the HELCOM coastal monitoring programme was purely a compilation of national reports of conditions in coastal areas. In many countries it was difficult to undertake studies in coastal areas, and data were difficult to obtain. Under the current system, the data from national monitoring programmes were to be submitted to HELCOM, and this would allow a better perspective to be taken of the overall situation.

Some comparisons were made with the development of monitoring in the OSPARCOM area. Originally, the data submitted were those from national programmes which were considered by the Contracting Parties to be relevant to JMP objectives. This led to difficulties in overall interpretation, as the coverage, nature, and quality of data were rather variable. As a step towards a more rigorously agreed programme, the NSTF had agreed a set of fixed stations, at which countries would make a standard series of measurements. The new programme under ASMO would probably be much more clearly directed at agreed issues of concern, although there will also be a certain amount of monitoring to collect data for periodic QSRs. Initially, the JMP had been chemically based, although since NSTF there has been an increasing biological component. The HELCOM CMP, on the other hand, is primarily biologically based, partly because the necessary sophisticated facilities for chemical monitoring are not widely available in parts of the Baltic Sea area.

HELCOM has developed an outline of monitoring activities, with mandatory and tentative measurements and matrices. Countries were in the process of informing HELCOM which of these measurements would fit into their own national programmes. The process of revising the national programmes in several countries was introducing some delays into the final formulation of the first phase of the CMP.

WGEAMS recognized the special circumstances surrounding the work in the Baltic Sea area, and the great advances that would now be possible. They noted that there was a danger that the CMP might become a compilation of national programmes, without detailed central direction. The group felt that HELCOM should not merely act as a recipient for information from national programmes, but that it should aim to provide a strong lead to the development of internationally coordinated programmes. There was no need for programmes to be identical in all areas, but the effort should be directed to those matters of special concern in particular areas of the Baltic coasts. However, there is a need for coordinated planning of the programme to improve the effectiveness of the work.

The first phase of the CMP is directed at the assessment of "hot spots". Some of the existing data on hot spots are relatively old and of doubtful quality, and a coordinated effort, as is planned for 1996–1997, should provide an opportunity to improve the overall reliability of the data, through improved facilities and QA procedures, and at the same time give a valuable synoptic picture of the current situation. The assessment of these data and the subsequent further development of the programme should provide an opportunity for a full integration of biological effects monitoring with chemical and physical measurements. WGEAMS also hopes that circumstances will then allow the HELCOM countries to plan the continuation of the CMP as a fully coordinated programme led by international assessments of the needs of the Baltic coastal areas. This will require a firm specification of detailed objectives, methods, quality assurance measures, and assessment procedures that would be adopted by all participants in the CMP.

10 REVISION OF THE HELCOM BMP/COMBINE (HELCOM 4)

S. Carlberg presented an account (Annex 9) of the progress in the revision of the HELCOM Baltic Monitoring Programme (BMP). WGEAMS noted that the basic structure proposed for the new programme would be a combination of core mandatory activities to be supplemented by a wide range of voluntary measurements. In addition, it was foreseen that other problem-oriented work would be undertaken through 'campaigns' (such as the ICES/HELCOM Baseline Study of Contaminants in Baltic Sea Sediments) in which it was not mandatory that all countries participate. The main areas of improvement were indicated to be the better definition of the aims of the programme, the bringing together of a wide range of activities into COMBINE which should lead to better coordination of effort, improved and more clearly defined QA procedures, a clearer division between mandatory core activities and other work, and the introduction of assessments of the required and actual statistical power of the programmes that were either in place or being planned.

The redesign had taken place after a detailed assessment of the preceding programme, largely along the lines indicated in the 1994 WGEAMS report.

The proposed sampling strategy for the eutrophication component of the BMP was that countries should combine their efforts and resources to make observations at defined frequencies and defined locations throughout the Baltic Sea. There were a large number of stations which would be sampled only twice per year, there were a lesser number that would be sampled several times a year to follow the broad variation in nutrient, etc., levels throughout the year, and a smaller number of stations that would be sampled 20 or more times per year to investigate in detail the mechanisms leading to primary production. In addition, there was a flexibility that allowed additional stations at variable locations to be sampled to follow the development of localized or periodic phenomena, such as areas of low dissolved oxygen or plankton blooms. These data would be supplemented by automatic sampling from instruments installed on Baltic ferries to measure, for example, temperature, salinity, turbidity, fluorescence, particle-size distribution, etc., and satellite imagery to delineate the area of plankton blooms. It was also hoped to deploy moored instrumented buoys at key locations for continuous data gathering.

WGEAMS expressed concern that now that the programme had been formulated, it was still not clear how much would actually be carried out by the HELCOM countries. Many countries were in the process of reviewing their national monitoring programmes, and it was not clear to what extent their revised programmes would fit the design of the BMP.

WGEAMS considered that the programme was an exciting development in internationally coordinated monitoring. It contained the same elements as a programme being planned for the monitoring of the Saint Lawrence seaway. Most existing international monitoring programmes rely on relatively established sampling and analytical techniques, while the use of more complex techniques and equipment tended to be confined to research programmes. The proposed BMP offered a great stride forward in sophistication of monitoring techniques, all targeted at eutrophication and associated effects. All the techniques and equipment already exist and had been proved to provide reliable data, but the combination of the methods into one internationally focused programme was a singularly new development. WGEAMS hopes that the programme will be able to go ahead in the way that it has been planned, as they consider that it offers a real opportunity to take monitoring forward in a way that will provide effective monitoring, and supply some data in time to make management decisions on a day-to-day basis, and also be intellectually stimulating to all involved. It has the prospects of significantly increasing the understanding of the mechanisms leading to plankton blooms, and of their development and decay.

The contaminants component of the new BMP/COMBINE has also been defined in detail, and tables were presented of species and contaminant combinations that were proposed for inclusion in the programme. Species were selected which could be analysed as individuals, have a broad distribution, were accessible, for which there was a good understanding of the ecology, physiology, etc., and which were suitable for biological effects studies. Species selected ranged from commercial fish (cod and herring) to *Cladophora* and *Uria* eggs.

The plans envisaged that statistical assessment of the power of various sampling designs should be undertaken, with the view that it might be possible to reduce the number of individuals per sample from 25 to around 10–20. This implies that the HELCOM group envisaged that sampling would take place which did not follow the current ICES Guidelines. Following the WGSAEM meeting, there will be an assessment of temporal trends in biota from the Baltic Sea at the end of April, and it is expected that the group making this assessment will also consider the power of the current programmes and appropriate alterations to the programme design.

As with the CMP and the BMP eutrophication proposals, the degree to which the programme would be followed is strongly dependent on the contributions that will be made from national monitoring programmes. WGEAMS noted that this is not an ideal basis on which to proceed.

11 PLAN OF ACTION TO IMPLEMENT THE RECOMMENDATIONS IN THE 1994 ACME STRATEGY PAPER ON THE ROLE OF ICES IN ENVIRONMENTAL MONITORING

WGEAMS was requested in its terms of reference (C.Res.1994/2:7:7) "to propose an overall plan of action to implement the recommendations in the 1994 ACME strategy paper [WGEAMS 1995/11/1] on the role of ICES in environmental monitoring".

Thus, the strategy paper (Annex 10) was discussed in general terms and a plan of action was formulated by mapping specific suggestions for implementing each of the recommendations contained in the ACME document.

WGEAMS was generally in agreement with the ACME paper. It supported the definitions of monitoring as stated. The objectives of monitoring presented in the paper were also supported. In the discussion, it was pointed out that they were consistent with ACMP and ICES philosophy over the years. WGEAMS also concurred that the objective of monitoring is broader than contaminants and included the measurement of physical, chemical, and biological variables in the marine environment. The purpose of designing programmes to describe and follow long-term patterns and trends in marine processes and in the marine ecosystem was thought to fit equally into the categories of research or monitoring. However, the main discussion about the section on objectives concerned the need for ICES to have a definition of the geographical limits of its monitoring-related activities, at least in general terms. WGEAMS felt that the ICES role in monitoring should apply to marine and brackish waters, i.e., to all areas where the water is saline and connected directly to the coastal seas or the Atlantic Ocean, including the sediments, plants, animals and habitats contained in these areas. Particularly important is the inclusion of estuaries, as far as salt water penetrates. Furthermore, even though ICES should not have direct monitoring activities in fresh water, it was felt that sources and inputs to the marine area are important and that this may require ICES to work with national authorities in the various countries to obtain better coordination between river monitoring and coastal monitoring, among other things.

WGEAMS examined each ACME recommendation concerning the role of ICES in environmental monitoring and made the following comments and suggestions on implementation, numbered as in Section 5 of the extract from the 1994 ACME paper [WGEAMS 1995/11/1].

1) <u>Provide advice on the design of monitoring programmes</u>

Comments: It was felt that the ICES advice is useful because it is neutral, and while Commissions often ask for specific technical advice, nothing prevents them from seeking guidance on the objectives and design of monitoring programmes. It was also pointed out that the use of the expression "cost-effective" in the ACME paper should mean that choices have to be made given that available resources are limited, but that they should not compromise the ability of the programmes to yield answers to the questions posed at the outset.

Implementation: ICES should continue to provide advice on the objectives and design of monitoring programmes. This can be accomplished by providing customers with recommendations on an optimum programme as well as on a minimum one, and by presenting the various alternatives in the choice of methodology. This way managers can make cost-effective decisions.

2) <u>Provide advice on methods and QA, and conduct intercalibrations</u>

Comments: Quality assurance (QA) is critical and ICES, which has pioneered many aspects in this field, should remain actively involved. QA is required not only for the chemical measurements (contaminants, nutrients, etc.), but also for physical and biological measurements. The current QUASIMEME programme is scheduled to end by mid-1996. There is likely to be an application to the EC Standards, Measurement and Testing Programme for a second phase of QUASIMEME, but it is too early to know whether funding will be provided. Therefore, there may be a need for ICES to step up its involvement again.

Implementation: ICES should maintain its position at the leading edge of QA and intercalibrations, and continue to provide advice on all non-routine aspects of these fields. The potential change in the ICES workload due to the possible termination of QUASIMEME should be examined as soon as possible.

3) Continue to explore the statistical aspects of monitoring

Comments: This is a vital function. Although WGSAEM has concentrated its efforts so far largely on aspects of the sampling and interpretation related to contaminant data, it should also provide advice concerning physical and biological oceanographic data as it did in 1994 concerning plankton time series and algal blooms. Often, statistical evidence is the only one which will bring about needed change in monitoring programmes. Recent work on temporal trend analysis and on the power of programmes has played a key role in this respect.

Implementation: ICES must maintain its work on statistical aspects of monitoring through its Statistics Committee and WGSAEM. Stronger interactions should also be encouraged between these and other relevant committees and groups. ICES, ACME and the Statistics Committee should provide more precise requests to WGSAEM in order for that group to accomplish its task in the most efficient manner.

4) Provide data banking

Comments: ICES keeps major separate banks of oceanographic, environmental and fisheries data. It also has a formal agreement with OSPARCOM and AMAP on the handling of environmental data. This role of ICES is seen as very important. Data are received in ICES from a variety of sources and from Member Countries on a voluntary basis; in some cases, reminders are sent by ICES, in others not. There is room for improvement here both by ICES and by the Member Countries. The issue of access to the data was also raised; although access probably is fairly wide, data held for OSPARCOM for instance, cannot be released without permission. Finally, the question was raised as to whether or not the Cooperative ICES Monitoring Studies Programme continues to exist and, if so, what exactly it consists of at present.

Implementation: ICES should maintain its role in data banking. The question of compatibility and of integration of the three separate databases should continue to be examined. Access to data should be made as wide as possible. The status of the Cooperative ICES Monitoring Studies Programme should be clarified.

5) Evaluate the effectiveness of monitoring programmes

Comments: At its 1994 meeting, WGEAMS examined the question of evaluating the effectiveness of monitoring programmes, particularly in the context of temporal trend monitoring of contaminants in biota. WGEAMS proposed guidelines which were incorporated in the 1994 report of ACME. In addition to such generic work, ICES could also assess the effectiveness of given programmes if requested to do so, its neutrality making it a credible organization for such a task.

Implementation: ICES should continue its involvement in providing guidelines for assessing the effectiveness of monitoring programmes, and in applying the guidelines to actual programmes, on request from customers.

6) Ensure international involvement in monitoring

Comments: In the past, ICES has limited its involvement in international fora that focused on defining monitoring and designing global programmes. With important programmes such as GOOS getting underway, it is crucial that ICES be active in such fora so as to influence decisions in a generic fashion and also in a more specific manner for the North Atlantic.

Implementation: ICES should explore ways of increasing its involvement in international fora designing global monitoring programmes such as GOOS. The meeting between ACME and a GOOS representative, planned for May 1995, should be used to strengthen ties and could lead to more formal cooperation.

7) Promote the use of modelling in monitoring

Comments: WGEAMS agreed that modelling could help optimize the design of monitoring programmes and therefore reduce costs, and while the objective is not only cost reduction, it is clear that this is an important aspect.

Implementation: Modelling is an important tool in monitoring, and ICES should continue to encourage and support research on the development of models applicable to physical, chemical, biological and ecological processes. Except for physical modelling, the other areas of modelling are still in the early stages and development should take place gradually as premature attempts at integration could spell disaster.

8) Review major existing monitoring programmes

Comments: WGEAMS is of the opinion that ICES can play a very useful role in reviewing major monitoring programmes such as JAMP and BMP, when these are being reviewed, redesigned or updated. It should be noted that HELCOM has a standing request to ICES for advice on the BMP.

Implementation: ICES should continue to play a role in reviewing major monitoring programmes in its area of responsibility. It could offer customers like OSPARCOM advice on a continuing basis, as is done for the BMP for HELCOM.

9) Assess future key issues and how they could be monitored

Comments: Given its stature and its role in marine environment of issues, ICES should be pro-active and constantly on the look-out for major new issues affecting the North Atlantic. WGEAMS agreed that ICES has in its working group structure a unique pool of expertise which can propose monitoring strategies for major issues in the future.

Implementation: ICES should continually assess major future issues and how best ICES strengths can be used in the design and implementation of an adapted monitoring strategy. WGEAMS has done this for issues over the next decade, and the detailed discussion and suggestions can be found in Section 10 of the present report.

10) Provide advice on management options resulting from monitoring

Comments: ICES is a scientific, not a management, organization. However, ICES has the expertise necessary to advise on the results of a monitoring programme and on the limits that these results impose on follow-up action by decision-makers.

Implementation: ICES, through ACME, should, if requested by customers, provide scientific comments on the options for action laid before managers following the results of monitoring programmes. Such an activity would indeed be parallel to that of ACFM when it prepares fisheries advice.

The ten implementation sections above thus constitute the WGEAMS contribution to the overall plan of action proposed in response to the term of reference given to WGEAMS by ACME on the role of ICES in environmental monitoring.

During the course of the discussion, some members of WGEAMS felt that the mention in the ACME paper of the need for customers to pay for ICES services related to monitoring needed clarification, since customers already pay for such. What is actually meant in the document is that anything additional to existing agreements with the customers would require extra funding.

The question of the limited discussions within ICES on monitoring programmes conducted on the east coast of North America was also raised. WGEAMS felt that nothing prevented Canada and the USA from resorting more often to ICES advice, and that North American issues and programmes would be examined thoroughly in the ICES structure if put forward by the Member Countries from North America.

Finally, some members brought to the attention of WGEAMS the existence of a new informal independent working group on fixed monitoring networks, mostly for the North Sea. It deals primarily with meteorological and oceanographic data.

12 DESIGN AND IMPLEMENT A MONITORING STRATEGY TO ADDRESS MAJOR ENVIRONMENTAL CONCERNS OVER THE NEXT DECADE

WGEAMS approached this problem through the preparation of a list of the subjects that they considered to be the major environmental concerns for the next decade, and in some cases further ahead. In preparing the list, the group took note of a list of issues of concern recently prepared by ASMO, and the topics suggested by a UK group for inclusion in GOOS, but recognized that there would be benefit in grouping the various issues into a small number of major topic headings. The concerns identified are listed below, but are not ranked in order of importance.

Having developed a series of issues of particular concern for the future, WGEAMS then considered how skills necessary to prepare advice on appropriate monitoring and assessment procedures to address these issues matched the skills and expertise currently available within the ICES system.

a) The influence of changes in the exchange of water between the Atlantic Ocean and shelf sea areas

Justification: Recent research has indicated that changes in Atlantic oceanic circulation rates and patterns can be correlated with changes in fisheries, for example, through affecting the transport of fish larvae and their subsequent recruitment to the fisheries. The rates of water inflow through the Fair Isle current and through the English Channel have considerable influence on the distribution of nutrients and contaminants in the North Sea area, and the degree to which the water of the Baltic Sea is exchanged with the open North Sea is of great significance to the hydrography, chemistry and biology of the Baltic Sea area. The exchange of water with the Atlantic also implies exchange of contaminants, but such a mechanism which removes contaminants from the shelf must transfer them to the open ocean.

Action: The primary skills and information required to tackle the physical component of this problem rest with hydrographers and access to a large body of information on the current and past conditions (in a classical hydrographic sense) in the sea. These are readily available in the ICES system, with its long association with oceanographic questions, and its extensive hydrographic database. The other side of the problem, namely, the chemical processes associated with the transfer of water between the open Atlantic and the coastal seas, is also well covered by existing ICES expertise. However, there are few links between the chemists and the hydrographers which lead to combined hydrographic and chemical models, that are required to predict the effects of changes in water exchange. The individual skills exist within ICES, and to some extent appropriate modelling is being undertaken elsewhere, but ICES does not have a structure in which such modelling is carried out.

The creation of this new linkage could progress in parallel with the development of GOOS, and could enhance advice on programme design and implementation for GOOS or other programmes.

b) Global changes in oceanography and production

Justification: Changes on a large, perhaps global, scale can arise from both natural and anthropogenic processes. The biological consequences of these changes may be difficult to predict and, conversely, the unforeseen collapses of some fish stocks on both sides of the Atlantic can only partially be attributed to fishing pressures. There is a need to improve the monitoring activities which address changes in the physical environment, for example, temperature and salinity, and also primary and secondary production processes. Remote sensing techniques can be applied to some physical parameters and to primary production; other more traditional approaches need to be applied to zooplankton populations, although programmes such as the Continuous Plankton Recorder (CPR) are invaluable. The rates of primary and secondary production have relevance to wider studies of the carbon cycle, CO_2 buffering, etc. The aims of combining physical and biological measurements must include forecasting the development of algal blooms to allow protective action to be taken if necessary. It therefore includes the more localized processes of eutrophication which are of particular concern in parts of the Baltic Sea and the southern North Sea.

Action: As for the preceding item, long-term monitoring and modelling of hydrographic variables is needed, and this well matches traditional ICES expertise. However, information on primary and secondary production is not yet held by ICES, although proposals to develop a suitable database have been put forward for MAST funding.

There is considerable expertise on production processes within the Biological Oceanography Committee structure. However, as for item (a) above, the linkage between the hydrographers and the biologists, and the associated modelling of complex processes, is only weakly developed. A start has been made in this direction through joint meetings of the Working Group on Harmful Algal Bloom Dynamics and the Working Group on Shelf Seas Oceanography, but the linkage needs to be strengthened and extended. Modelling of the impact of physical parameters on production processes needs to be supported by monitoring in key locations, and the scope of the modelling extended.

c) Terrestrial processes

Justification: There are a small number of large-scale or widely distributed terrestrial processes which can affect the quality of the marine environment. These include the effects of acid precipitation, which in addition to affecting stocks of anadromous fish species, can also lead to increased riverine discharges of contaminants through alteration of weathering processes in soils. The impoundment of water in lakes for subsequent use in the generation of hydroelectric power has greatly altered the flow rates in spring in some northern rivers, e.g., in the St. Lawrence estuary and northern Baltic Sea areas, and also in the Hudson Bay. In turn, this can affect ice distribution, primary production, and fish and marine mammal reproduction in the adjacent seas. Further, probably transitory, processes include increases in the discharge of certain agricultural pesticides as the economies of former Soviet Union states adjust to new conditions.

Action: There is no structure within ICES where the impact of terrestrial processes on the marine environment is brought together, although a symposium on the links between acid rain and salmonid stocks was held a few years ago. Any effects in the sea should be confined to the coastal zone. However, working group members from both Canada and Sweden indicated that effects in the coastal zone, for example, on fish recruitment, could be considerable. It was suggested, and generally accepted, that terrestrial processes were outside the normal areas of ICES activities. However, it was proposed that a Symposium be held with the objective of assessing the scale and importance of a limited number of terrestrial processes (e.g., acid rain and river impoundment) on the marine environment and marine organisms, thereby providing ICES with guidance on the overall importance of these factors.

d) Processes affecting fish reproduction

Justification: So far as fish populations are concerned, the most damaging environmental processes are those which affect the reproductive capacity or, rather, the capacity to produce young which subsequently recruit to the spawning, or exploitable, stocks. Processes can act on the fecundity, sexual maturation, larval growth, development and survival, and subsequent recruitment. A range of compounds (e.g., nonyl phenols) have been found to mimic steroids (sex hormones) in freshwater fish species with serious impacts on their breeding capacity. Tributyl-tin (TBT) has been found to have a similar effect on some gastropods in the sea. Other groups of environmental contaminants are known to have the potential to affect reproductive processes in fish, but the scale and significance of any effects in the sea is unknown.

The areas of elevated water temperatures around some coastal power generation plants can attract enhanced densities of some fish species. However, recent studies in Sweden have indicated that the "abnormal" relationships between seasonal light and temperature cycles in these waters can lead to disruption of the normal reproductive processes of the fish.

Action: The study of the processes involved in fish reproduction and recruitment is spread over a number of ICES Working Groups. There is, therefore, considerable expertise available, which could approach these complex questions from a variety of points of view. WGEAMS considered that the formation of a group to advise on all these processes should not be recommended. However, the question could be approached though a series of problem-oriented groups, for example, dealing with the spawning problems of the Baltic cod, or with the influence of synthetic oestrogens on anadromous fish, or the influence of nonyl phenols on marine fish species.

e) Habitat changes

Justification: Many forms of exploitation of the sea and the coastal margin are known to lead to alteration and degradation of marine habitats. The impact of heavy trawl gears and of aggregate extraction on the seabed have been recognized for some years. The trawling for macroalgae for alginate extraction also leads to loss of habitat and increased erosion of adjacent coastal areas. Drainage and construction activity can damage intertidal and immediately subtidal areas which may be important spawning and nursery grounds for marine species. Litter can cause problems for marine species and lead to increased costs of fishing activities, as well as being aesthetically unsatisfactory on beaches. The high concentrations of litter on the seabed or beaches in some areas must be considered a degradation of the habitat.

Action: There are many ICES Working Groups dealing with different aspects of this broad problem, for example, the Benthos Ecology Working Group, the Working Group on Ecosystem Effects of Fishing Activities, and the Working Group on the Effects of Extraction of Marine Sediments on the Marine Environment. These groups report to different parent Committees and, while this was not a vital point, it was suggested that coordination and linkages could be improved.

Other aspects of habitat change are not well covered. There is no group concerned with the importance of coastal lagoons, intertidal areas, mud flats, etc., as spawning and nursery grounds for marine species. There is considerable activity by pressure groups to reduce the rate of alteration of these areas, but it is still not clear how important (quantitatively) they are for the range of marine species which use these areas. A group could be established to explore these questions. These areas are also intensively used by seabirds for feeding, etc., and WGEAMS was not clear whether it would be within the ICES remit, or desire, to become involved in seabird ecology and population dynamics in relation to the alteration of the coastal margin.

The impact of algal harvesting, primarily for alginate extraction, is not clear, nor is it covered by any current ICES group. As well as the removal of the habitat represented by the algal fronds, in some areas the collection of the algae (e.g., *Fuscillaria*) can damage the underlying herring spawning grounds. It was suggested that the task of assessing the ecosystem significance of algal harvesting be given to the Benthos Ecology Working Group.

Litter is not dealt with in any current ICES group, and could perhaps be considered more of a management problem than a scientific problem. There are a number of other organizations with an interest in this area, including OSPARCOM ASMO. Sweden has offered to take the lead on litter in ASMO, and it seems unnecessary for ICES to take any independent initiatives at this time.

f) Effects of contaminants

Justification: The importance of contaminants in relation to the quality of sea foods, and to the quality of the environment in general, is well known, but must continue to be regarded as a priority issue. The radically increasing understanding of these matters indicates that, with the exception of mercury in the coastal zone, the "common" metallic contaminants do not normally give rise for concern. Similarly, the presence of radionuclides in the sea (in the absence of major accidental releases) should not be regarded as a priority issue of environmental quality in relation to marine species. However, concern remains over compounds such as PAHs, CBs, TBT, offshore chemicals, and other synthetic organic chemicals.

Action: The occurrence and effects of contaminants is well covered by the current ICES structures, including MCWG, WGMS, WGBEC, etc., and new structures are not required.

g) Transfer of organisms

Justification: There is increasing concern over the actual and potential impact of species introduced from other parts of the globe to waters where they have not previously been found. There are many examples of both accidental and intentional introductions of alien species which have had impacts far greater and less desirable than might have been expected or intended. Transfer can take place through tanker ballast water, transport of animals for aquaculture, and other processes which can move live organisms from one area to another.

A related issue concerns the importance of viruses in the sea. The impact of the phocine distemper virus has been well recorded, but the importance of viruses as disease vectors in other marine populations is little studied.

Action: These topics are covered by the Working Group on Introductions and Transfers of Marine Organisms and the Working Group on Pathology and Diseases of Marine Organisms.

h) Impact of mariculture

Justification: The growth of mariculture has been dramatic over the past ten years, and it is likely to continue to develop. Harvests of cultured Atlantic salmon are now much larger than those of wild Atlantic salmon. It is necessary to be aware that this industry has impacts on the environment in which the species are cultivated, and also on the wild stocks, both locally through escapees, and those elsewhere which are used to manufacture the feed.

Action: These topics are covered by the Working Group on Environmental Interactions of Mariculture.

13 ENVIRONMENTAL MODELLING

WGEAMS was unable to update the document on environmental modelling presented in the 1991 WGEAMS report, as there were no experts on the types of modelling referred to in the terms of reference present at the meeting. WGEAMS noted that the previous report on this subject was still helpful, but recognized that progress has been made in the intervening years, particularly in computing power. It was noted that the subject of environmental modelling which brought together different disciplines within ICES fields of interest had been discussed under items 11 and 12, above, and that the conclusions drawn were largely that ICES was not actively involved in work on these multidisciplinary models at the present time. The expertise to undertake the work could be found within the various subject area working groups, but coordination between subject areas was at an early developmental stage. It was noted that the Study Group on Environmental Modelling of the Baltic Sea had considered modelling matters, and had concluded that large complex models were not yet appropriate to the Baltic Sea and that more progress could be achieved through smaller models which could perhaps later be integrated into a larger structure. Such an approach had been taken under the ERSEM project.

14 GEOGRAPHICAL INFORMATION SYSTEMS (GIS) IN MONITORING AND ASSESSMENT WORK

No experts on GIS were present at the meeting. However, several members were able to report on national experience and activity in this area.

A. Franklin reported that the UK DFR had recently purchased MapInfo for a PC-based system. It was proving to be very useful and currently contains details of industrial and municipal discharges to coastal waters. As well as providing a graphical interface with the data, the system allows the interrogation of additional sheets of data relating to areas or discharges.

D. Claisse reported that France is reforming its database containing results from monitoring programmes. The new database will be used in association with ArcInfo/ArcView, and M. Joanny could make a presentation on this subject at the next meeting of the working group.

K. Stange reported that her institute is in the process of learning to use MapInfo.

In Sweden, both ArcInfo and MapInfo are used. HELCOM created a Working Group to discuss how GIS could be employed in its work. The system agreed on was to create a series of files of basic information which could then be formatted in various ways to make them suitable for input into various GIS systems. It would then be possible for users to input their own data to be displayed in association with the basic information. It was expected that this might lead to a more standardized form of output of geographically based information from monitoring programmes over the HELCOM area. OSPARCOM has undertaken a similar exercise, but has estimated that two permanent members of staff would be needed to support the system; no decision has yet been made on implementation.

The *Ad Hoc* Group on the ICES Secretariat Databases, which met in February 1995, has recommended that ICES work towards a GIS system for the presentation of all their data. A preliminary to this would be the bringing together of the environmental, hydrographic, and fisheries databases into a single structure to allow ready access to data from the different disciplines. It was reported that AMAP had employed a GIS consultant to advise on the preparation of data for publication.

WGEAMS concluded that there was now considerable interest in GIS, and that several countries had made decisions as to the systems they would use. This could result in some degree of incompatibility, but this might not be a serious problem. It was concluded that GIS could be a valuable tool in the management and investigation of information, and in decision support.

15 ANY OTHER BUSINESS

15.1 Environmental Status of the ICES Area

A suggestion was put forward for ICES to publish an annual environmental status report of the entire ICES area. The idea was presented by Dr Sætre in a letter to the Chairman of the Hydrography Committee (made available to WGEAMS by K. Stange), asking for comments from working groups affiliated with this committee. WGEAMS was asked informally to offer comments, to identify potential customers, and to suggest how such a task could be implemented. An environmental status report could include topics such as ocean climate, production, trends in pollution and eutrophication, fish diseases, and descriptions of special events such as harmful algal blooms or major pollution accidents.

It was agreed that hydrographical data would be the most readily available information. A status report describing hydrographical conditions would be useful for ACFM in fish stock assessments. Data on other parameters regarding eutrophication and pollution would probably be more difficult to report on an annual basis. It is suggested that ICES look into the feasibility of making hydrographical data which are reported to ICES more readily available to potential users of this information.

15.2 Review Document Concerning Background Concentrations of Contaminants in Various Environmental Matrices

This document was prepared at a meeting held in The Hague in 1992. It was passed to the Chairman of WGEAMS with a request that comments on the document be provided to ICES, either through discussion at the working group meeting, or as an individual assessment.

A. Franklin reported that to some extent the document was already being superseded. Workshops under the auspices of OSPARCOM are planned for autumn 1995 and 1996, at which both background concentrations and ecotoxicological reference values will be discussed as possible assessment tools.

WGEAMS recognized the underlying purpose and aims of the attempt to compile data on background concentrations. However, the document seems to derive a single value for each contaminant/matrix combination, and this is inconsistent with an appreciation of natural geographical variability, arising for example, from geochemical factors. WGEAMS agreed that the task could only be approached on a location-by-location basis, an argument that was supported by a critical paper presented at JMG concerning concentrations of metals in sediments.

The definition of background values developed early in the report was helpful, but then it appeared that the definition was not followed rigorously throughout the discussion, such that the conclusions were not consistent with the report contents. There were considerable problems in attempting to determine background values for matrices such as sea water and the atmosphere, which change with time and which leave little or no record of their previous composition. By seeking to represent background conditions as those which existed before 1850, direct analyses of sea water and the atmosphere cannot be available.

The alternative, but rather different, approach of seeking to determine typical values in pristine areas also has inherent problems. Firstly, the natural geographical variability mentioned above remains largely unaccounted for and, secondly, it is debatable whether it is possible to find any truly pristine environment. The transport of a range of contaminants over long distances in the atmosphere results in the contamination of remote areas, although not to the same extent as areas closer to primary sources.

The use of sediment cores from accumulating areas may provide the most direct route to background concentrations in appropriate locations. However, care must be taken to ensure that broad changes in environmental conditions have not taken place. For example, the increased primary production and input of organic matter to sediments in the Baltic Sea have induced large increases in the concentrations of some contaminants in the sediments. The sedimentary record, therefore, responds to both the flux of contaminants to the sea, and the flux to the seabed of those materials which accumulate contaminants from the overlying water. Any attempt to use sediment cores as reliable reflections of previous conditions must ensure that the depositional processes and environment have not markedly changed in the intervening years. For example, many recent mud deposits in Scotland are underlain by post-glacial clays, and some sediments in the German Bight are underlain by post-glacial aeolian sands (deposited at times when the sea level was rather lower than today). Recent studies of sediment cores in the Baseline Study of Contaminants in Baltic Sea Sediments are reported to suggest that post-depositional mobilization of adsorbed contaminants, particularly metals, and other diagenetic processes may be very important in determining concentration profiles in anoxic sediments.

There were a significant number of inaccuracies, technical errors, and poor proof-reading evident in the document, which at times were annoying and/or misleading.

WGEAMS concluded that there were a significant number of serious flaws and inconsistencies in the report, and that the declared intention of OSPARCOM to undertake new work on the subject was an appropriate response.

15.3 Global Ocean Observing System (GOOS)

A discussion of some possible details of the observations that should be included in GOOS was included in the terms of reference for this meeting. However, the Chairman had been informed by the ICES Secretariat that the relationship of ICES as a whole with GOOS would be a subject of the ACME meeting in May 1995, and that a special session with a GOOS official had already been arranged. In the light of these developments, WGEAMS was advised that it was not necessary for them to discuss this item. Given the possible importance of GOOS, or other very large-scale projects in marine science in the future, a series of documents were made available to WGEAMS for information, covering the Case for GOOS, the Approach to GOOS, the Outcome of an ECOPS GOOS Workshop, and an Assessment of the UK Requirements for GOOS Data and Products.

16 CONSIDERATION AND APPROVAL OF THE RECOMMENDATIONS AND REPORT

WGEAMS read and approved the report and recommendations, subject to minor amendments to be completed by the Chairman.

17 CLOSING OF THE MEETING

The meeting was adjourned by the Chairman at 16.00 hrs on 31 March 1995.

ANNEX 1

LIST OF PARTICIPANTS

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ANNEX 2

DRAFT AGENDA

1) Opening of the meeting.

2) Adoption of the agenda.

3) Arrangements for the preparation of the Working Group report.

4) Reports of activities in other fora of interest to the meeting.

5) Examine the WGBEC strategy paper on the use of biological effects techniques in monitoring and recommend possible means of implementation (OSPAR 1.3, HELCOM 9).

6) Prepare further advice on the use of seaweeds in monitoring programmes, based on a review to be prepared intersessionally (OSPAR 1.2, HELCOM 4).

7) Prepare comments on the role of seabird eggs in contaminant monitoring programmes, based on a review to be prepared intersessionally (OSPAR 1.2).

8) Consider whether existing guidelines on monitoring contaminants in fish and shellfish need to be updated, in relation to scientific developments and proposals by ASMO, and coordinate an updating and completion of the table on spawning periods of fish and shellfish in relation to monitoring of contaminants, contained in the 1992 ACMP report (OSPAR 1.4).

9) Discuss progress with the development of the Coastal Monitoring Programme of HELCOM (HELCOM 4).

10) Discuss progress made in the revision of the HELCOM BMP/COMBINE (HELCOM 4).

11) Propose an overall plan of action to implement the recommendations in the 1994 ACME strategy paper on the role of ICES in environmental monitoring.

12) Develop detailed suggestions as to how ICES strengths can best be used in the design and implementation of a monitoring strategy to address major environmental concerns foreseen within the ICES area over the next decade.

13) Update the document on environmental modelling presented in the 1991 WGEAMS report, with a view to providing ACME with an assessment of progress in, and the scope for, modelling activities relevant to ACME responsibilities, paying particular attention to the coupling of physical and biological models and their application to the management of fisheries and marine environmental issues.

14) Discuss and report on the application of Geographical Information Systems in monitoring and assessment work.

15) Any other business.

16) Consideration and approval of recommendations and report.

17) Closing of the meeting.

ANNEX 3

LIST OF MEETING PAPERS

Annex 2 from the Minutes of the 1994 ACME Meeting [CM 1994/A:4]: ICES Role in Environmental Monitoring

Use of chemical analysis of macroalgae in monitoring programmes, I.M. Davies

Seabird eggs in monitoring of pollutants and their biological effects, O. Sandström

ICES Work Programme for 1995, from OSPARCOM

ICES WGBEC Strategy Document: A proposal to JAMP for the adoption of an integrated marine environmental monitoring strategy

Coastal Monitoring Programme (CMP) of HELCOM

Reference areas in coastal monitoring, U. Grimås

The revision of the HELCOM Baltic Monitoring Programme (BMP)

Background concentrations of natural compounds, R.W.P.M Laane (ed.)

Comments on the above, presented by Germany, TF 10/5/1-Add.1-E(L), and TF 10/5/1 (North Sea Task Force documents)

Coastal Monitoring Programme, National station nets for various parameters

Report of the fifth meeting of the Environment Committee (EC) of the Helsinki Commission Baltic Marine Environment Protection Commission

IACMST Survey of UK requirements for GOOS data and products

Report of ECOPS GOOS Workshop, 26–27 October 1993

EuroGOOS Memorandum of Understanding

The case for GOOS, IOC 1993

The Global Ocean Observing System, J. Woods, Marine Policy, 18: 445–452 (1994)

The Approach to GOOS, IOC, 1993

Revision of Monitoring Guidelines, ICES Secretariat

Draft Strategy for a Joint Assessment and Monitoring Programme (JAMP), ASMO(2) 94/4/1-E

ASMO (2) Summary Record, December 1994

Report of HELCOM Workshop on the Revision of the Baltic Monitoring Programme (BMP) and Guidelines

Summary Record of SIME meeting, February 1995

ANNEX 4

USE OF CHEMICAL ANALYSIS OF MACROALGAE IN MONITORING PROGRAMMES

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It has unfortunately not been possible to carry out a comprehensive review of this subject. The following comments are largely based on experience in the UK, and members of the Working Group are invited to contribute from their own national experience.

Macroalgae are not generally used in UK monitoring programmes, and are not included in the UK National Marine Monitoring Programme.

1 Organic Contaminants

I have not found any references in the literature to the widespread use of macroalgae in monitoring for organic contaminants, and indeed there is little reason to expect that accumulation of lipophilic organic compounds should occur in macroalgae.

2 Trace Elements

There is a much more extensive literature concerned with trace metals in macroalgae, and work prior to 1985 is well reviewed by Bryan *et al.* (1985). A number of general points may be made, derived from this review and other subsequent reports:

a) Macroalgae respond largely to the concentrations of metals present in the water column, as there can be no dietary route of uptake.

b) They appear to accumulate some available fraction of the total metal present in solution, and therefore apparent concentration factors can show considerable differences between locations.

c) It is necessary to carefully control the portion of the algal plant that is sampled for analysis. Lowest concentrations are normally found in the growing tips, and progressively higher concentrations in older parts of the plant. This is normally interpreted as indicating a gradual increase in metal binding sites with age, although some authors have suggested that the portions of plants of different ages may preserve a record of conditions in preceding years.

d) There is evidence of interactions between metals during adsorption, and that high concentrations of some metals can inhibit the uptake of other metals.

e) There is a problem of the difficulty sometimes experienced in preparing samples of algae free of adhering particulate material, epiphytes, and epifauna. The presence of varying amounts of such material complicates the interpretation of relative concentrations obtained from the analysis of the samples of algae.

f) Different species of seaweed can be selected to cover different salinity and depth regimes but, as would be expected, direct comparisons of concentrations in different species cannot always be made with confidence.

g) Macroalgae are more widely distributed than some other organisms used in monitoring programmes and, therefore, a single target macroalgal species can provide a more comprehensive description of environmental conditions than can be obtained from some other monitoring organisms.

3 Radiological Monitoring

Macroalgae have been widely used in monitoring the marine environment for radiological contamination. Algae were adopted as target monitoring organisms very early in the development of such programmes, as they were shown to concentrate certain important nuclides from sea water, thereby reducing the analytical difficulties facing the monitoring organizations. Data have been made available from both UK programmes concerned with the discharge from Sellafield (and other locations) and from programmes in the Baltic Sea area. Algae have been particularly useful in mapping the distribution of available ^{137}Cs, ^{60}Co, and ^{65}Zn. For some radionuclides, *Fucus* shows higher concentration factors than *Mytilus*, and in many parts of the Baltic *Fucus* can be much more readily obtained than *Mytilus* in the quantities required for analysis.

4 Use of Macroalgae in Current and Proposed Monitoring Programmes

The following comments are made particularly in relation to the current reassessment of OSPARCOM monitoring programmes. ASMO, as successor to JMG, has adopted the principle that monitoring programmes should be clearly directed at biological causes of concern, and that programmes should be designed to test hypotheses, or answer defined questions. If we adopt this approach, it is necessary to ask what causes for concern are associated with trace metal contamination (particularly lead, cadmium, and mercury) and with radionuclides, and which can be addressed most appropriately through algal monitoring.

Except in a very few unusual areas where extreme levels of contamination are known to occur, the main cause for concern over the trace metals listed above is their accumulation in sea food and subsequent transfer to man. There may be additional concerns relating to the accumulation of these substances in marine top predators, but it appears that seabirds and mammals possess mechanisms for coping with high intakes of potentially toxic metals. The contribution of lead, cadmium, and mercury in macroalgae to the human diet is very small and, therefore, macroalgae are not an appropriate monitoring medium for these substances. This clearly does not preclude the examination of metals levels in macroalgae in relation to other research objectives, such as the flux of metals through ecosystems, etc.

In relation to radionuclides, the causes for concern, i.e., the primary targets of the monitoring programmes, are more diffuse, but the possible exposure of the human population to radionuclides remains the ultimate concern. In general, the population of the ICES area consume only small amounts of food products derived from seaweed. Macroalgae therefore provide only a small component of the dietary radiological exposure, and fish and shellfish provide a much larger proportion of the exposure derived from the marine environment. Macroalgae are therefore not the first choice monitoring target in most cases, although in some areas algae are exploited for food, e.g., to prepare lava bread in Wales, and other products from dulse, etc. In such areas, there is a stronger case for monitoring selected macroalgal species in relation to human health.

There is a clearly established precedent and body of data on radionuclide concentrations in macroalgae, collected in relation to assessment of the distribution of radionuclides in the sea. The continuation of such studies should take account of this body of data.

5 References

Bryan, G.W., Langston, W.J., Hummerstone, L.G., and Burt, G.R. 1985. A guide to the assessment of heavy metal contamination in estuaries using biological indicators. NERC, Occasional Publication No. 4. 92 pp.

ANNEX 5

SEABIRD EGGS IN MONITORING OF POLLUTANTS AND THEIR BIOLOGICAL EFFECTS

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Introduction

One of the main problems in contaminants monitoring is related to the selection of a proper and well defined matrix for sampling. Water samples are complicated, as the particulate matter always occurring in natural waters to a very high and varying degree acts as a trap for most contaminants - lipophilic substances as well as metals. Sediments as well are poorly defined matrices. The contaminants are bound to the organic fraction of the sediment, and this fraction is highly variable in composition as well as its share of the total sediment sample.

Biological matrices are preferred by many scientists (Schubert 1985). When you monitor contaminants in living organisms, you are also closer to an integrated dose-effect analysis. However, there are still problems concerning how well defined your sample is. Macroalgae like bladder-wrack provide tissues that can be sampled by standardized techniques, but they harbour a lot of epiphytes and epifauna that can not easily be removed. In radionuclide monitoring it is known that some elements tend to accumulate strongly on the surface of epiphytic diatoms (Snoeijs & Notter 1993). When using mussels, it is not possible to extract intestinal contents etc. from the samples. Fish, birds and mammals provide better opportunities, as it is possible to cut out well defined muscle samples from most species. However, mobility, seasonal variations, and variations between sex and age groups complicate. Finally, birds eggs have been suggested for contaminants monitoring as they are expected to provide an unusually well defined matrix and as many contaminants tend to be accumulated in the egg yolk. Biological effects on, e.g., chick physiology and survival, with eventual effects on the population level, may also be studied in integrated programmes. Birds, however, are very mobile and marine species usually migrate over long distances between overwintering and breeding areas. Their exposure thus often will be highly unpredictable.

The advantages and drawbacks associated with the use of birds in monitoring have been reviewed by Furness (1993). Although there exist problems related to, e.g., mobility leading to unknown integration of pollutant burdens, birds have been particularly successful to indicate pesticides in food webs. Many birds can be classified as top predators, and as such they are very vulnerable for bioaccumulating pollutants. High mortality, eggshell thinning, and hatching failure, are sad examples of pesticide impact on predatory birds. A high trophic position is especially common among seabirds, as they often feed on fish or larger invertebrates. This group consequently may provide potential sentinels to be selected for monitoring in early-warning systems also addressing human health problems.

This report is a review of attempts made to include seabird eggs in aquatic contaminants monitoring. Examples will be given on tests of statistical power in trend monitoring and on couplings between pollutants concentrations and biological effects, allowing conclusions on the ecological relevance of egg data. The review is prepared as a background document for

ICES discussions on priority matrices in contaminants monitoring.

Can eggs be recommended in monitoring of all contaminants?

Four main groups of contaminants may be distinguished in the marine environment: organic pesticides, PCBs and dioxins, heavy metals, and radionuclids. Furness (1993) presents a comparison between different monitoring units for the detection of trends and effects of these substance groups. Organic pesticides have been successfully monitored by egg sampling, and a series of biological effects have been correlated to pollutant concentrations. Classical examples are provided by the studies made on DDT and its derivatives, following the wide-spread use of this insecticide during the 1950s and 1960s. The peregrine falcon *Falco peregrinus* population in Britain suffered badly from DDT poisoning. DDE concentrations in eggs were strongly negatively correlated to egg shell thickness, indicating low chick survival, and a temporal correlation with the use of DDT could also be demonstrated (Ratcliff 1970; Peakall *et al.* 1975). A similar reduction in reproducion success was seen in the Swedish population of white-tailed sea eagle *Haliaeetus albicilla* (Helander 1983, 1985). Although other pollutants like PCBs may have contributed to the effect, DDE was suggested to be the most potent factor as there was a decline in reproductive performance with increasing levels of DDE in the eggs (Helander *et al.* 1982; Helander 1994). This correlation was much weaker for PCB and mercury.

In the case of DDT poisoning, egg analysis has been considered as an efficient way to detect the responsible substance as well as to indicate the mechanisms behind observed population failures. There is, however, evidence that other pesticides like dieldrin and aldrin may have contributed to the effect patterns in the British studies. Still, had there been no ornithologists watching and documenting the population trends in these top predators, and had there not been such a suitable matrix as the egg for chemical analysis, this toxic pollution would have been much more widespread before enough scientific evidence would have been available to ban the use of DDT and other persistent pesticides.

Although birds of prey seem to be the best sentinels, there is an obvious sampling problem. Regular egg collections from most populations are unacceptable, so analyses are often restricted to addled eggs remaining in the nests after the hatching period. These eggs may not have pollutant levels typical of the whole population. This difficulty may be avoided by studying more abundant species at somewhat lower level in the food chain. Eggs of common terns *Sterna hirundo* and herring gulls *Larus argentatus* are used to monitor North Sea coastal areas (Becker 1991).

Comparing other potential monitoring units, many authors seem to be convinced that eggs provide a very suitable matrix for organic pesticide analysis. The substances accumulate in the egg yolk, making the chemical determination more accurate and simple, and there are examples of significant correlations between egg concentrations and biological effects. Although PCBs appear to be very toxic to marine mammals, evidence of a toxic impact on birds is much weaker (Furness 1993). However, it is generally accepted that surveillance of PCB levels in eggs is a useful method to document trends and patterns in PCB distribution (Furness 1993; Bignert *et al.* 1995).

Indications of reproduction failure correlated to increased levels of chlorinated dioxins and furans was seen in a British Columbia colony of great blue herons *Ardea herodias* (Elliott *et al.* 1989), living close to a pulp mill using elementary chlorine for bleaching. The herons failed to raise any young as the eggs were destroyed. However, predation by crows and ravens was considered to be the main cause of egg destruction. Other studies demonstrated increased hepatic EROD activity, increased frequency of chick edema and lower chick weights correlated with elevated levels of dioxins and furans (Sanderson *et al.* 1994a, b). After process changes in the pulp mill, egg concentrations decreased and chick health improved.

Osprey *Pandion haliaetus* egg sampling was also used to study differences in dioxin and furan levels upstream and downstream pulp mill sites in the Columbia river system, Canada (Whitehead *et al.* 1993). Significantly higher concentration were detected downstream the mills. Eggs from Double-creasted Cormorants *Phalacrocorax auritius* were used in coastal monitoring of dioxins in Howe Sound, Canada (Whitehead *et al.* 1992). Declines in concentrations between 1988 and 1990 were indicated. However, sample sizes were too small to allow accurate statistical comparisons. Generally, the high costs associated with dioxin analyses have restricted sample sizes below what is normally considered necessary when using biological materials.

Heavy metals, particularly mercury, have attracted much attention in contaminants monitoring as there have been severe metal incidents in many countries. Mercury poisoning resulting in high mortality appeared, e.g., when birds fed on seeds dressed with fungicides. Most studies on heavy metals in birds have used internal tissues. Cadmium in concentrated in the kidney, mercury in liver and kidney, lead in bone, and zinc and copper in liver. Metals, however, do not bioaccumulate to the extent of organic pesticides, and the advantage of eggs in monitoring is not too obvious. Eggs, however, reflect metal uptake from local foraging better than, e.g., liver or kidney samples from adult birds (Barrett *et al.* 1985). If your monitoring objective is to measure uptakes integrated over longer periods of time, this sensitivity to acute exposure of course will be a drawback. Methylmercury tends to be deposited in the plumage and will be annually lost during moulting (Furness *et al.* 1985). Feather analyses thus will provide integrated measures covering the inter-moult period, whereas egg levels indicate the mercury exposure during some weeks before the egg-laying.

Cadmium should be number two on the list of hazarduous metals in aquatic habitats. Very little cadmium seems to be transferred to eggs, and seabird data usually show low concentrations despite high levels in kidney. Lead transfers to eggs as well are invariably low.

Compared to other tissues, including nonavian organisms, eggs do not seem to be primarily recommended for metal monitoring, mercury excluded. Also, most metals do not show bioamplification, and there are reasons to select more sessile organisms than birds for monitoring. However, the advantages of a well defined matrix, access without killing adult animals etc., are obvious when using birds eggs in metal as well as in pesticide monitoring. Metal levels in birds eggs are considered to give a better picture of hazards to man than data from other ecosystem compartments, including benthic plants and sessile invertebrates.

Birds eggs have been only occasionally used as a matrix for radionuclide monitoring (Furness 1993).

A good sentinel should not only provide accurate contamination data; it should as well be a sensitive indicator of biological responses. Most top-predators, like eagles and falcons, are very sensitive to a wide range of chemicals, and will thus provide a good early warning system. The sampling problems addressed above, however, may restrict their use in monitoring programmes. Other, more available, species may stand rather high concentrations before effects become visible. Ducks and some of the gulls fall into this cathegory.

As a conclusion, sea-bird eggs may be recommended as a suitable matrix for the monitoring of many hazardous substances, and there is considerable evidence that levels in eggs may be coupled to responses in relevant ecological endpoints. For a proper selection of sentinels, however, problems associated with availability for sampling, high resistance towards a toxic influence, etc., reduce the list of potential species considerably.

Mappings of contaminant distributions

Seabirds eggs have been used to study geographical distributions of organic pollutants as well as toxic metals. The use of eggs restricts the sampling to a very short period, reducing the problems of seasonal variations in concentrations. The sampling moreover will not be affected by sex or reproductive stage, a problem often recognized when analysing muscle or liver samples, etc. However, there are still statistical problems and possible errors in interpretations. Top predator species may not be available for collections of large samples, and the geographical distributions of single pairs or colonies may not always be optimal for mapping procedures. The most critical problem, however, is the difficulty in most species to define the area of exposure as they are more or less migratory and as they generally have a variable and seldom well defined food base. Gulls, e.g., may find their food in marine as well as terrestrial environements, and are often seen on cultivated fields in spring before the egglaying period. In some cases, however, the behaviour of the selected species may be an advantage, as in the guillemot. This species moves within rather restricted areas - like the open sea of the Baltic proper - and has a very narrow and well defined spectrum of prey species of pelagic fish. Consequently, only a few samples will reflect the general background contamination of the total basin. Accordingly, the common tern would be a good choice for coastal monitoring, as it feeds mainly on small fish close to the shore and does not depend on terrestrial foraging.

Geographic variations in organochlorine concentrations have been documented in North Sea populations of common terns and herring gulls (Becker 1991). Studies of more large-scale distributions provided evidence for a transport of these persistent substances even to the polar regions (Nettleship and Peakall 1987)

Eggs reflect metal uptake for local foraging, an advantage for mapping purposes. Striking patterns have been documented from studies of mercury in European and Atlantic waters, and common guillemots *Urea aalge* provide the best examples (Parslow and Jefferies 1975). Irish Sea colonies showed much higher levels than reference north-west Scotland birds. Geographical patterns in mercury levels were also reported around British and Irish gannet and herring gull colonies. Concentrations in samples from south-west Britain were more than 10 times higher than in eggs collected in northern Norway. Peaks in mercury concentrations have been detected in the Elbe estuary, when herring gull and common tern eggs were analysed from different regions of the German North Sea coast (Becker 1989). When gulls are used for monitoring, however, it is not easy to relate the observations to the marine environment only.

Long-term contaminants trend monitoring

Long-term monitoring of time trends in contaminant concentrations can not be made without careful statistical planning. Considering the different components of variance, it is obvious that even trends of a magnitude exceeding 10 % per year will be hard to detect in most programmes. Analytical errors, seasonal variations, influence of sex differences, differences between size and age groups, variations caused by poorly defined sampling matrices, etc., all add to the uncertainty of trend monitoring. Organic pesticides, PCBs, chlorinated dioxins and furans, generally occur in low concentrations and the analytical procedures have not always produced accurate concentration data. A continuous development of laboratory techniques has increased the precision. However, in trend monitoring it may be disastrous if the analytical methods are replaced. The accuracy of a single observation is less valuable than the precision of detection of relative changes over time.

Birds eggs provide many definite advantages compared to other monitoring matrices. One sex, females, in a well defined reproductive phase is monitored. The season is fixed within very narrow limits. Eggs provide unusually well defined matrices for contaminant analyses, perhaps the most important argument in favour of egg monitoring.

Most trend analyses reported have been made by comparing a restricted number of separate samples from different time periods, not by analysing annual data series. This is a risky procedure, as the natural between-year variations may lead to very wrong interpretations. Random pick of data from a long-term Swedish monitoring programme could produce significant negative trends in contaminants (the true development), no trend at all, and significant positive trends (Bignert *et al.* 1993). This study strongly advocates annual samplings, and also illustrates the importance of careful statistical planning.

The Swedish contaminants monitoring programme perhaps provides the best example of using seabird eggs in long-term trend detection and analysis. PCB and DDT pollution has been monitored by sampling guillemot eggs since 1969. A significant decrease in sDDT and PCBs was shown during the 70s and beginning of the 80s (Olsson and Reutergårdh 1986). Although the process is slower, a continued improvement is seen during the recent years (Bignert *et al.* 1995). Bignert and coworkers also found a strong correlation between the concentration trends in fish (Baltic herring) muscle and guillemot eggs. Beeing a fish-eating bird, this species evidently mirrors the general contamination over larger water areas like the Baltic basins.

A similar decrease in pesticide concentrations in seabird eggs was documented in British monitoring of shag *Phalacrocorax aristotelis* eggs sampled from colonies in north-east England and south-east Scotland, following the restricted use in the late 1960s (Coulson *et al.* 1972).

Long-term trends of mercury contamination have been successfully documented by analysing plumage feathers, taking advantage of the possibility to make retrospective comparisons by analysing museum materials. Levels in eggs are only about 20-25 % of the concentrations in feathers, and mercury is particularly accumulated in the egg white proteins. However, as egg levels probably reflect short term exposure better than feather concentrations, eggs may be preferred to monitor trends in the vicinity of breeding sites.

Eggs have been used in pesticide, PCB and mercury monitoring at the German North Sea coast (Becker 1989, 1991, 1992a, b; Becker *et al.* 1992). The spatial distribution suggested local contamination in agreement with the general opinion on where "hot spots" should be situated, The data were also used for trend analysis. A considerable between-years variation was evident for most substances and very few trends could be detected. A major draw-back in these studies is that the trend analysis was made by comparing data from one year, 1981, with five years data from 1986 to 1990. In some cases significant changes seemed to be evident from the statistical analysis. However, as this generally was an effect of the first year deviating from all others, and knowing the large between-years variations documented in other studies as well as this, the relevance of these tests may be questioned. The Swedish study cited above (Bignert *et al.* 1993) issues a clear warning against interpreting trends from unsufficient data sets.

Chlorinated dioxins and furans, together with planary PCBs, are among the most toxic environmental contaminants so far monitored. As they occur only in minute amounts, the analytical problems have been very large. Available data for trend analysis are so far limited, but there are indications from Canadian studies that concentrations drop very fast in locally polluted areas when effluents are reduced (Sanderson *et al.* 1994b). The possibility to detect significant trends in the general background contamination of larger water bodies by egg analysis is, however, not yet satisfactorily tested.

Conclusions

Birds eggs seem to fulfil many of the prerequisites of a suitable monitoring unit. It is generally agreed by the cited authors that the egg is a good matrix for analysing organic contaminants, and that many sources of variation may be avoided or minimized by using eggs. However, most birds produce more than one egg, and it is well known that concentrations may differ between the first and the last egg of a clutch.

Considerable evidence is available on spatial as well as temporal variations in contaminants concentrations in birds eggs that agree with what is expected from the use of pesticides, PCBs, and metals, and the recent restrictions in the environmental load. However, some metals may be less efficiently monitored in eggs, as they do not accumulate to such an extent as in muscle or liver tissues.

The problems associated with the use of sea-bird eggs in monitoring are problems innate to the use of birds to document spatial or temporal contamination patterns in a defined area. Migratory habits, the distribution of nests or colonies in relation to the desired sampling sites, availability of the prefered sentinels, etc., sometimes do not speak in favour of the use of birds in contaminant monitoring programmes. For monitoring of marine ecosystems, there is also a considerable problem to select suitable sentinels. Many common species feed on land as well as in the sea, and also in exclusively marine species the food base is seldom well specified and may be seasonally variable. However, when there is a species like the guillemot available for sampling, all the potential benefits from using the egg as a matrix become evident, and a high geographic resolution and high power in trend monitoring will be possible.

Monitoring of contaminants levels in birds eggs may in many species also be combined with biological effects studies. Historically, dramatic effects on hatchability, chick survival etc., have been seen when parents were exposed to different kinds of contaminants also causing high levels in the eggs. In an integrated monitoring of contaminants end their effects, it may thus be suggested to include variables like eggshell thickness, hatchability, the frequency of unsuccessful breeding attempts, numbers of fledged young, etc. Biochemical indicators of a toxic exposure and physiological health studies have as well been developed for birds.

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ANNEX 6

SPAWNING PERIODS FOR BIOTA SAMPLED IN THE 1990 SUPPLEMENTARY BASELINE STUDY OF CONTAMINANTS IN FISH AND SHELLFISH (months of the year)

FISH SPECIES		ICES FISHING AREAS																				
Latin name	English name	I	II	IIIa	IIId	IVa	IVb	IVc	Va	Vb	VIa	VIb	VIIa	VIIb,c	VIId	VIIe,h	VIIf,g	VIIj,k	VIIIa	VIIIb	VIIIc	VIIId	IXa
1st Choice Species																							
Limanda limanda	Dab	5–8	NI	4–6		2–5	2–5	2–5	3–5	4–6	3–5	NA	2–5	2–5	(2–5)	(2–5)	2–5	2–6			NA		NA
*Gadus morhua**	Cod	2–5	2–5	1–4	3–8	1–4	1–3	12–3	3–5	2–5	1–3	2–4	2–4		12–2	2–4	2–4		NA	NA	NA	NA	NA
2nd Choice Species																							
Nephrops norvegicus	Norway lobster	NA	NI	9–11		9–11	7–11		5	6–8	6–11	NA	9–10	9–10			8–10	8–10	5–8	5–8	6–8		5–10
*Platichthys flesus**	Flounder	4–7	NI	1–4	3–5	1–6	1–8	1–4	NA	1–5	NI	NA	NI	NI	2–4	2–4	NI	NI	1–3	1–3	NA		1–6
Merlangius merlangus	Whiting	NA	NA	2–7		3–7	2–8	1–8	5–6	5–6	3–7	NA	3–5	3–5			3–5	3–5	2–6	2–6	NA		NA
Merluccius merluccius	Hake	NA	NA	4–8		5–7	NA	NA	NA	4–6	5–8	NA	NA	5–7			5–7	5–7	1–4	1–4	1–4		12–4
Other Species																							
*Pleuronectes platessa**	Plaice	2–6	3–4	1–4		1–3	1–4	12–3	3–4	2–7	1–3	NA	1–3	2–4	12–3	12–3	1–4	2–4	NA	NA	NA		NA
Microstomus kitt	Lemon sole	NI	NI	4–8		5–10	5–10	4–6	3–4	5–8	4–7	NA	NI	NI	4–6	3–6	NI	NI	NA	NA	NA		NA
Solea vulgaris	Common sole	NA	NA	4–7		NA	3–6	3–6	NA	NA	NA	NA	4–6	3–5	3–5	2–5	2–5	2–5	2–4	2–4	1–4		12–4[+]
Sardina pilchardus	Pilchard	NA	NA	NA		NA	NA	NA	NA	NA	NA	NA	NA	NI			2–3	1–3	9–6	9–6	10–6[1]		10–4
Clupea harengus	Herring	NA	2–4	2–4	3–6, 9–10	8–9	8–10	9–1	3, 6–7	2–4	3–4, 8–10[2]	NA	9–3	10–12	11–12		10–3	10–11	11–1	NA	NA		NA

COASTAL SHELLFISH SPECIES		COUNTRY											
Latin name	English name	Belgium	Denmark	France	Germany	Iceland	Ireland	Netherlands	Norway	Portugal	Spain	Sweden	UK
1st Choice Species *Mytilus* sp.*	Mussel	4–5	5–6, 9	2–6	4–9	7–8	2–5 (main)	4–5	5–7 (main)	4–6	3–5, 9–10	5–6	4–5 (Eng) 4–10 (Sco)
2nd Choice Species *Crassostrea gigas*	Pacific oyster	NA	Variable	6–9	6–9	NA	NA	7–8	NA		NI	NA	7–10 (Eng) (occasionally only)
Other Species *Palaemon serratus**	Prawn	NI	5–7 (sp. rare)	11–6 (egg carrying)		NI	11–2 (egg carrying)		NI	12–1	12–1, 35	NI	NI

*Species recommended by JMG14 NI = No Information NA = Not Applicable [+]Dec.–Feb. or Jan.–Apr., depending on subarea

[1]Spawning period with two peaks, the biggest one in Nov.–Dec. and another between Mar. and Apr./May [2]North Minch 3–4, remainder VIa 8–10

ANNEX 7

COASTAL MONITORING PROGRAMME (CMP) OF HELCOM

INTRODUCTION

The tasks for the *ad hoc* Working Group on Coastal Monitoring were established by the Environment Committee (EC 4) in 1993 and are reflected in EC 4/17, Annex 10.

The main tasks includes:

- an outline of a coastal monitoring programme
- information on national programmes for river water quality
- annual report to EC and proposals for actions to be taken
- assessment every 5 years on the state of the coastal areas

The development of a strategy to forecast the response of coastal waters to changes in discharges and emissions may be regarded as the main point. The programme should be based on identified common national measurements. Guidelines of relevance for the programme should be given.

The coastal monitoring programme should be harmonized with the open sea monitoring programme and assigned under the umbrella of COMBINE. This means that the coastal monitoring programme should be regarded as a subprogramme under the COMBINE and that a coordination should be sought for concerning common objectives, methodologies, guidelines, etc.

In order to ensure such a linkage between the monitoring programmes of the coastal areas and the open sea, the convener and a number of national representatives in the ad hoc Working Group of Coastal Monitoring took part in a Workshop on the revision of the BMP and its guidelines in Copenhagen 2-6 May, 1994.

GENERAL AIM

The general objectives expressed for COMBINE are relevant for coastal areas and are accepted within the CMP:

"To identify and quantify the effects of existing anthropogenic discharges/activities in the Baltic Sea, in the context of natural variations in the system, and to identify and quantify the improvements in the environment as a result of regulatory actions".

When going from these general objectives to more detailed and quantified expressions, the Working Group agreed that there are environmental problems related to:

EUTROPHICATION

CONTAMINANTS

EFFECTS ON BIOTA

which need monitoring activities of and descriptions by:

GEOGRAPHICAL DISTRIBUTION and

TEMPORAL TRENDS.

Eutrophication and occurrence of contaminants constitute evident problems in the Baltic, well documented for the open sea as well as the coastal zone. Effects on biota include, in a broad sense, also man, e.g. health effects by consumption of contaminated marine food products or poor hygienic conditions for bathing. The effects on and by recreational activities are generally more pronounced along the coasts than in the open sea and for that reason they are identified as a separate problem area in the First Assessment of the State of the Coastal Waters.

To the important monitoring categories should be added the

INPUTS.

Data on inputs should be provided by the appropriate subsidiary bodies of HELCOM. Of special importance for the coastal zone are the direct inputs from landbased diffuse or point sources. Observation of improvements in the environment related to the reduction of such inputs might strengthen the arguments for further decisions and measures to be taken.

SPECIFIC FEATURES OF THE COASTAL ZONE

Taking the step into the coastal zone, the background environmental conditions and the pre-requisites for monitoring techniques change compared with those of the open sea as an effect of a close and direct connection to:

THE PHYSICO/MORPHOMETRIC COASTAL MARGIN CONDITIONS,

A BROAD SPECTRUM OF CHEMICAL AND BIOLOGICAL WATER QUALITY CONDITIONS, and

THE DIVERSE USAGE OF WATER RESOURCES BY MAN.

The specific premises are reflected in the Report on the State of Coastal Waters, 1993. The lessons learned by the information given in the report and the availability of the coastal zone for an integrated programme will be of value for the further development of a common programme for the total Baltic; sources included.

The advantage of given specifics can be summarized as:

* PATCHINESS OF ENVIRONMENTAL CONDITIONS

* HIGH FREQUENCY OF MEASUREMENTS WHEN NEEDED

*AVAILABILITY OF SEDENTARY ORGANISMS, ILLUSTRATING GRADIENTS

*BUILDING UP OF GENERAL OR SPECIFIC CASE STUDIES OFFERING INTERPRETATION OF CAUSE/EFFECT RELATIONSHIPS

These technical points mentioned will have an effect on the matrices of organisms, substances, methodology, etc. The results from the coastal zone will also, in many cases, be of relevance for the interpretation of processes in open sea and prognoses not only for coastal zones but for the total water area of the Convention.

The gain of results from coastal areas is of especial importance since:

THERE IS A RELATIVELY SHORT TIME FOR RESPONSE AND RECOVERY OF POLLUTED COASTAL AREAS. THIS IS OF INTEREST FOR THE CONFIRMATION OF EFFECTS BY MEASURES TAKEN AND FOR FUTURE POLICY.

STRATEGY OF THE CMP

The strategies for monitoring of eutrophication and contaminants in the open sea were discussed at the Meeting in Copenhagen; the coastal areas being taken into consideration more or less in detail.

A general time table for the BMP was recommended with a revised monitoring programme for the open sea areas finalized at a work shop in spring 1996. It is also recommended that a Coordination Group should be established during 1995 to harmonize this programme. It seems evident that the CMP should join that time table in order to attain the desired linkage between the various sub-programmes within COMBINE, e.g. concerning methodology.

The *mandatory* ingredients in the specific coastal programme should be identified concerning variables/elements to be measured in selected matrices at sites and with a frequency that is relevant for the interpretation of results.

In addition there will be recommendations and encouragements for *tentative* ingredients, either followed by monitoring routines or in research projects. These complementary activities might function as preliminaries, e.g. for introduction of new monitoring techniques or for explanation of mechanisms behind observed effects.

Internal variabilities will require different strategies, e.g. for the open and inner coastal waters. Characteristic conditions prevailing in parts of the Convention waters are also of interest for the monitoring strategy, e.g. the establishment of reference areas in specific sub-regions.

It should in this context be remembered that many qualities are unique for the Baltic. One example is the concentrations of some metals in blue mussel, which are about five times higher than in western waters, e.g. the North Sea. The background to this fact might be the semi-enclosed character of the Baltic and salinity, which is not possible to manipulate by administrative restrictions or measures taken. Thus, the interpretation of monitoring results needs a back-up by research to reach a realistic policy.

Siting and frequency

The selection of sites in the coastal zone is of national concern and will have to be based on national experiences. Some main characters should, however, be covered.

Monitoring should be established in **polluted areas** estimated to be of importance for a local area, the so-called "hot spots". A detailed definition of the qualitative/quantitative frames for such a "spot" is intricate and often a matter of discussion. Besides local effects, the importance of such an area as a source affecting the open sea has to be taken into account.

The "background" or "not affected" condition of the Baltic coastal waters is, of course, impossible to find as an infallible reference. On the other hand, there are areas with acceptable water quality conditions, which might function as **reference areas.** Such areas are selected in a special study in the northern Baltic and should be considered also for the southern part.

The availability of sedentary/stationary organisms, indicating effects from a point source, e.g. in **gradients**, confirms the coastal areas as being worthy of priority for many monitoring purposes. The rather stable directions of water currents along certain parts of the coasts and, thereby, the net transport of elements from a point source, facilitates the understanding of behaviour and effect radii of various elements that are introduced into the marine environment from land or fresh water.

The frequency of sampling and measurements should be related to the stability of the system studied.

In general, the variations in the abiotic and biotic variables are very high in the open, pelagic system while conditions within the benthic system are more stable.

Intrinsic properties of biota act in the same direction; short generations and patchy appearances of species in open waters compared with the benthic communities of species.

The discussion on frequency and areal patchiness of the different areas of open sea and coasts requires further comments on media and their qualifications for monitoring purposes.

Media and organisms

Pelagial

The following-up of temporal trends in the open waters requires a high frequency of sampling, especially if the ambition is to include short periods of peaks for comparisons between areas, for instance the yearly production of organic material. The sampling frequency, corresponding to the requirements for an interpretation of results is, for practical reasons, easier to maintain close to the coasts.

With some exceptions, high-frequency sampling stations are mainly of interest for the studies of the pelagial. *Only a few coastal areas are available as representative for the pelagial of open sea conditions. The conclusion is that the coastal pelagial will be of interest for research on eutrophication mechanisms rather than routine monitoring.* Exceptions are large archipelagos, that are of interest *per se*. In some countries, high-frequency sampling stations are established and a further introduction of the system is of interest, especially in countries with wide-open coasts.

Benthos

Looking at the benthos, there are clear differences in conditions precedent for macrozoobenthic organisms in deep areas of the open sea and in the shallow coasts. In general, the conditions change from monotony to large variety of species and communities towards the coastal zone. The inertia of the deep areas and scarcity of species mainly reflect a slow development which might be covered by low sampling frequency. Exceptions might occur by rare, dramatic changes in random areas of affected bottoms, of interest for specific projects.

The answers found in the coastal zone are the sum of the reactions of a variety of species with specific demands upon their environment and thereby building up specific communities. *The composition of a community is sensitive to given environmental requisites but characteristic for given premises and is often used as an indicator. Thus, the areal variability is large while the temporal variation is relatively small, which allows a low sampling frequency.*

To judge from results presented in the Coastal Assessment Report the zoobenthos communities are used by all member countries to reflect the conditions in coastal areas between and/or within years. The technique is, thus, available for coastal monitoring activities.

Of specific importance, and included at least in case studies, are the investigations of the belt of macroalgae, including species composition and bathymetrical distribution. Long-term observation series over several decades are available and have been intensified in many coastal areas during the last decade with good results. Therefore, macrophyte benthos monitoring is highly recommended for eutrophication studies.

Besides specific observations, e.g. on the brown, green, and red algae, there are studies on diatoms. These micro-algae reflect a variety of environmental conditions and are also known as good indicators of metals and radioactive substances, illustrated amongst others in the Coastal Assessment Report. Intercalibration exercises on taxonomy have been carried out with specialists from all member countries and the organisms are strong candidates for inclusion in a future monitoring programme.

One example of disturbance to the benthic communities and ecological functions are the effects caused by intensive fishing activities, e.g. by trawling, which is noted in other marine coastal areas and is of interest to analyze in the Baltic coastal zone.

Fish

A group of organisms of ecological and economic importance is the fish fauna of the coastal zone. They represent a high trophic level where many background conditions in the aquatic environment are integrated. They also respond to these conditions by a series of reactions which are more sophisticated than those found among organisms on lower organizational levels.

The reactions of fish - from cells to communities - are used in many countries for monitoring of biological effects and many examples are given in the Assessment Report of long-term as well as short-term responses. The effects of eutrophication as well as contaminants are evident and *a fish monitoring programme is under expansion around the Baltic. One of the advantages of studies on fish is the relatively limited extent of the field programme, offering studies of various effects* from eutrophication to contaminants on the same material.

Among contaminants, two metals, mercury and cadmium, are given the highest priority for reduction. Of these metals, mercury is of special concern for the coastal zone. The need to follow up this metal in coastal monitoring at various trophic levels is inevitable. Areas of high concentrations in fish regarded as toxic, e.g. to man, are presented by most countries. It is, thus, *important to include at least one coastal fish species in the mercury programme as a representative of importance for consumption.* Perch was recommended by the sub-group at the Copenhagen meeting in 1994 as mandatory for mercury and should also be recommended by the Coastal Monitoring Group.

Of specific interest is the availability of stationary species for the purpose of "biological effects monitoring". The species used for these purposes are often called "sentinel species". Especially the effects on reproduction, which is a key point in biological response to environmental disturbances, can be studied on coastal stationary fish species. The eelpout (viviparous blenny) is regarded as an exellant species for such a purpose.

There are also connections between pollution and fish diseases which are illustrated by some countries at point sources, e.g. pulp mills, but which still await the routine monitoring techniques.

Birds

Sea birds occupy higher position in the food web, which makes them ideal monitoring organisms for contaminants in marine environment. It has been shown in the past that a high level of contamination might cause breeding failure and population decrease. Recent studies on eggs of Common Tern (*Sterna hirundo*) reveal very good results and underline the advantage of using common tern eggs in spatial and temporal monitoring of marine pollution on a local scale. This easy to assess and common shore-breeding species should be included in the CMP.

OUTLINE OF THE PROGRAMME

The initial phase of the Coastal Monitoring Programme will require an overview of the regional variability. The so-called "hot spots" are already included in national contributions to the Coastal Assessment, concerning eutrophication, metals and water quality for health conditions. This picture might have to be complemented by existing information on other environmental disturbances.

It should be observed that the **initial overview should include as many parameters/variables as possible** to ensure a reliable pattern of geographical conditions before decisions are taken for trend monitoring or further geographical overviews.

The proposals from member countries of possible reference areas are of special importance already at the planning stage. It seems probable that the main tools used for description of disturbed areas are rather common while relatively undisturbed areas are not covered by a reciprocal programme. Such areas should be discussed in the *ad hoc* Coordination Group. When discussing **reference areas the Baltic Sea Protected Area Programme (BSPA) should be taken into consideration.**

It can be foreseen that many of the methods used nationally for description of status of coastal areas are transferable to a common coastal programme. However, checks must be made not only in general terms but also in detail before results from national programmes can be regarded as comparable.

Thus, besides a general listing of common sub-programmes, which might give guidance for interpretation of large variation in environmental quality, there has to be a more detailed analysis of discrepancies to meet future demands on precision.

A rough regional pattern of the coastal areas has already been reached. The magnitude of differences is, however, still uncertain. This has to do with the absence of reference areas and a large time-lag of results from affected areas that are not followed-up after measures have been taken. It is of vital importance to get the regional background established before the next step is taken, which is a programme for evaluation of status as a base for parallel following-up of trends.

There should be **areas dedicated for trend monitoring** in the future. It is quite clear that the frequency of some variables in the polluted areas should be adjusted to inertia of the system studied. As an example could be mentioned the bathymetric distribution of the algal belt.

The frequency indicated in the Table 1 should take into account, amongst others, the recommendations given for statistical treatment of the material studied.

The following-up of measures taken, e.g. by a reduction of inputs into an area, is of importance for the programme dedicated for trends. To increase the effectiveness of such a monitoring in relation to available resources, the peripheral areas of obvious disturbances or effects, and where early changes are to be expected, should be selected.

Finally it is underlined that the **laboratories participating in the CMP should participate also in the ongoing QA-programmes**, e.g. in the two biological intercalibrations in 1995.

COASTAL MONITORING PROGRAMME, AN OUTLINE OF THE PROGRAMME AND THE PRESENT STATUS OF THE ACTIVITIES WITHIN THE CONTRACTING PARTIES

ASPECTS	VARIABLES		frequency	DK	EE	FI	DE	LV	LT	PL	RU	SE
GENERAL	- temperature	mandatory	>monthly	x	x	x	x	x	x	x	x	x
	- salinity	mandatory	>monthly	x	x	x	x	x	x	x	x	x
	- oxygen/hydrogen sulphide	mandatory	>monthly	x	x	x	x	x	x	x	x	x
	- Secchi depth (light attenuation)	mandatory	>monthly	x	x	x	x	x	x	x	x	x
EUTROPHICATION	- nutrients; open coast NO_2-N, NO_3-N, NH_4-N, tot-N PO_4 P, tot P Si	mandatory	>monthly in winter	x	x	x	x	x	x	x	x	x
	- nutrients, inner coast NO_2 N, NO_3-N, NH_4-N, tot N PO_4 P, tot-P Si	mandatory	>monthly together with phytopl.	x	x	(x)	x	x	x	x	x	x
	- microbiology, number, production	tentative		nd	d	x	(x)	x	x	(x)	x	nd
	- phytoplankton, spec. comp., abund., biom.	tentative		x	x	(x)	(x)	x	x	p	x	(x)
	- phytoplankton, dom. and toxic spec.	mandatory	adequate sampling to follow the year cycle				x					x
	- chlorophyll-a	mandatory	>monthly	x	x	x	x	x	x	p		x
	- primary production	tentative		x	p	x	o	d	x	(x)		x
	- zooplankton, spec. comp., abund., biom.	tentative		x	p	d	o	x	x	d	x	o
	- macrophytobenthos, spec. comp., abund., depth distr., biom.	mandatory	<1/year	x	x	p	p	d	p	p	o	x
	- zoobenthos, spec. comp., abund., biom	mandatory	1/year	x	p	x	x	x	x	(x)	x	x
	fish, spec. comp., abund., size distr	tentative	1/year	(x)	x	x	d	x	p	p	o	x

ASPECTS	VARIABLES		frequency	DK	EE	FI	DE	LV	LT	PL	RU	SE
CONTAMINANTS												
radionucl	- see MORS											
metals	- sea water/surficial sediment: Zn, As, Cr, Ni, Cu, Cd, Pb, Hg	tentative		d/(x)	d/(x)	d/(x)	x/x	(x)/x	d	d/nd	p p	nd/d
	- green algae (Cladophora), Cu, Cd, Pb	tentative	l/year	?	d	nd	nd	nd	d	d	o	d
	- blue mussel (Mytilus), Cu, Cd, Hg, Pb	mandatory	l/year	?	nd	d	d	x	d	d	o	x
	- Macoma, Cu, Cd, Hg, Pb	tentative		?	x	x	nd	x	d	nd	o	nd
	- Saduria, Cu, Cd, Hg, Pb	tentative		?	nd	x	nd	(x)	d	nd	o	nd
	- perch, muscle Hg	mandatory	l/year	?	x	d	nd	p	d	nd	o	x
	liver Cu, Cd	tentative	l/year	?	x	d	nd	p	d	nd	o	x
	- flounder, liver Cu, Cd	tentative	l/year	?	nd	d	nd	p	d	?	o	nd
	- viviparous blenny, muscle Hg	mandatory	l/year	?	nd	d	d	p	d	d	o	x
	- common tern, eggs, Hg	tentative	l/year	?	nd	d	d	o	nd	nd	o	d
organ tox *)	- sea water/surficial sediment: toxaphene, DDT, coplanar CBs, PAHs, dioxins, org-tin, AOX	tentative		nd/d	x	d	x	o/o		(d)/d	(x)/(x)	nd
	- blue mussel, DDT, PCBs/CBs, γ HCH, HCB	mandatory	l/year	d	d	d	d	o	o	d		x
	perch, DDT, PCBs/CBs, γ HCH, HCB	tentative	l/year	?	x	d	nd	o	o	nd	o	x
	- viviparous blenny, DDT, PCBs/CBs, γ-HCH, HCB	mandatory	l/year	?	d	d	d	o	o	d	o	x
	- common tern, eggs, DDT, PCBs/CBs,γ-HCH,HCB	tentative		?	d	d	d	o	o	nd	o	d
											o	
biological effects monitoring	- fish, pollutants/diseases	tentative				d						d
	- fish species comp., abund., size distr.	tentative				d						x
	- perch, biomarkers	tentative				d						d
	- viviparous blenny, reproduction	mandatory	l/year			d						x
HEALTH	- microbiology	mandatory	see regulations	x	x	x	x	x	x	x	?	x

Explanations:

x = done already
p - planned
d = desirable
nd - not desirable
o = no possibility at all, in near future
*) = only some organ. tox. measured, not all)

Existing studies on salmon, guillemot eggs and seals are encouraged to be continued in those Contracting Parties where studies have been initiated. Biological effects monitoring is not ready for monitoring stage yet, however, the Contracting Parties are encouraged to do the studies on research basis. The Contracting Parties are also encouraged to look the reproduction state of e.g. viviparous blenny.

COMMENTS ON NATIONAL COASTAL MONITORING PROGRAMMES

The structure of a Coastal Monitoring Programme (CMP), presented in the Table 1, has been discussed at a Meeting of the *ad hoc* Working Group in Riga in May 1994.

The proposal reflects a series of experiences - the running national programmes, principles considered at the Workshop on Revision of the BMP in Copenhagen (EC 5/7 1b/1), results gained by the assessment of coastal areas (HELCOM Proc. No. 54) and decisions taken on priorities at Ministerial level (HELCOM 15/18).

The presented version is considered and accepted by the national representatives of the *ad hoc* Working Group for presentation at the EC Meeting, 1994. It should, however, be kept in mind that various details of techniques, methods, etc. will be taken up for further discussion within the framework of the COMBINE.

The positions taken by the members of the CMP WG, directly or by correspondence, include a series of explanatory comments of activities from "already done" to "not possible in the near future". This original structure is maintained in the presented material. The five alternatives given (question-marks not included) should be regarded as a first step taken, and to be the subject for further considerations.

Some of the problems and reasons for hesitation of the inclusions of specific parameters or techniques might be solved by a more distinct time table or a distinction between monitoring routines, pilot surveys and research projects. Other areas for clarification are the possibilities of an exchange of material between countries and/or laboratories, arguments for a complete or reduced programme in certain coastal areas, etc.

Mandatory activities are proposed within all main monitoring items:

* General background variables
    temperature, salinity, oxygen, Secchi depth
* Eutrophication
    nutrients: open and inner coasts
    chlorophyll-a
    phytoplankton
    macro-phytobenthos
    zoobenthos
* Contaminants
    metals: Mytilus, Perch, Blenny
    organic tox.: Mytilus, Blenny
* Biological effects monitoring
    reproduction: Blenny
* Health
    microbiology, etc.

Some deviations occur in the national programmes performed today, concerning sampling frequency, occurrence of indicator organisms, etc. Information on such variabilities is available for further harmonization and development of a common Coastal Monitoring Programme in the future.

RECOMMENDATIONS

The First Meeting of the ad hoc Working Group on Coastal Monitoring agreed upon the following recommendations:

1. EC works out a Quality Assurance Policy which should be the basis for the accreditation procedures. QA procedures should also include the coastal monitoring programme and the laboratories providing data for the CMP should participate in the present ongoing QA-activities.

2. EC requests the Contracting Parties to collect and compile data on hygienic conditions of inner and open coastal waters and to make the data available to the HELCOM database. Furthermore, the procedures used should be harmonized (e.g. following the revised Guidelines for Bathing Waters by the European Commission).

3. To fulfil the demands of EC-Nature for monitoring activities, reference stations should preferably be chosen within the Baltic Sea Protected Areas (BSPA).

4. EC requests ICES to consider and evaluate the effects on the Baltic Sea coastal areas caused by bottom trawling.

5. EC defines a more precise approach to and definition of the monitoring of biological effects .

6. EC requests TC to provide (annually) pollution load data from rivers and direct inputs compiled on a monthly basis.

7. The same time-table and procedure as proposed for the BMP by the Copenhagen Workshop (Annex 3 of the draft report of the Workshop) should be applied for the development of the CMP to ensure the correct compilation.

Table 2.

VARIOUS PARAMETERS AND TRANSPORTED MATERIAL IN RIVERS, MEASURED OR CALCULATED, TO THE CONVENTION AREA DURING 1992

Parameter	Unit	DK	EE	FI	DE*	DE#	LV	LT	PL	RU*	RU#	SE	Needed for CMP
Frequency	y^{-1}	12	12	12	13	13	12	12	24	?	?	12	
I PHYSICAL QUALITIES													
Flow rate	m^3/s	x	x	x	x	x	x	x	x	x	x	x	+
Temperature	°C	x	x	x	x	x	x	x	x	x		x	-
pH		x	x	x	x	x	x	x	x	x		x	-
Conductivity	µS/cm				x	x				x			-
Conductivitiy	mS/m		x	x								x	-
Turbidity	mg/l			x					x	x			-
Abs. difference	420/5											x	-
Susp. mat.	mg/l		x	x	x	x	x	x	x	x	x		–
Diss. mat.	mg/l								x				-
SAK254nm	1/m				x	x							-
SAK436nm	1/m					x							-
Colour	mg/l		x	x			x		x	x			-
Abs. filt.	420/5											x	-
Abs. unfilt.	420/5											x	-
II OXYGEN													
O_2	mg/l		x	x	x	x	x	x	x	x			-
O_2 sat.	%		x	x	x	x	x	x		x			-
III ORGANIC MATTER													
COD(Mn)	mg/l		x	x	x			x	x	x	x	x	-
COD(Cr)	mg/l		x				x	x	x				-
$KMnO_4$	mg/l								x			x	-
DOC	mg/l				x	x							–
TOC	mg/l			x	x	x			x			x	–
Org C	mg/l			x					x				-
BOD_5	mg/l	x			x		x	x	x	x	x		–
BOD_7	mg/l		x	x		x	x	x		x	x		
BOD teor	mg/l					x							-

'arameter	Unit	DK	EE	FI	DE*	DE#	LV	LT	PL	RU*	RU#	SE	Needed for CMP
V MAJOR IONS													
.a	mg/l		x	x			x	x	x	x		x	-
1g	mg/l		x	x			x	x	x	x		x	-
ıardness	mg/l		x					x	x				-
ıa	mg/l		x	x			x	x	x	x		x	-
	mg/l		x	x			x	x	x	x		x	-
:CO_3	meqv/l		x					x		x		x	-
.lkalinity	mmol/l	x		x				x					-
	mg/l		x	x	x	x	x	x	x	x		x	-
O_4	meqv/l		x	x			x	x	x	x		x	-
(diss)	mg/l		x	x			x	x				x	+
NUTRIENTS													
H_4-N	mg/l		x	x	x	x	x	x	x	x	x	x	+
O_2-N	mg/l	x	x	x	x	x	x	x	x	x	x	x	+
O_3-N	mg/l	x	x	x	x	x	x	x	x	x	x	x	+
ıeld-N	mg/l								x			x	
ɔt-N	mg/l	x	x	x	x	x	x	x	x	x	x	x	+
O_4-P	mg/l	x	x	x	x	x	x	x	x	x		x	+
ɔt-P	mg/l	x	x	x	x	x	x	x	x	x		x	+
ɔt-P diss	mg/l			x									-
TRACE ELEMENTS													
	µg/l	x	x	x			x	x	x	x		x	-
	µg/l			x				x	x	x		x	-
	µg/l			x				x					-
	µg/l			x	x	x		x	x	x			-
	µg/l			x	x	x		x	x				+
	µg/l		x	x	x	x	x	x	x	x	x	x	+
	µg/l		x	x	x	x	x	x	x		x	x	+
	µg/l		x	x	x	x	x	x	x	x		x	+
	µg/l		x	x	x	x	x	x	x	x	x	x	+
	µg/l			x	x	x							+
	ng/l		x	x	x	x		x	x	x	x	x	+
	µg/l			x									-

Parameter	Unit	DK	EE	FI	DE*	DE#	LV	LT	PL	RU*	RU#	SE	Needed for CMP
VII ORGANIC CONTAMINANTS													
PCBs/CBs	ng/l					x			x				-
DDT	µg/l						x	x	x	x			+
DDD	µg/l						x	x	x				+
DDE	µg/l						x	x	x	x			+
DDT (sum)	µg/l								x				-
DMDT	µg/l				partly				x				-
lfa-HCH	ng/l					x	x	x		x			-
eta-HCH	ng/l					x		x					-
amma-HCH	ng/l					x	x	x	x	x			-
HCB	ng/l					x							+
enole	mg/l		x		x			x	x	x			-
eterg anion	mg/l							x	x	x			-
VIII PRODUCTIVITY													
hloroph-a	µg/l			x	x								-

* Mecklenburg-Vorpommern
\# Schleswig-Holstein
* At Gulf of Finland
\# Kaliningrad area

COMMENTS ON THE NATIONAL RIVER PROGRAMMES (Table 2)

Further discussions must be held concerning the co-ordinated River Programme within COMBINE. This includes all activities, from establishment of guidelines for sampling, measurements and reporting to the over-all quality assurance. In this context, some notations could be given of interest for future work.

GENERAL

Some parts of the national programmes are under consideration and/or will be reported at the EC-meeting in 1994. This is valid for the total programme in the Kaliningrad area and details concerning organic contaminants in rivers from the area of Mecklenburg-Vorpommern and Sweden.

The programmes reported by the various countries cover the main riverine flows to the Baltic. Maps of actual rivers in the national programmes are given by some, but not all, countries. Some have also given an example of transport by at least one river of importance to the Convention area. This information should be followed up at the next stage of analysis together with the specific variables followed in the various rivers.

In all countries the frequency of measurements in rivers are at least 12 times per year. This covers the main physical/chemical parameters of relevance for the reporting, interpretation and intercomparison of results. Deviations from these routines might apply to automatically gathered information by higher frequency (flow rate, temperature, etc.) or specific elements among contaminants with a lower frequency.

TECHNIQUES IN USE

Various methods are demonstrated in the overview, offering information about the same main characters of river waters. This should be an objective for further elaboration. Some countries have also identified the analytical methods used of interest for detailed comparisons.

Some examples:

Under the heading of physical qualities "Turbidity, Suspended matter and Absorbtion difference (Abs. unfil. minus Abs. filt.)" are expressions of the same character of the water which can be regarded as synonyms even if the values are not always directly transformable/ comparable. The visual estimation of "Colour" belongs to the same category. There are arguments for an agreement of SAK 436 (a spectral absorbtion coefficient) as the common expression. "Dissolved matter" is another expression which might be transferred to the total of "Major ions".

There is a set of expressions for the content of organic matter in the river water. The value for $KMnO_4$ is transformable to Chemical Oxygen Demand, COD(Mn) by a certain factor. COD(Cr) is mainly used in waters with a higher content of organic material. Analyses of DOC/TOC are not to the same degree affected by interference with chlorides, which is of advantage for the analysis of waters in estuarine areas and can operate over a wide concentration range.

The BOD is an expression of the Biochemical Oxygen Demand from 5 or 7 days. The relevance of these values for the open Baltic can be discussed. They might, however, be of importance for the status of estuaries or isolated local coastal areas.

Under the heading of major ions there are a variety of units indicated which have to be standardized. The often-used expression "hardness" must be identified, e.g. as CaO or $CaCO_3$. Alkalinity and HCO_3 are synonyms.

A variety of units are also used in the scientific literature for nutrients and sometimes also for trace elements and organic contaminants.

In all cases where different units are being used there has to be an agreement on a common standard in the reporting formats followed by all countries to the benefit of the routines.

CONCLUSIONS

The necessity of a standardization of methods, reporting formats, etc. has been pointed out several times above and is underlined within the general quality assurance policy.

Even before analysis of details in the presented material, the main pattern of parameters can be discerned in the national programmes.

Some physical measurements such as water-flow, temperature and pH are well represented in the programmes as well as oxygen and most fractions of the nutrients.

A series of metals is also included in most programmes, of which cadmium and mercury have been given the highest priority by the Commission for measures to be taken in the future.

Some major ions and unified methods for expression of organic matter seem close to an agreement of inclusion in the programmes.

The organic contaminants are rather scarcely represented in the river programmes. The possibility to reach comparable and relevant results in the analysis of these elements in river water can be expected to be the subject of further discussions by experts.

BALTIC MARINE ENVIRONMENT PROTECTION COMMISSION - HELSINKI COMMISSION -

Environment Committee (EC)
Fifth Meeting

EC 5/ 7.2/2
11 October 1994

Nyköping, Sweden
10-14 October 1994

Agenda Item 7.2 MONITORING PROGRAMME FOR COASTAL WATERS

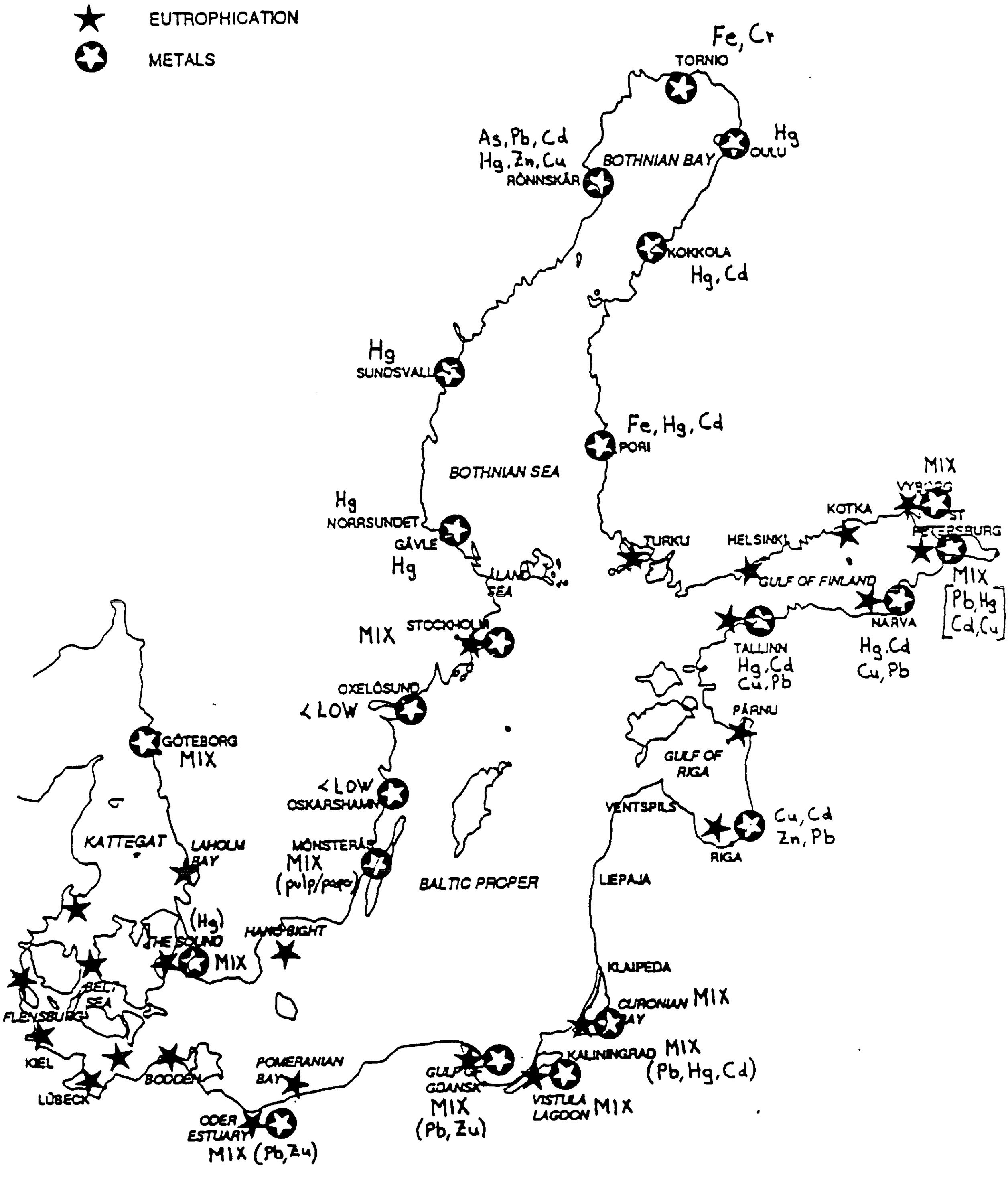
Information on specific heavy metals of concern in problem areas identified in the coastal assessment

Submitted by the Convener of the ad hoc Working Group on Coastal Monitoring, Ulf Grimås

With reference to the request by the EC/TC-Chairmen meeting, the attached information on specific heavy metals of concern in the coastal areas have been compiled on the basis of the information in the Coastal Assessment (BSEP No. 54) and national information by the ad hoc Working Group on Coastal Monitoring.

BALTIC SEA ENVIRONMENT PROCEEDINGS
No. 54
FIRST ASSESSMENT OF THE STATE OF
THE COASTAL WATERS OF THE BALTIC SEA
HELSINKI COMMISSION
Baltic Marine Environment Protection Commission
1993

Figure 66. Main problem areas indicated in national reports.



ANNEX 8

REFERENCE AREAS IN COASTAL MONITORING (HELCOM)

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New Draft/13 March 1995

Objectives

There is a demand for establishment of reference areas in the coastal zone, one important aim being to facilitate distinction between natural and artefact conditions.

Reference areas should provide information on natural long-term and short-term background variabilities in the environment. This should be done in parallel with the monitoring of affected areas. It is of importance to ensure that also exceptional and extreme conditions are included in the background material to enable correct interpretation of results.

The adjustment of observations to normal conditions is inevitable if correct and adequate measures are to be taken. For example, oxygen deficit during a short period, conditioned by a general overload of organics and stagnation of water transports, has an immediate and far-reaching effect over large sea areas and should be approached by other means than locally induced, unsatisfactory water quality.

This is not an under-estimation of local problems. On the contrary, the Coastal Assessment and the inclusion of the Coastal Margin into the interests of the Convention, emphasize the particular importance of acceptable quality of the coastal zone, e.g. for such vital activities as recreation, fisheries, etc. It is also quite clear that purposeful handling of the coastal problems renders positive effects comparatively rapidly in the local area and, in the long run, also in the open sea.

The given example underlines the need to elucidate aims and means in monitoring activities of reference areas. In the discussion of the background for a reference monitoring programme, it was suggested that explanations of mechanisms like long-term eutrophication in the open sea could be looked for in open coastal areas. Direct reference to a related, coastal ecotype being influenced by such effects should, however, be of primary importance for the introduction of this kind of monitoring programme on a reasonably broad scale.

Classification of aims and means of reference

It has been suggested that the areas dedicated as Baltic Sea Protected Areas (BSPA) should preferably be used when selecting reference areas for monitoring activities. For this process, the large numbers of nominated BSPA have to be taken into account and the reasons for their designations considered. The reverse proceedure should be examined; the designation of already selected marine reference areas to be included in the series of BSPAs.

In parallel, a wish has been expressed for establishment of monitoring procedures in the BSPA as such. The aspects of such programmes differ in objectives and basic requirements compared with over-all aims. Specific conditions, linked to the selection proceedure are often of particular national interest and should be operated as such. It is expected that their individualities should be followed up by certain profiles within an investigation programme of relevance for the objectives. The menu and techniques for the aquatic investigations are given in the general marine monitoring programme. The structure of the programmes should be decided by relevant national authorities.

For many reasons it could be wise to make a distinction between the two investigation activities; in the general reference areas and in the BSPA. The former are included in the international routines of "general monitoring activity", the second is a national "directed status control". The directed control areas might be followed by a few parameters of interest and with a flexible frequency. The results are still of great value for the understanding of existing water quality in interaction with routine monitoring. The term "directed status control" is just a proposal. Other proposals are welcome.

Certain criteria should then be established for designation of the true international General Reference Areas in monitoring.

Principles for selection of General Reference Areas

After defining the objectives of the monitoring efforts - of national interest or of general and theoretical importance - a site selection for monitoring of marine reference areas should be made. The "background" or "not affected" condition of the Baltic coastal waters is, of course, impossible to find as an infallible reference. On the other hand, there are areas with acceptable water quality conditions, which might function as reference areas.

Some general criteria have been used in the northern Baltic and could be recommended to meet in the Convention area as a whole:

* THE AREA REPRESENTS AN IMPORTANT PROTOTYPE OF A RELEVANT COASTAL ENVIRONMENT

* THERE ARE NO LOCAL DISTURBANCES , E.G. BY POINT SOURCES

* THERE IS A WELL DEVELOPED BENTHIC FLORA AND FAUNA

* POPULATIONS OF STATIONARY ORGANISMS, E.G. FISH SPECIES, MUST OCCUR

* THERE ARE BASIC CONDITIONS FOR EXISTING OR POTENTIAL POPULATIONS OF TOP PREDATORS, I.E. MARINE BIRDS AND MAMMALS

* THE AREA IS LARGE ENOUGH TO ENSURE THAT THE PROBABILITY OF IRREGULAR IMPACT FROM SURROUNDINGS IS LOW; NOW AND IN THE FUTURE

Among the criteria should also be mentioned the value of existing, basic information by long-term series of environmental data. It should, however, be kept in mind that misuse of such material has to be avoided, e.g. from such areas followed by routine measurements because of other reasons than those dedicated to documentation of natural background conditions.

Some reflections on representativity and future monitoring strategy

The state of the water areas of the Convention is heterogeneous. There are extremes representing geographical differences from north to south, e.g. in climate and salinity. It is also self-evident that natural background conditions like morphometry have an impact on the state and reactions of the coasts.

The prevailing conditions within geographical zones are dictated by the "inherited" natural qualities and those "acquired" by human activities. The series of artificial impacts, layered upon the background characteristics, increase the spectrum of patchiness in function or status of media and biota. In turn, this affects the needs and means of monitoring and relevance of references.

Irrespective of the reason, the question thus arises to what degree the selection of general reference areas and, on a larger scale, the monitoring strategy and technique, should be influenced by similar or specific environmental conditions, inherited or acquired. It seems reasonable that a system of geographical sub-programmes should be considered and formulated, based on equivalent characters.

With reference to the results presented in the assessment of the status of the coastal zone there is a large-scale pattern illustrating three main categories of areas; the western outlet region affected mainly by eutrophication, effects of metals in the northern part and a combination of both agents in the south/eastern parts. This could be one example relevant for the aims of status control in local areas.

Such a sub-system should be considered for a general approach of monitoring as well as assessment and, thereby, with relevance also for the designation of general reference areas in the coastal zone.

ANNEX 9

PROGRESS IN THE REVISION OF THE HELCOM BALTIC MONITORING PROGRAMME (BMP)

Background

The Helsinki Commission (HELCOM) has instituted several monitoring activities, including chemical and biological monitoring of the open sea areas of the Baltic (BMP), monitoring of radioactive substances in the same areas, as well as monitoring of airborne pollutants to the Baltic Sea. A special form of monitoring is also the pollution load compilations that have been carried out twice with the aim of quantifying input via rivers and other sources along the coastlines. Furthermore, HELCOM is now in the process of developing a harmonised coastal monitoring programme (CMP).

In 1991 HELCOM decided to strengthen the management of its monitoring and that, therefore, all its continuous monitoring activities should be coordinated by its Environment Committee (EC) under a new umbrella called Cooperative Monitoring in the Baltic Marine Environment (COMBINE).

The BMP was started in 1979. The aims of the programme were defined as "*to follow the long-term (annual and longer periods) change (trends) of selected determinands in the Baltic ecosystem*". However, in the general sense the programme expressed a broader goal: to "*provide data for the preparation of a more comprehensive assessment of the state of the Baltic marine environment*" (Baltic Marine Environment Proceedings No. 27B). According to this broad concept of monitoring, the programme included from its start both repeated measurements of known pollutants and measurements of natural components and properties of the sea indicative of the ecological condition of the sea area.

The BMP has now been in operation for more than 15 years. The programme has been implemented in periods of five years. The two periodic assessments of the monitoring data have provided feedback to the monitoring and the programme and, accordingly, its Guidelines document has been revised twice. A third periodic assessment is currently being prepared.

The EC decided in 1990 that the BMP could be revised on a more continuous basis and should no longer be limited by the five-year periodicity. EC also started this revision process and decided that a revised BMP should contain a minimum "core" programme which should be mandatory for all member countries plus a voluntary part.

This latter part should comprise more problem-oriented or project-oriented campaigns. In the absence of a better alternative, "baseline studies" was accepted as a generic term for this part. In such baseline studies, member countries would take part according to capacity, expertise and other resources, but the results should be available for all member countries. This baseline part would include measurements of new determinands (chemical/biological/biological effects) and additional measurements of existing determinands for which there is limited information. The ICES/HELCOM Baseline Study on Contaminants in Baltic Sea Sediments is the first of such problem-oriented voluntary monitoring activities.

When EC created COMBINE, the aims/objectives for this overall monitoring were defined as "*To identify and quantify the effects of existing anthropogenic discharges/activities in the Baltic Sea, in the context of the natural variations in the system, and to identify and quantify the improvements in the environment as a result of regulatory actions*". Furthermore, it was agreed that the BMP (as well as CMP) should focus on eutrophication and its effects (also taking into account the natural hydrographic variations) and on contaminants in biota and the effects of these contaminants. The objectives were:

<u>*For hydrographic variations:*</u> *To set the background for all other measurements related to the identification and quantification of the effects of anthropogenic discharges/activities. The parameters providing an indication of natural fluctuations in the hydrographic regime of the Baltic Sea must therefore be monitored on a continuous basis.*

<u>*For problems related to eutrophication:*</u> *To determine the extent and the effects of anthropogenic inputs of nutrients on marine biota.*

<u>*For contaminants in biota:*</u> *To compare the level of contaminants in selected species of biota (including different parts of their tissues) from different geographical regions of the Baltic Sea in order to detect possible contamination patterns, including areas of special concern (usually known as 'hot spots'),* <u>*and*</u>

To measure levels of contaminants in selected species of biota at specific locations over time in order to detect whether levels are changing in response to the changes in inputs of contaminants to the Baltic Sea, and

To measure levels of contaminants in selected species of biota at different locations within the Baltic Sea, particularly in areas of special concern, in order to assess whether the levels pose a threat to these species and/or to higher trophic levels, including marine mammals and seabirds.

For the effects of contaminants: To carry out biological effects measurements at selected locations in the Baltic Sea, particularly at sites of special concern, in order to assess whether the levels of contaminants in sea water and/or suspended particulate matter and/or sediments and/or in the organisms themselves are causing detrimental effects on biota (e.g., changes in community structure).

Recent and Future Developments

The HELCOM EC convened the Workshop on the Revision of the Baltic Monitoring Programme (BMP) and Guidelines to meet these new objectives. The Workshop was held in Copenhagen, 2–6 May 1994, under the chairmanship of Stig Carlberg (Sweden).

The results of the Workshop were presented in a document to the WGEAMS meeting [WGEAMS 1995/10/2].

The Workshop elaborated a rather complete proposal for the monitoring of contaminants and their effects; this is further described in Annex 4B of the workshop report mentioned above.

Concerning monitoring of eutrophication and its effects, the experts identified a number of items that were of relevance for the BMP. However, it was also recognized that conditions are different in the different parts or subregions of the Baltic Sea and that, therefore, the programme must be flexible enough to accommodate these differences. Thus, it was agreed that the proposed programme (see Annex 4A in the workshop report) should be seen as a "joint maximum programme". It was further agreed that this proposal should be used as a "menu" and that the Member Countries should refer to this menu in their elaboration of proposals for monitoring in the respective sea areas for which they have a primary or shared responsibility for open sea monitoring. These proposals should be sent to the HELCOM Secretariat by 31 December 1994. Several of the proposals were still not submitted by the end of February 1995.

The Workshop agreed that these national proposals should then be used by the chairman and subgroup chairmen of the Workshop, together with the HELCOM Environment Secretary, to draft a harmonized proposal for a revised BMP. This, and the related guidelines document and quality assurance procedures, should then be finalized at a second workshop to be held in the spring of 1996. The results of the second workshop should then be discussed and decided on by the HELCOM EC in October 1996, with a final decision taken by the Helsinki Commission in early 1997. The new programme could then enter into force, e.g., as early as 1 July 1997. This plan is schematically represented in Appendix 1.

The HELCOM EC agreed to this plan and timetable (see extract from the relevant summary record as presented in document ICES WGEAMS 1995/10/3). The HELCOM EC also decided that laboratories reporting to BMP/CMP should introduce in-house quality assurance procedures, including appointing a person responsible for relevant quality assurance work. Finally, the HELCOM EC agreed on a quality assurance policy and will propose this as a policy for all work related to monitoring and pollution load compilations in HELCOM. Incidentally, this quality assurance policy is identical to the policy adopted by the Oslo and Paris Commissions a few years ago.

In the process described above, it has become evident that some of the Member Countries are in the process of revising their national monitoring programmes and this work has delayed their proposals concerning the revised BMP. More serious than the delay itself is the "reverse" timing between the national and the international efforts to revise the monitoring programmes. If national programmes are redefined first, this has as a worst case the potential of turning the revised BMP into a patchwork of non-harmonized national contributions. This would, of course, make the international programme less useful, less cost-effective, and very difficult to coordinate.

However, as can be seen in Appendix 1, there are several other activities that parallel what has been described above. The workshop identified a number of issues, e.g., the number of fish required as a sample for analysis of contaminants in biota, on which statistical power analysis of existing monitoring data would provide the basis for advice in the revision process. The workshop, therefore, requested ICES as well as the statistics group working on the HELCOM Third Periodic Assessment to do such analyses as further described in Annex 3 of the workshop report. It can also be expected that the ongoing assessment work will identify the need for other improvements in the monitoring programme.

ICES is responsible for a very comprehensive input to the ongoing revision process. The sediment baseline study was mentioned above. Furthermore, there are the ICES/HELCOM Steering Group on Quality Assurance of Chemical Measurements in the Baltic Sea (SGQAC) and the ICES/HELCOM Steering Group on Quality Assurance of Biological Measurements in the Baltic Sea (SGQAB). The first group conducted a very successful workshop in Hamburg (October 1993) and the second group is conducting a series of workshops and intercomparison exercises concerning pelagic and benthic biology in 1994 and 1995. Finally, the QUASIMEME project has agreed to supply intercomparison samples for chemical analyses of nutrients in sea water and contaminants in biota and sediments as an unofficial extension of the QUASIMEME project in support of the work of the SGQAC mentioned above.

ANNEX 10

ICES ROLE IN ENVIRONMENTAL MONITORING

1 REQUEST

The ACME was requested in C.Res.1993/2:7 "to provide advice relevant to the revision of monitoring programmes coordinated by regional pollution regulatory commissions and Member Countries and review the topic of monitoring strategies and programme design on the basis of materials produced intersessionally by relevant Working Groups and ACME members."

2 SOURCE OF THE INFORMATION PRESENTED

Monitoring programmes, their objectives, implementation, and constraints, have been discussed on a regular basis within ICES. In 1988, the ACMP examined the topic in detail based on a paper prepared that year by the WGEAMS on the "Philosophy, principles and strategy of monitoring". The 1992 ACMP Report again took up the subject of monitoring, in particular on deficiencies in the design and conduct of then current international monitoring programmes. In 1993, the ACME requested some of its members to prepare discussion papers on the issue of monitoring and the role of ICES/ACME in this area. Five papers were produced for the 1994 ACME meeting, and they were considered along with the 1994 WGEAMS advice as well as various references from ICES and in the open literature.

3 STATUS/BACKGROUND INFORMATION

a) Definition of monitoring

Before making recommendations on what the role of ICES/ACME should be in monitoring, it is essential to agree on a definition of monitoring. In its 1988 report, the ACMP adopted the following definition: "In the context of assessing and regulating environmental and human health impacts of anthropogenic activities, specifically the introduction of wastes, monitoring is the repeated measurement of an activity or of a contaminant or of its effects, whether direct or indirect, in the marine environment." The UNEP definition of monitoring is as follows: "Monitoring is the process of repetitive observing, for defined purposes, of one or more elements of the environment, according to prearranged schedules in space and time and using comparable methodologies for environmental sensing and data collection." The UNEP definition is broader than the previous one in which there was a focus on contaminants and wastes. The former definition is tied to anthropogenic change, while the latter applies to both natural and man-made change, and corresponds to the ACME's wide vision of the marine environment.

b) Objectives of monitoring

Monitoring programmes in the marine environment can be conducted at different scales (global, regional, local) and focus on various aspects (environmental quality, ocean climate, marine productivity). These programmes often suffer from a lack of focus on the key questions requiring answers as a matter of priority. This has led to data-rich, information-poor situations in many cases. A monitoring programme must address the right questions: Are the increased levels of nutrients the issue, or is the proliferation of algae the issue? Is the presence of contaminants the issue or is the issue the potential effects of certain contaminants on animals and humans? While all of the preceding are issues of scientific interest, not all are necessarily of interest to the customers of advice prepared by ACME.

This underlines the fact that monitoring can be conducted for a variety of purposes, depending on the customers and their needs. However, purposes for monitoring are often not clearly defined at the outset, resulting in a package the customer is not always willing to buy into. The following can be listed as various purposes for designing monitoring programmes:

1) To provide the information necessary to assess the impacts of specific natural variations and/or human activities;

2) To identify, describe and follow long-term patterns and trends in marine processes and ecosystems;

3) To judge the efficiency of regulatory measures or to ensure compliance with specific regulations, in order to assist in decision-making on matters concerning the quality of the environment.

Problems will often stem from the fact that scientists may try to combine several of the above purposes, while decision makers may generally want to support only one. Thus, the first challenge is to get all interested parties to agree on the purpose of a given monitoring programme, keeping in mind that monitoring and research must go hand in hand.

Even if the purpose is clear, this does not mean that there is no need for choices, prioritization, and trade-offs. The choices are not only scientific, they are also economic: a cost-benefit analysis is required along with the scientific considerations in the design of a monitoring programme. There may also be a need for risk analysis to help choose which aspects of environmental quality monitoring programmes could be dropped without consequences for public safety.

The ACME felt that these clarifications on the objectives of monitoring were also a prerequisite to making recommendations on the role of ICES in environmental monitoring.

4 NEED FOR FURTHER RESEARCH OR MORE DATA

The focus of these ACME discussions was kept on monitoring strategies and on the role ICES/ACME can play in this context for the ICES area. Specific points to consider in the design of monitoring programmes were not discussed, but will continue to require examination by ACME and ICES Working Groups on an on-going basis.

5 RECOMMENDATIONS ON THE ROLE OF ICES/ACME IN ENVIRONMENTAL MONITORING

ICES has long played an important role as an advisor on environmental monitoring programmes, as a leader in the intercalibration and standardization of sampling and analytical methods, and as the custodian of a large data bank. It is felt that, given its unique intergovernmental stature and technical expertise, ICES still has an important role to play in the field of monitoring for Member Countries and regulatory Commissions at a regional level in the ICES area.

Recognizing that ICES exists primarily to promote and conduct research and investigations in the marine environment, it is recommended that, with the ACME serving as the focal point, ICES pursue the following activities in environmental monitoring:

1) Continue to provide advice to customers on the need, objectives and design of monitoring programmes, and on the choice of cost-effective methodology;

2) Continue to provide advice on methods and on quality assurance and to conduct intercalibrations via various Working Groups;

3) Continue to explore the statistical aspects of monitoring;

4) Continue to provide data banking facilities;

5) Continue to evaluate the effectiveness of monitoring programmes;

6) Continue to be involved in the international definition of monitoring and its objectives, and play an active part in the design and implementation of global international monitoring programmes such as GOOS;

7) Promote the use of modelling with a view to optimizing the design of monitoring programmes and reducing costs;

8) Review major existing monitoring programmes as needed, and make recommendations on their future, using Working Group expertise or *ad hoc* groups as required;

9) Assess the most important marine environmental concerns within the ICES area over the next decade, and examine how best ICES strengths can be used in the cooperative design and implementation of an overall monitoring strategy.

Regarding the prescription of management action resulting from monitoring, the ACME could, if requested by customers, prepare options for action where necessary, thus taking on a role parallel to that of ACFM in preparing fisheries advice.

6 ADDITIONAL COMMENTS

a) It must be underlined that, in many of the activities listed in the previous section, ICES would be able to deliver the required products to its customers only if most or all costs were borne by those customers.

b) Since ICES seeks to establish and maintain working arrangements with other international organizations having related objectives, it should strive to ensure active coordination and cooperation, not only with regulatory Commissions and the EC, but also with organizations such as IOC, SCOR, UNEP and IMO involved in the marine environment. In this context, the ACME considers that active ICES participation in GOOS (Global Ocean Observing System) is particularly important.

ANNEX 11

RECOMMENDATIONS

To ACME

The Working Group on Environmental Assessment and Monitoring Strategies recommends that:

1) ACME support the conclusions of the WGBEC Strategy Document, and that WGBEC take into account the comments of WGEAMS in preparing a further version.

2) ACME encourage the greater integration of chemical and biological monitoring techniques, particularly since this leads to increased effectiveness and reduced costs of monitoring programmes.

3) Chemical analysis of macroalgae should not at this time be introduced as a mandatory component of international contaminant monitoring programmes, but that it could be included as a voluntary activity in appropriate circumstances.

4) The analysis of seabird eggs could be used, on a voluntary basis, in the monitoring of organic contaminants. Current data suggest that guillemots and common terns from selected colonies may be the most appropriate species, but that iterpretation of the data must take account feeding patterns, migrations, and lipid utilization and metabolism.

5) The existing guidelines on fish and shellfish monitoring relating to the proposed JAMP programme should be revised as indicated in this report.

6) ACME should adopt the revised table of spawning times of species used in contaminant monitoring.

7) ACME should strongly support the innovative and unified approach proposed for the new HELCOM BMP monitoring related to eutrophication, as it represents an opportunity to use new and sophisticated procedures in international cooperative monitoring activities.

8) ACME consider WGEAMS comments regarding implementation of the 1994 ACME Monitoring Strategy document.

9) ACME consider WGEAMS comments on strategies to address major environmental concerns foreseen over the next decade.

10) ACME support the initiatives of OSPARCOM to reconsider the report on background concentrations in environmental compartments.

11) ACME explore the feasibility of producing an annual report on the hydrographic conditions in the ICES area during the preceding year, and methods by which it could be made available to potential users.

To the ICES Council

12) the Working Group on Environmental Assessment and Monitoring Strategies (Chairman: Dr I. Davies, UK) meet for five days in March 1996 in Öregrund, Sweden to:

a) review developments following the OSPARCOM/ICES Workshop on Biological Effects Monitoring to be held in Aberdeen in October 1995 in relation to ICES advice on monitoring strategies;

b) assess the implications of the results of the ICES/HELCOM Baseline Study on Contaminants in Baltic Sea Sediments for future sediment monitoring strategies;

c) discuss developments in statistical aspects of monitoring, in relation to the new OSPARCOM and HELCOM programmes;

d) develop an approach to decision making regarding the appropriate power of temporal trend monitoring programmes;

e) report on the relative effectiveness of the preparation of Environmental Assessments on a regional or subject basis, in the light of experience in, for example, the North Sea and the Baltic Sea areas;

f) consider the current (revised) guidelines on chemical monitoring of fish and shellfish in relation to ICES advice on monitoring strategies;

g) discuss progress in the development of the HELCOM COMBINE (BMP and CMP);

h) undertake tasks arising from the joint meeting with WGSAEM in 1996.