Advisory Committee on the Marine Environment

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REPORT OF THE

ICES/HELCOM WORKSHOP ON BALTIC SEA SEDIMENTS: CONDITIONS AND CONTAMINANTS

Helsinki, Finland
14–16 April 1999

International Council for the Exploration of the Sea

Conseil International pour l'Exploration de la Mer

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1 INTRODUCTION

The ICES/HELCOM Workshop on Baltic Sea Sediments: Conditions and Contaminants (WKBSED) met in Helsinki, Finland from 14–16 April 1999 to consider the following terms of reference:

a) to carry out an overall review of the results of the Baseline Study of Contaminants in Baltic Sea Sediments;

b) to review the results of other relevant studies of Baltic sediments, particularly in relation to contaminant distribution and processes;

c) to prepare a multidisciplinary evaluation of these results and their implications for future monitoring of contaminants in Baltic Sea sediments [HELCOM 1999/4].

The Workshop structure consisted of a plenary session with reviews from on-going research fields of sedimentology in the Baltic Sea (Annex 1). The Workshop then divided into two Sub-groups: Sub-group 1 was given the task of reviewing the use of sediments in Baltic Sea monitoring; Sub-group 2 was given the task of reviewing research objectives considered most critical to the understanding of the processes and representativity of the chemical results.

The list of participants at the Workshop is appended as Annex 2.

The Chair, Dr Matti Perttilä, opened the Workshop at 10.00 hrs on 14 April 1999 by welcoming the participants and recalling the tasks of the meeting. He pointed out that one of the tasks as defined by ICES, to review the report of the Sediment Baseline Study from a multidisciplinary perspective, was for obvious reasons considered by the conveners to be out of the realistic reach of a three-day meeting.

The Workshop was opened with presentations on the state-of-the-art of several sectors associated with sediment studies, as well as the present status of the reporting of the 1993 Baseline Study of Contaminants in Baltic Sea Sediments, in relation to the HELCOM monitoring programme. These items were discussed further in two Sub-groups. A short synopsis is given below of the discussions in the Sub-groups as well as in the plenary session.

2 OUTCOME OF THE SUB-GROUP ON SEDIMENT RESEARCH (SUB-GROUP 1)

The Sub-group on Sediment Research was chaired by Markus Meili (Finland) and attended by:

Birger Larsen, Denmark
Jukka Mattila, Finland
Heikki Pitkänen, Finland
Jouni Lehtoranta, Finland
Vesa Gran, Finland
Katarina Leminen, Finland
Kaarina Laakso, Finland
Henry Vallius, Finland
Aarno Kotilainen, Finland
Sanna Riuttanen, Finland
Kaarina Weckström, Finland
Pentti Välipakka, Finland
Tuula Kohonen, Finland
Olavi Sandman, Finland
Matti Mälkki, Finland
Ari Laine, Finland
Leena Karjala, Finland
Jaana Räty, Finland
Liisa Tuominen, Finland
Hannu Haahti, Finland
Ann-Britt Andersin, Finland
Bärbel Müller-Karulis, Latvia
Thomas Noji, Norway
Lars Rahm, Sweden
Rolf Carman, Sweden
Sven Blomqvist, Sweden

Markus Meili gave information on the different dating methods that are in use in the Baltic Sea region. Cs-137 seems to give highly reliable and reproducible results. This seems to indicate the slowness of the different diffusion processes in the Baltic Sea sediments. However, it appears that ammonium may compete with caesium on the binding sites. In sites where the sedimentation rate is exceptionally high, several centimeters per year (e.g., Himmelsfjärd area in Sweden), even seasonal variations can be detected.

Per Jonsson completed the presentation by highlighting the use of sediment laminae for dating purposes. In general, laminated sediments should be more suitable for monitoring purposes than bioturbated sediments because of better depth/time resolution. Laminated sediments occur in offshore and archipelago areas of the Baltic Proper and the Gulf of Finland, and in the archipelago areas of the Gulf of Bothnia. The development of lamination is generally annual, giving in especially low sedimentation areas an edge over the isotopic age determination which requires sediment core slicing. In open Baltic Sea areas, the rate of sedimentation varies between 1 and 19 mm/y, and in archipelago/coastal areas between 4 and 60 mm/y. In the Stockholm archipelago, lamination occurs in the early 20th century in the inner parts, in the early 1960s in the central parts, and in the 1980s in the outer archipelago, indicating influence from the city. However, influence on the archipelago areas by the offshore conditions can also be evidenced. On the whole, the expansion of laminated sediments is an efficient tool when effect-related water quality criteria are to be established in the marine environment.

Lutz Brügmann gave an overview presentation on factors affecting trace element chemistry in sediments. He explained the combined effects of distance to pollution sources, transport, hydrography and redox potential, diffusion and other internal processes, as well as the generalized effects of the element's position in the periodic table.

Henry Vallius showed examples of recent studies on the distribution of elements in the Gulf of Finland, including some examples of the effect of sampling position on the variability of metal binding as indicated by different digestion methods.

Rolf Carman discussed the occurrence of nutrients in sediments and the processes they undergo. The burial patterns of carbon, nitrogen and phosphorus in soft-bottom sediments from all sub-basins of the Baltic Sea have been investigated. The highest total concentrations of carbon and nitrogen are found in the central deep part of the Baltic Proper. The concentration of inorganic carbon is normally far below 1 % in the entire Baltic Sea except for some localities with anoxic conditions where authigenic precipitation of mixed manganese carbonates occurs, for example, the eastern Gotland Deep. Manganese seems to be of essential importance for such precipitation. As is the case for carbon, a dominant proportion of nitrogen found in sediments is organically bound. For phosphorus, on the other hand, a dominant proportion is inorganically bound. The highest total concentrations are found in the eastern part of the Gulf of Finland and in the well-oxidized sediments of the Bothnian Bay and Bothnian Sea.

The organic C/N ratio is very stable vertically through the sediment at each location, indicating that the degradation of the organic matter in the sediment proceeds in a C/N proportion. The organic C/P ratio within the sediment departs considerably from the Redfield ratio, mainly due to more or less instantaneous releases of easily hydrolyzable organic phosphorus molecules.

Vesa Gran completed the discussion by presenting the results of recent studies on elemental ratios in the Gulf of Finland.

Liisa Tuominen told about the results from the EU-BASYS Sub-project 3b.2.3, where studies have been conducted on denitrification, pore water nutrient profiles, nutrient fluxes between sediment and water, sediment oxygen consumption, macro- and meiofauna and bacterial production in sediment. Generally, the denitrification rate was highest in the central Gulf of Finland, where a high peak of nitrate in the pore water was also observed. In the deep stations in the Baltic Proper, almost no nitrate was found in the pore water and the denitrification rate was very low. The main gaps in knowledge are the lack of information on near-bottom currents, the effects of episodic events, and layer models that are far from realistic. There are also some methodological gaps remaining.

Per Jonsson reviewed the present research status on organochlorines in sediments. In sites with high sedimentation rates, a similar temporal development can be detected in sediments as has been reported for biota, but there are marked spatial differences. EOC1 concentrations in the sediments are similar in the 1993 Sediment Baseline Study samples as compared to 1980 samples. The EPOC1/EOC1 ratio has increased four-fold during the 20th century. Both ΣPCBs and ΣPAHs show an atmosphere-induced distribution. The PAH discharges appear to have been diminishing, as the down-core depth for maximum ΣPAHs corresponds to around 1980. Thereafter, the concentrations have been decreasing. There are indications of increasing concentrations of PBDE. It appears also that most of the discharged EOC1 from pulp mills is stored in the sediments. Attempts to formulate a mass balance for the PCBs indicate that the annual burial of

ΣPCBs is approximately equal to the annual input from rivers, direct discharges and the atmosphere. The overall eutrophication of the Baltic Sea may have influenced the burial of halogenated compounds into the sediments.

Harri Kankaanpää showed results indicating that up to 90 % of the chlorinated substances in sediments may be of natural origin. Sunlight energy may be sufficient for chloride to be oxidized into chlorine, which in turn reacts readily with marine organic material (e.g., humics) to produce chlorinated substances. It also seems that the sum parameters EOX and AOX are not suitable indicators of pollution.

Lars Rahm discussed the effects of hydrographic changes on sediments. There are numerous signs of eutrophication in the Baltic Sea, but only a few systematic records are found. The sediments may act as environmental archives with regard to nutrients, but the capability to interpret the observations are very much dependent on our basic understanding of the large-scale changes that take place in the Baltic Sea drainage basin. Many of these changes will affect the biogeochemical and geological processes which are responsible for much of what is observed in the sediments.

Compared to the world's oceans, the Baltic Sea is shallow and thus the sediments play a more crucial role in its ecosystem. This is undoubtedly reflected in the sediments. However, since our analytical capability, with regard to nutrients, is limited to the period beginning with the end of the 1960s and forward, our time horizon is consequently relatively short. As an example, trend analyses on nutrients in the pelagial can only be carried out during this period. Nevertheless, we have been able to determine the major nutrient fluxes and sinks on a basin-scale. We have also been able to differentiate between the nutrients with regard to their characteristic time scales. However, if we want to go further back into history, we must use 'covariables' in order to extend our knowledge about the past.

Reliable hydrographic measurements exist from the end of the nineteenth century showing minor variations in temperature and salinity. The redox conditions, on the other hand, seem to have drastically changed in the deep basins from the 1950s onwards. This has been interpreted as the deep water response to increased nutrient load and increased primary production. This fits well-founded estimates of changes in nutrient load during this century (and especially since the 1950s). Despite an estimated substantial increase in phosphorus and nitrogen (but unchanged silica load), the primary production seems to have increased significantly less. However, we have good reasons to believe that the increase in load is a much longer process, probably running parallel with the increase in human population and agricultural production during the last two centuries. Some observations corroborating this hypothesis are found in a corresponding increase in concentration of biogenic silica in Baltic sediments. This may be caused by increased diatom blooms and deposition as a response to the increased nutrient load. Another change occurring since the 1950s is the intense regulation of rivers. This will certainly result in an increased nutrient load and thus also in silica retention. Hence, we see two anthropogenically caused processes counteracting each other, but acting on different time scales. This is just one illustration of the complex interplay between natural and manmade processes that control our environmental archives. The point is that the variations inherent in, e.g., sediment records easily hide the long-term impacts of human and/or natural origin, due to the lack of understanding of the entire drainage basin ecosystem.

Sven Blomqvist opened the discussion on sediment processes, introducing the function of phosphate and nitrate as the growth-limiting nutrients. In the freshwater environment, phosphorus usually limits primary production, whereas primary production in coastal waters is often nitrogen limited. Inefficient phosphate precipitation may explain this difference.

When shifting from anoxic to oxic conditions, Fe(II) is oxidized by oxygen. The subsequent simultaneous precipitation of iron and phosphate might be described as a process where phosphate ions are incorporated into iron-rich particles. The Fe/P ratio in the particles is determined by the dissolved Fe/P ratio in the anoxic water before oxygenation. Within the pH-range 7–8, the empirical relation is independent of salinity. The particles have a lower limiting Fe/P ratio of about 2, suggesting that an iron hydroxide phosphate complex is formed. Consequently, at least two iron atoms are needed to precipitate one phosphate ion. In this respect, the Fe/P ratio will control the extent to which phosphate can escape precipitation. A comparison of the dissolved Fe/P ratio, developed during anoxic conditions in various sediment-water systems, demonstrates significant differences between freshwater and marine environments. Fe/P ratios ≥ 2, necessary for efficient phosphate precipitation, were only found in fresh water. Brackish-marine systems were characterized by Fe/P ratios ≤ 2, and following oxygenation, by inefficient phosphate precipitation. Thus, with a Fe/P ratio below 2, there is not enough iron to precipitate all the phosphate, some of which will stay dissolved and potentially available for primary production.

Jouni Lehtoranta discussed the Fe/P relationship in sediments. In the eastern Gulf of Finland, P was mostly bound with iron in the surface sediment. Both the concentration and the proportion of iron-bound phosphorus decreased with sediment depth. In the sediment, total phosphorus concentrations decreased but total iron concentrations were constant with sediment depth. In pore water, total dissolved iron (TDFe) concentrations were lower than dissolved phosphate (DRP) concentrations although there was almost twenty times more total iron than total phosphorus in the sediment.

Both sediment and pore water results disagreed with phosphorus fractionation studies, which indicated that mobile phosphorus was iron-bound and released from iron compounds. It is evident that TDFe in the pore water is bound to iron sulphides. In general, the molar ratio between TDFe and DRP was lower than two in pore water. If TDFe and DRP are released in this ratio in anoxic conditions from sediment to water, there is not enough iron in the near-bottom water to bind phosphate when conditions turn oxic.

Heikki Pitkänen gave a presentation on the decreased sediment phosphorus-binding capacity in the eastern Gulf of Finland and its effects on concentrations in water. Sediments of the eastern Gulf of Finland act as an effective trap for the strong land-based loading of both N and P under good oxygen conditions, e.g., during the early 1990s. Under poor oxygen conditions after the mid-1990s, the sediment retention capacity for P has strongly declined which has increased phosphate concentrations both in near-bottom and euphotic layers and enhanced eutrophication and toxic algal blooms. Increased vertical stability explains a part of the decreased trend in near-bottom oxygen. However, it is possible that the strong increase in internal loading has also been affected by other processes. Explanations could be, e.g., the acceleration of the sedimentation rate of organic matter and/or the weakening of the P-binding capacity of deeper (permanently anoxic) sediment layers.

Markus Meili reported on transport processes of material between the coast and the open sea, mainly concentrating on the information obtained by the Cs-137 method. He was then followed by Matti Mälkki, who told about mineralogical studies carried out in connection with the EU-BASYS project. He has been using mineralogical evidence as a tracer for transport. It would appear that the transport process from basin to basin in the Baltic Proper area is difficult to follow, whereas there is clear evidence of a coast to open sea transport.

Oleg Andreev told about recent developments in the field of modelling ecosystem processes. He showed results obtained both to describe the transport process as well as to quantify the regeneration processes in sediment cores.

Åsa Danielsson spoke of the representativity of sediment sampling. A sediment sample is not a random value, although it may include a minor random component. The concentrations measured depend on both time and space, which are caused by, e.g., load, currents, redox conditions, deposition, and other processes in both the water mass and the sediments. Analyses of these dependencies will give additional information about the sediments and the processes governing them. Spatial information is often neglected in sediment studies, where often the distribution over sediment depth has been taken into consideration at only a few stations.

Good sampling is essential in sediment studies to obtain accurate measurements. It is very costly and should therefore be considered carefully before actually being carried out, e.g., to receive representative samples. Spatial information can be valuable for giving a better description of the sediments, to check for representativity, to identify processes of importance, to locate homogeneous areas and sources of contamination, to analyse covariation and dependence between variables and/or stations and to improve monitoring.

Perhaps the most commonly used scale concept concerns spatial trends. These often describe gradients from a certain location and may be used to analyse the effect of a known source. Other types of scales consider 'within-area patterns', e.g., due to currents, diffuse sources or deposition processes. One step further is to analyse spatial distributions. These show patterns within an area and may be used to identify sources, homogeneous areas, crucial processes and/or covariation between stations (or variables).

Not only is this spatial information of descriptive value, it may also be valuable in improving monitoring programmes. The aim is to achieve cost-effective sampling, where as much information as possible is extracted at a minimal cost. This can be achieved by including spatial information and knowledge from 'old' data.

To summarise, spatial information is significant from many different points of view. It is therefore important not only to analyse the temporal development (deep cores), but also to look more closely into spatial dependence. A common database, such as the one at HELCOM, will be fruitful for these kinds of studies.

Harri Kankaanpää continued this subject, discussing the accuracy of the ship positioning for sampling. By means of differential GPS, an accuracy of ± 5 m can be achieved under good conditions. Because of the complicated bottom topography in many areas of the Baltic Sea, this accuracy should be required as the first prerequisite to obtain repeatable results.

Eeva-Liisa Poutanen summarized the present status of the Helsinki Commission monitoring programme COMBINE. She also gave a summary of the results of the 1993 Sediment Baseline Study, as well as comments and criticism provided by the ACME. This item is more fully expounded upon in the report of Sub-group 2.

3 OUTCOME OF THE SUB-GROUP ON MONITORING (SUB-GROUP 2)

The Sub-group on Monitoring was chaired by Lutz Brügmann (Germany) and attended by:

Per Jonsson, Sweden
Szymon Uscinowicz, Poland
Hanna Kahelin, Finland
Tarja Pyykkö, Finland
Åsa Danielsson, Sweden
Harri Kankaanpää, Finland
Henry Vallius, Finland
Mintauts Jansons, Latvia
Thomas Leipe, Germany
Volker Weigelt, Germany
Heidi Ahola, Finland
Tuula Kohonen, Finland
Boris Winterhalter, Finland
Eeva-Liisa Poutanen, Finland, acted as secretary of the sub-group.

Baseline Study

The Sub-group recalled the aims of the HELCOM COMBINE programme (to identify and quantify the effects of anthropogenic discharges ... to identify and quantify the changes..) and noted that the new programme is more effects-oriented compared to the 'old BMP'.

The Sub-group recalled the history of the Baseline Study of Contaminants in Baltic Sea Sediments (SBS) and regretted that still after several years the work is not finalized and published. The Sub-group appreciated the huge amount of work done by several laboratories in analysing the sediment samples and, therefore, stressed the importance of having the meta data as well as the **original data** made available, most preferably on CD-ROM. In this connection, the Sub-group noted the difficulty of using the 'ICES sediment reporting format' and recommended that the data should be compiled using some commonly used PC program (e.g., Excel). To secure that the data are submitted in a compatible form, the Sub-group invited the Finnish Institute of Marine Research to consider their possibilities to elaborate an Excel-based format for the data collection.

The Sub-group expressed the view that, in the possible future work, data handling has to be agreed from the very beginning and the agreed procedures have to be followed.

The Sub-group was of the opinion that in the present draft report of the SBS there is plenty of valuable information. However, a lot more information could possibly be obtained from the existing huge amount of data by joint interdisciplinary in-depth interpretation.

The Sub-group stressed the necessity of having the first study finalized before any new efforts are initiated. Noting the problems in getting the draft report published by ICES, the Sub-group proposed as a possible solution to publish only a short summary together with the original data.

The Sub-group noted that since 1993, a great deal of new information has become available on Baltic Sea sediments which has to be taken into account when judging the outcome of the first SBS and elaborating recommendations for future activities.

Selection of proper sampling sites, comparable techniques of sampling, and interpretation of results were the topics which were found to cause problems and uncertainties in using sediments for the monitoring of contaminants.

Regarding **sampling sites**, the Sub-group noted that some of the sites investigated during the SBS appeared to be unsuitable for the sediment baseline study purpose. This fact became known, however, only at a stage when the cores had already been studied.

For **sample preparation,** the draft report of the SBS recommended no size fractioning (total sample). The Sub-group noted, however, that for heavy metals, it may be important for some sedimentation areas, e.g., in the southwestern Baltic Sea, to measure also the < 20 µm fraction and, therefore, accepted after a long discussion that both the total sample and < 20 µm fraction may be analysed for these parameters when deemed necessary. In order to be able to

compare the results, the Sub-group agreed that in addition to possible grain-size normalization for heavy metals, normalization using the contents of Al and/or Li (metals) and organic carbon (persistent organic contaminants) is recommended.

Regarding the **parameters** analysed within the SBS, the Sub-group noted that in some cases critical opinions have been expressed on the usefulness of some sum parameters such as AOX and EOX, whose analysis makes sense only in areas or transects close to sources.

In general, the Sub-group was of the opinion that the vertical distribution of contaminants resulted in reliable information on historical patterns of the contamination of the Baltic Sea in the order of decades, and in some areas (laminated sediments) even within years.

For organic contaminants, e.g., PAHs, DDT, PCBs, there seems to be a very good basis at several stations for using core data for such kinds of purposes.

For using down-core data on metals, the Sub-group was aware that, in addition to contamination history, the profiles reflect as well the result of post-depositional diagenetic redistribution. New results from the Bornholm Basin, where sites (cores) have been re-investigated after twenty years, stressed that probably for several areas in the Baltic Sea, such post-depositional changes of metal distributions are negligible.

Baseline study or monitoring?

The Sub-group considered whether it is worth transferring the **baseline study** to **monitoring** and was of the opinion that with repeated baseline-type studies it would be possible to follow both anthropogenic effects and climatological changes. It would also be possible to compare one basin to another basin, but it would not be possible to judge the effectiveness of input reduction measures taken, due to the fact that by these baseline-type studies it is not possible for all basins and all relevant parameters to follow short time-scale (< 10 years) changes.

The Sub-group proposed considering (after having finalized working up the data and reporting the results of the first SBS) a repetition of the baseline study after ten years. When preparing the second SBS, the lessions learned from the first SBS (proper sampling sites, change in parameters, methods, conduct, etc.) should be taken into account as well as the results of on-going or subsequently completed scientific studies in the Baltic Sea (e.g., BASYS, GOAP, etc.). Remark: Regarding the selection of a representative sampling station, the original proposal for conducting the first SBS, i.e., to take additional cores around the primary station, must be followed. (Due to restricted time, this has only been done in the Arkona Basin!)

Monitoring of short-term changes

Time-representative sampling was considered the main problem in monitoring short-term changes. Besides using surface sediments for this purpose, several potential related approaches have been identified, i.e.,

a) sampling and analysis of fluffy material from above the sea bottom;

b) sampling and analysis of suspended particulate matter (SPM) by using flow-through centrifugation; and

c) sampling and analysis of sedimenting material using traps for collection.

It is proposed to encourage studies (monitoring as 'supporting studies') on the usefulness of such techniques for monitoring purposes. The Sub-group noted that some of those studies (fluffy material studies in the Pomeranian Bay, IOW; trap material studies in the Gulfs of Finland and Bothnia, FIMR) have proved their short-term monitoring potential.

Short-term trend-oriented studies of surface sediments depend very much on representative sampling. Use of a medium-sized box corer was considered to be a minimum requirement. Grab samplers were not considered suitable for taking the soft muddy Baltic sediments.

Sampling frequency

Samples should be collected most preferably every year, but as a minimum every second year. To obtain statistically significant trends, at least ten years of monitoring was considered to be necessary.

Sampling time

Regarding the preferable season for sampling, the Sub-group proposed to concentrate on the winter months. As there are areas where this would be difficult because of ice-covering, a suitable period with low variability of natural background conditions (not during or immediately after blooms or storm events) should be selected.

Sampling area

The Sub-group agreed that for selecting the proper sampling areas, the same criteria as proposed earlier for the conduct of the SBS should be applied. The monitoring programme focuses on detecting trends for the open sea, not for coastal areas.

Parameters

Regarding grain size, the Sub-group agreed that normalization by sieving may be used when found appropriate for the basin under investigation. If analyses on the total sediment fraction are performed, it is necessary to measure all relevant parameters needed for normalization.

The Sub-group proposed that as an additional parameter organotin (TBT and other species) should be included in the list.

Regarding the methods to be used for analysing metals, the Sub-group recommended that in addition to total 'content', a fraction of more environmental relevance should be analysed.

The Sub-group also recommended that together with contaminant studies, ecotoxicological effect studies (biological effects monitoring) should be carried out using the total sediment, eluted and/or solvent-extracted fractions and proper organisms (bacteria, plankton, fish, etc.) as targets.

How to sample?

When selecting the thickness of the surface sample to be taken (1–2 cm), information about sedimentation rates is needed. It should be ensured that recent sediments are collected. Approaches to be applied regarding the determination of sedimentation rate and thickness of surface sample might differ between different basins.

The Sub-group recommended that when sediment basins are chosen, a thorough geological study of the area should be available (e.g., by using high-resolution echo sounding).

Number of samples

The existing knowledge of the basin should be used as background information when deciding on the number of samples to be collected. The Sub-group noted that in the case of uniform basins, comparatively fewer samples are needed, but for simple statistical analyses a minimum number in the order of 10–12 samples are needed. The aim of the sampling strategy is firstly to obtain knowledge on the variability within the basin and around the station (an area between about 1 km × 1 km to 500 m × 500 m). The Sub-group also considerd whether individual samples or pooled samples should be used for analysis, but recommended that a decision on this issue should be made only after thorough study of the area and preliminary analytical results on individual samples. The Sub-group noted that a number of activities on these statistical issues are under discussion in ICES and the advice by ICES should be taken into account as appropriate.

4 CONCLUSIONS

The Workshop concluded that most of the items discussed under the Sub-groups have been covered in the Sediment Baseline Study report as it now stands. It is clear that a lot of new evidence on the significance of sediments in relation to monitoring the marine environment is available and that the Baseline results offer much more for scientific interpretation than what has been brought up in the Baseline report. However, it was acknowledged that the final report is not the venue to publish a full interpretation of the results, but rather just an overview of the distributions and primary interpretations, together with those recommendations that can be backed up by the interpretations. The Workshop recommended that the results of the Baseline Study should be published, with minor modifications, as soon as possible.

ANNEX 1: AGENDA

ICES/HELCOM Workshop on Baltic Sea Sediments

(Second announcement)

The ICES/HELCOM Workshop on the Baltic Sea Sediments will be held, as announced earlier, on 14–16 April 1999 in Helsinki, Finland, at the premises of the Finnish Environment Institute, Kesäkatu 6, FIN-00260 Helsinki, Finland.

Organizing institutes:

Finnish Institute of Marine Research (FIMR)
Finnish Geological Survey (FGS)
Finnish Environment Institute (FEI)

Conveners:

Prof. Matti Perttilä (FIMR)
Prof. Boris Winterhalter (FGS)

Workshop structure and main topics

The purpose of the Workshop is to bring together scientists working in the field of the Baltic Sea sediments, including both experimental chemistry and geochemistry, as well as modelling.

The Workshop will be structured in a form to encourage free multidisciplinary discussion on the main topics. Each topic will be presented by an expert of the field, followed by one or two prepared short comments to see another angle to the problem. Contributions in form of posters are encouraged and time will be allocated for their presentation during the discussions. The following topics will be discussed during the Workshop:

- Oceanographic changes in the recent decades in the Baltic Sea
  Speaker: Lars Rahm
  Comments: Matti Perttilä

- Sediment sampling: what do samples represent?
  Speaker: Åsa Danielsson
  Comments: Harri Kankaanpää

- Sediment types of the Baltic Sea
  Speaker: Ingemar Cato (Geological Survey of Sweden)
  Comments: Boris Winterhalter (Geological Survey of Finland) and
  Birger Larsen (Geological Survey of Denmark and Greenland)

- Dating methods
  Speaker: Markus Meili (Uppsala University)
  Comments: Birger Larsen (Geological Survey of Denmark and Greenland)

- Sedimentation rates and lamination
  Speaker: Per Jonsson (Uppsala University)

- Carbon and nutrients in sediments
  Speaker: Rolf Carman (Stockholm University)
  Comments: Liisa Tuominen (Finnish Institute of Marine Research)

- Halogenated compounds in sediments
  Speaker: Per Jonsson (Uppsala University)
  Comments: Harri Kankaanpää (Finnish Institute of Marine Research)

- Trace elements in sediments

  Speaker: Lutz Brüggmann
  Comments: Henry Wallius (Geological Survey of Finland)

- Coast/open sea transport

  Speaker: Markus Meili (Uppsala University)
  Comments: Matti Mälkki (Finnish Institute of Marine Research) and
  Oleg Andreev (Finnish Institute of Marine Research)

- Use of sediments in the Baltic Sea environment monitoring

  Speaker: Eeva-Liisa Poutanen (Finnish Institute of Marine Research)

- What do we need to know more about the sediments?

- Overall discussion

Objectives and scopes

Marine sediments provide a possibility to assess in a consistent manner the changes in the environment. Not only the present-day distribution of contaminants can be exposed, but also at the same time the depositional history of the sampling site, providing certain hydrochemical and biological conditions are met. The use of biota as a pollution indicator in the Baltic Sea suffers from the drawback that only very few, if any, species are represented in all the sub-areas in sufficiently large quantities.

The state-of-the-art of the characteristics of the Baltic Sea sediments and their chemistry and dating methods will be discussed on the basis of present-day research. Results and experiences gained through the 1993 Sediment Baseline Study will also be discussed.

At its 1998 meeting, the ICES Advisory Committee on the Marine Environment (ACME) noted the need for a dedicated sediment workshop, stating that the purpose of the Workshop is to bring together scientists working in fields relevant to Baltic Sea sediments to review on a multidisciplinary basis the results of the Sediment Baseline Study as well as results from other Baltic Sea sediment research. The Workshop will be used to generate discussion regarding future Baltic Sea sediment research and monitoring, which should serve as a basis for the development of recommendations concerning sediment monitoring in the framework of HELCOM.

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