COOPERATIVE RESEARCH REPORT

No. 92

# REPORT OF THE ADVISORY COMMITTEE ON MARINE POLLUTION, 1979

https://doi.org/10.17895/ices.pub.7712

ISBN 978-87-7482-573-9

ISSN 2707-7144

International Council for the Exploration of the Sea
Palægade 2-4, DK-1261 Copenhagen K
Denmark

January, 1980

TABLE OF CONTENTS

Contents (ctd) Page



-o-o-o-

# REPORT OF THE ADVISORY COMMITTEE ON MARINE POLLUTION, 1979

## List of Members

| | |
|---|---|
| Prof. G Kullenberg | Chairman |
| Dr A D McIntyre | Chairman, Marine Environmental Quality Committee |
| Mr H W Hill | Chairman, Hydrography Committee |
| Dr T C Platt | Chairman, Biological Oceanography Committee |

## Coopted Members

Dr (Ms) M C de Barros

Dr R H Cook

Mr A Preston

Dr E D Schneider

Mlle F Soudan

Dr L Zmudziński

Mr L Thorell

Prof. A Voipio

Dr G Weichart

Dr (Ms) Janet Pawlak, ICES Environment Officer, Secretary to the Advisory Committee on Marine Pollution

# REPORT OF THE ADVISORY COMMITTEE ON MARINE POLLUTION, 1979

## INTRODUCTION

1. The Advisory Committee on Marine Pollution has been established by the International Council for the Exploration of the Sea with the task to formulate on behalf of the Council scientific advice on marine pollution and its effects on living resources to Member Governments and to regulatory Commissions. It is a firm procedure within the Council that reports of other subsidiary bodies must pass the Advisory Committee on Marine Pollution.

2. The Advisory Committee on Marine Pollution consists of a number of scientists acting - when they meet as a committee - in their personal capacity as scientists, responsible only to the Council. The membership of the Committee is such that it covers a wide range of expertise related to studies of marine pollution. The members are not national representatives. The present membership of the Committee is found on page 1.

3. In the present report, the Advisory Committee on Marine Pollution has prepared one overall report in anticipation that most of the material, even when prepared specifically for one Commission, will be of interest to all three regional Commissions. Thus, information both of a general nature as well as in response to specific requests is contained herein.

## MONITORING: PRINCIPLES IN DERIVING CRITERIA AND SETTING STANDARDS

4. At the 1978 mid-term meeting, the Committee had considered and adopted a paper on "Monitoring in relation to Pollution of the Marine Environment" (see Annex 1 to Coop.Res.Rep., No.84 (1979)). Deciding that this work should be expanded to cover standard setting in an environmental context, the Committee had constituted an ad hoc group to consider and prepare a working paper on the scientific principles involved in deriving criteria, setting standards based on them, and applying these standards to marine environmental quality problems.

5. The Committee discussed a draft paper on this topic which had been prepared by the Chairman of the ad hoc group during the intersessional period. Time had not permitted any commentary within the membership of the ad hoc group before the meeting, so the ideas and principles were exposed to the whole Committee at the same time. After discussing the draft paper, the Committee decided to continue the consideration of this topic during the next intersessional period. The Committee reaffirmed its view of the importance of this work and expressed the hope that, in due course, a combined document on the philosophy and concepts of monitoring and the scientific principles for deriving criteria and setting standards could be published in the Cooperative Research Report series.

## INTERCALIBRATION ACTIVITIES

6. The Committee discussed the present status of the various ICES inter-calibration exercises. Regarding intercalibration of trace metal analyses in sea water, it was noted that a draft report on the results of the fourth round trace metal intercalibration in sea water would be considered by the Marine Chemistry Working Group at its May 1979 meeting. This exercise was designed to determine the analytical precision of participating laboratories in the measurement of a number of trace metals. The

Committee noted that plans are well underway for a fifth round intercalibration of heavy metal determinations in sea water, which is intended to examine the influence of various sampling methods and storage procedures on the ultimate results. A questionnaire has been circulated to provide information on equipment and methods presently in use and the results will be studied by the Marine Chemistry Working Group as an aid in developing the final plan for the exercise.

7. As requested by the Joint Monitoring Group of the Oslo and Paris Commissions, intercalibration exercises for the analyses of mercury and cadmium in sea water are being initiated. The samples for the cadmium intercalibration are being sent to participating laboratories at the end of April 1979. The Committee noted that, if the results of the analyses are submitted to the Coordinator within the designated time period, a report on the outcome of the intercalibration will be prepared by the end of December 1979. The intercalibration exercise on mercury in sea water is in the preparatory stages and the distribution of samples is expected in autumn 1979.

8. Two intercalibration exercises on the analyses of contaminant levels in biological materials are now in the final stages of completion, namely, the fifth intercalibration exercise on heavy metals in fish flour and the third intercalibration of organochlorine residue analyses in fish oil. The samples for each exercise were distributed in autumn 1978 to approximately forty laboratories, and by mid-March 1979 results had been received from around half of the participants. The preliminary reports of the results of these intercalibrations, including statistical analyses of the data, are being presented at the Marine Chemistry Working Group meeting in May 1979. It was noted that laboratories designated to take part in the Joint Monitoring Programme of the Oslo and Paris Commissions were among those participating in these two intercalibrations.

9. Given the number and variety of intercalibration exercises which have been or are being conducted, the Committee felt that it was useful to attach an information paper on the status of the ICES intercalibration programme as of October 1978 (see Annex 1).

10. Considering the subject of intercalibration in general, the Committee stressed that before baseline or monitoring studies are conducted, it is essential that participating laboratories have successfully intercalibrated their methodologies. These intercalibrations should meet the realistic quality requirements of the particular monitoring programme.

## SCIENTIFIC STUDIES IN RESPONSE TO AN OIL POLLUTION INCIDENT

11. In considering this topic, the Committee recalled that at the 1977 Statutory Meeting the Council had established an ad hoc Group to plan a meaningful programme of scientific studies to investigate the immediate and long-term effects of significant oil spills or blow-outs, including the identification of the observations, resources and expertise needed. The plans should include the studies necessary for both a minimum level response as well as for a complete study of resultant effects.

12. The Committee noted that the ad hoc Group had met twice since it was formed and had prepared a draft report which was not yet available for review. The Committee was informed that the basic framework of this report outlines tasks and research items that were deemed important in the scientific investigation of the effects of oil spilled in the marine environment, grouped as follows:

a) pre-event tasks and research,

b) operational tasks and research, and

c) basic or applied research problems especially suitable for investigation during or after a spill.

The Committee looked forward to considering the full report in detail at its October 1979 meeting, along with the results of the discussion which will be held in the Marine Environmental Quality Committee on this topic.

## MEASUREMENT OF PETROLEUM HYDROCARBONS IN SEA WATER

13. This topic has been discussed in several papers to recent ICES Statutory Meetings, but the item arose directly from the October 1978 ACMP meeting when the concerns of the Paris Commission were considered. The Committee was informed that the Commission has two particular interests in measuring petroleum hydrocarbons in sea water - the short-term control of equipment performance and the longer term monitoring of the environment. In this latter context, it has been suggested that the best approaches at present may be through the use of organisms and sediments, but measurements of oil in water may also be required. To do this efficiently, further knowledge is required on sampling methodology and analytical techniques, as well as on the most appropriate oil fractions to measure. Also, to ensure that results from different sources are comparable, the possibility of intercalibration of analyses should be examined. The Committee noted that work is currently underway in several ICES member countries on the problems of measuring oil in sea water and results are reported regularly. The Committee looked forward to seeing the results of the discussions of the problems of analyses of petroleum hydrocarbons and the possibilities of intercalibration of methodologies which will be held by the Marine Chemistry Working Group and the Working Group on Marine Pollution Baseline and Monitoring Studies in the North Atlantic at their meetings in May 1979.

## ISSUES RELEVANT TO DUMPING

### Deep Ocean Dumping

14. The Committee considered an introductory paper on dispersion and mixing processes in the deep ocean in relation to the dumping of pollutants, with special reference to the eastern Atlantic. This paper is given here as Annex 2.

15. The Committee noted that the extent of oceanographic knowledge of biological, physical and geophysical transport processes was very poor compared with similar knowledge for shelf sea areas. The discussion centred on the importance of the benthic boundary layer in the initial stages of dispersion, the need for a better understanding of the temporal and spatial variability of the thickness of the layer in the eastern Atlantic basin, and the horizontal and vertical dispersion rates within and through the layer into the overlying deep water masses. Attention was also drawn to the requirement for a better appreciation of the role played by mesoscale eddies in mixing, both horizontally and vertically, and a better understanding of vertical transfer processes, particularly along the slopes of the continental shelf and mid-Atlantic ridge as well as near the major oceanic fronts.

16. The Committee noted that a modest research programme, specifically related to examining the feasibility of the disposal of high level radioactive waste on or under the deep ocean floor, had already begun in a few member countries and that a significant expansion of this research could be expected in at least some of these countries in the near future. Clearly the results of these studies were of direct relevance to the Committee in its considerations of the potential for dumping non-radioactive pollutants into the deep ocean. It was, therefore, recommended that the Hydrography, Biological Oceanography and Marine Environmental Quality Committees be requested to keep these research programmes under review and report relevant results to the Advisory Committee on Marine Pollution as they become available.

Incineration of Wastes at Sea

17. The Committee discussed briefly the problem of the location of operational incineration ships in the ocean and decided to make arrangements for a discussion paper on criteria concerned with the location of incineration activities to be presented at the next session of the Committee, during the 1979 Statutory Meeting.

## POLLUTION STUDIES IN THE NORTH ATLANTIC

18. The Committee noted that the Working Group on Marine Pollution Baseline and Monitoring Studies in the North Atlantic will meet in Lisbon in May 1979 following the meeting of the Marine Chemistry Working Group. A number of items will be discussed, including the current intercalibration exercises for metals and organochlorine residues in fish and shellfish and for trace metals in sea water. The text of the report concerning extensions to the study of baseline levels of contaminants in fish and shellfish sampled off the Portuguese, Irish and North American coasts will be finalised together with the text of the 1977 Coordinated Monitoring Report. A first appraisal of some of the data for the 1978 Coordinated Monitoring Report will also be made. A draft report of the review of existing data on trace metal levels in sea water of the North Atlantic will also be considered with a view to a possible baseline study in coastal waters. Further consideration will be given to the problems of sampling and analyses for the determination of pollutant residue concentration trends in time and space. Among other subject areas that will be discussed in a North Atlantic context are petroleum hydrocarbons and developments in the monitoring of biological effects of pollutants.

## COORDINATED MONITORING PROGRAMME

19. The Committee considered a draft report on the 1977 results of the Coordinated Monitoring Programme. The report contained data from the Federal Republic of Germany, Belgium, England/Wales, Scotland, Ireland and Canada on the levels of selected heavy metals and organochlorine residues in fish and shellfish from the German Bight and Southern Bight of the North Sea, the Irish Sea, the Forth Estuary, and the Gulf of St Lawrence. Noting that the Working Group on Marine Pollution Baseline and Monitoring Studies in the North Atlantic had not yet had the opportunity to consider the report, the Committee decided to defer detailed discussion of the report until its October 1979 meeting when it could take into account the expert views of the Working Group.

20. Regarding the 1978 Coordinated Monitoring Programme, the Committee noted that data had been submitted so far from the United States and the

Federal Republic of Germany. The Committee looked forward to receiving the report on this subject at its next mid-term meeting. The Committee also took note of the intention of the Working Group to review the results of the first five years of its coordinated monitoring activities.

## FURTHER EVALUATION OF THE ICES STUDY OF INPUTS OF POLLUTANTS TO THE OSLO COMMISSION AREA

21. The Committee discussed whether it would be possible to carry further an evaluation of the ICES study of the inputs of pollutants to the Oslo Commission Area, which had been considered at the previous mid-term meeting. In the discussion, the Committee noted the numerous problems inherent in understanding the mass balances of pollutants in the marine environment, including the inputs of pollutants to the sea, their transport in the marine ecosystem and their ultimate fate. Additionally, the high rate of input of some substances (e.g., mercury and cadmium) from natural sources in certain areas makes the detection of concentrations due to man-made inputs extremely difficult. Further studies are clearly needed on these topics to permit a better interpretation of pollutant discharge data.

22. Concerning the ICES input study, the Committee agreed that the evaluation of the available input information had been carried as far as reasonable, given the present state of knowledge. In concluding its discussion, the Committee reaffirmed its agreement on the importance of conducting studies of pollutant inputs and recognised the value of coordinated monitoring programmes as an aid to the identification of areas where a closer study of the inputs of pollutants will be necessary.

## WORK REQUESTED BY THE OSLO AND PARIS COMMISSIONS

23. The Committee considered the programme of work which ICES had been requested to perform by the Oslo and Paris Commissions, on the recommendation of the Joint Monitoring Group. This work was divided by the Commissions into projects of a short-, medium-, and long-term character, as follows:

(a) short term:
- (i) to continue with the intercalibration exercises for mercury and cadmium in sea water and for mercury, cadmium and PCBs in organisms;
- (ii) to make proposals to standardise the depuration procedure for defaecation of filter feeders prior to further steps of analysis;

(b) medium term: to report on the outcome of the Symposium on Sediments in the light of the plans of the Joint Monitoring Group to incorporate sediment monitoring in the joint monitoring programme;

(c) long term:
- (i) to examine the problems of trend monitoring and to advise the Commissions accordingly, recognising that the detection of trends in the contamination of biota demands statistically precise data, and that the acquisition of such precision requires knowledge of the effects on contaminant levels of a range of factors including the location, size, age, sex and physiological conditions of the organisms;

(c) long term (ctd): (ii) to examine the physical, chemical and biological processes which control the movement of contaminants between the various compartments in the marine environment from the point of input to the ultimate sink, and provide advice to the Commissions on the principles underlying these processes.

After discussing each project, the Committee accepted these tasks.

Intercalibration Exercises

24. The Committee considered the progress in the intercalibration exercises requested by the Commissions and noted that two of the exercises, namely the intercalibrations of analyses of heavy metals and organochlorine residues in biological materials, were in the final stage of completion. Reports on the results of these exercises would be considered by the Marine Chemistry Working Group at its May 1979 meeting. The Committee looked forward to receiving the Working Group's conclusions on the intercalibration results for discussion at the next Committee meeting.

25. Regarding the intercalibration exercises on analyses of cadmium in sea water, the Committee noted that samples would be distributed shortly and the report on the results could probably be expected at the end of the year for review at the next mid-term meeting of the ACMP. The Committee noted that the work on the intercalibration of mercury in sea water was also progressing.

Mussel Depuration Procedure

26. The Committee considered a draft method for the cleansing of filter feeding molluscs prior to analysis. The Committee understood that this procedure was intended to further elaborate on the procedures for sampling and sample preparation of fish and shellfish used in monitoring programmes in the North Atlantic area, which had been accepted the previous year (see Annex II, Coop.Res.Rep., No.84 (1979)). With minor amendments, the Committee accepted the procedure, which is given in Annex 3 to this report.

Results of Symposium on Pollutant Interchange in Sediments

27. The Committee noted that this Symposium will be held in late 1979 and looked forward to receiving the report for discussion at its next mid-term meeting.

Problems of Trend Monitoring using Marine Organisms

28. As no further information was available on this subject since the time of the last mid-term meeting, the Committee decided to review the progress on this subject at its next meeting. This review would be conducted on the basis of the consideration of the results of the multiple regression programme by the Marine Chemistry Working Group and the Working Group on Marine Pollution Baseline and Monitoring Studies in the North Atlantic and other information which may be available at that time.

Transport of Contaminants in the Marine Environment

29. The Committee noted that it would require many years of study to obtain a reasonable understanding of the transport and fate of contaminants in the marine environment. However, work was being carried out on this subject and certain aspects of this topic will be discussed at the 1979 Statutory Meeting. In the Marine Environmental Quality Committee, the topic of environmental quality in selected estuaries and coastal regions would be discussed with a view to relating pollutant inputs, environmental levels and biological effects. The Hydrography Committee will consider, as one of its special topics, the interaction of physical, chemical and biological processes in the marine environment with particular reference to the experience gained in interdisciplinary experiments. Integrated processes will also be discussed in the 1979 mini-symposium, which will be on the topic "Integrated studies of physical, chemical amd biological processes in the sea". Additionally, the Committee noted that preparations were being made for a mini-symposium at the 1980 Statutory Meeting on the topic "Transport processes in estuarine and near-shore areas". Information on the results of this and other work will be transmitted to the Oslo and Paris Commissions in the annual ACMP reports.

PROGRESS IN THE STUDIES OF POLLUTION IN THE BALTIC

30. The ICES/SCOR Working Group on the Study of the Pollution of the Baltic met in Tallinn, USSR, 23-25 January 1979. The Committee considered the report of the meeting (ICES, Doc. C.M.1979/E:2) and specifically noted the following information concerning the longer term research programme of the Group.

a. The data collected during the Baltic Open Sea Experiment (BOSEX) 77 are presently being analysed by the participating groups and several papers have already been published. Information about the progress in this work is continuously passed on to all participants by means of the BOSEX Atlas, entitled Bosexiana, which is circulated through the ICES Service Hydrographique. Combined interpretation of the data has so far been carried out only for the chemical observations at the central station, for which an intercomparison has been made between nutrient data collected there by the different ships. The intercomparison showed very good correlations for salinity and temperature, acceptable correlations for most oxygen and phosphate ($PO_4$-P) data and somewhat less satisfactory for total phosphate, but very poor correlations for nitrite and ammonia. The Working Group noted that several sources of variability could have an influence on nitrite and ammonia in particular, including natural fluctuations on small scales in the water column as well as problems of sampling, sample contamination and analytical techniques. The Working Group stressed the need for evaluating all these sources of variability in detail and hoped to have the results presented in a paper to the 1979 Statutory Meeting. This was endorsed by the Committee. In order to stimulate further combined data analyses, the Working Group formed small *ad hoc* groups concerned with nutrient chemistry, microbiology, plankton biology and physical oceanography. In the development of future research programmes, the Working Group decided to concentrate on patchiness in the Baltic and the space and time scales involved.

b. In discussing the scientific principles for assessment and surveillance of the marine environment, the Working Group considered that five factors were particularly important to study: (1) actual baseline concentrations of pollutants, (2) flux rates (river inputs, atmospheric fallout, sedimentation), (3) estuarine mixing, (4) speciation of metallo-organic compounds (important in bioavailability and toxicity), and (5) bioaccumulation.

The Working Group noted that very little was known about the interaction between chemicals and biota, for example in relation to primary and secondary production, and that the time scales of processes and responses are very important. The Working Group concluded, in relation to monitoring, that (1) it was important to include biological parameters such as plankton, zoobenthos and certain microbiological indices, (2) effects of heterogeneity must be considered, (3) nutrient levels can be compared in a monitoring programme (given difficulties with nitrite and ammonia), but sampling and sample preservation techniques must be noted, (4) temperature, salinity, oxygen and possibly primary production are important to fish survival and reproduction, but fish motility creates additional problems in attempting to assess the effect of the environment on fish. The Committee considered these views and could generally endorse them. The Committee also stressed that further attention must be paid to the continuous follow-up of all factors affecting the quality of monitoring data.

c. Noting the Working Group discussion of ongoing coastal dynamics work, the Committee agreed with its emphasis of the importance of such studies in relation to pollution and assessment problems.

31. The Committee also noted the work carried out by the International Hydrological Decade/International Hydrological Project Group of Experts on the Water and Material Balance of the Baltic Sea and considered that the results of measurements of exchange through the Danish Sounds and the river input of organic material and nutrients were relevant to the pollution studies of the Baltic Sea.

## REQUEST FROM THE INTERIM HELSINKI COMMISSION

32. The Committee noted that the Interim Baltic Marine Environment Protection Commission decided, at its meeting in November 1978, that an assessment of the Baltic marine environment should be prepared on the basis of existing data, which could as much as possible function as a "baseline assessment" for comparison with subsequent assessments to be prepared from the results of the Baltic Monitoring Programme. The report of the Interim Commission meeting stated:

> "It is considered that, in view of the fact that the Baltic monitoring programme will begin in 1979, it will be necessary to prepare an assessment as detailed as possible of the known conditions of the Baltic marine environment as a basis for the evaluation of the monitoring programme. Such an assessment should utilise all relevant existing data and should also make use of results from bilateral programmes in the Gulfs of Finland and Bothnia and the Sound presently being conducted. It is suggested that such a detailed assessment should be carried out under the responsibility of the /Commission's/ Scientific-Technological Working Group (STWG), using the expertise of the international Baltic scientific community within ICES and BMB with the assistance of the ICES Secretariat."

33. The Interim Commission thereafter invited ICES to establish with it a Joint STWG/ICES ad hoc Group of Experts, consisting of Baltic marine scientists with as wide a field of experience and competence as possible, covering the various disciplines and uses of the marine environment. The Interim Commission intended that the Group should work in two stages, in that it was asked to prepare an outline of the assessment for comments by the STWG and ICES in the first stage, and thereafter complete the assessment, taking these comments into consideration. The work should be completed before the autumn of 1980.

34. ICES accepted this task and the first meeting of the STWG/ICES ad hoc Group of Experts was convened on 25-26 January 1979 in Tallinn, USSR.

35. The Committee noted the report of the STWG/ICES meeting and discussed the draft outline of the document. The Committee felt that such a baseline assessment would provide a valuable evaluation of previous studies of pollution in the Baltic while also acting as a basis for future assessments which will be made using data from the Baltic Monitoring Programme commencing in March 1979. However, the Committee counseled that, owing to the very tight timetable for carrying out the work as well as the complex nature of the scientific evaluations involved, the draft outline could benefit by placing a greater emphasis on the items of most immediate priority. Thus, for background material on general environmental parameters in the Baltic, strong reliance should be placed on the use of references to published materials, especially overall reviews including the earlier ICES document giving information relevant to the development of a monitoring programme in the Baltic. The Committee felt that the major focus in the document should be placed on an assessment of the pollution parameters which have been chosen for study in the Baltic Monitoring Programme. The document should try to identify trends in these parameters even if it would not be possible to explain the trends found. Given the pressure of time, the most important pollution parameters should be handled first and additional parameters could be considered later if time permitted.

36. The Advisory Committee looked forward to reviewing the progress in this task at its October meeting.

## CONVENED OR PLANNED SYMPOSIA

### Workshop on Monitoring the Biological Effects of Marine Pollution

37. The Committee noted that the Workshop had been held as planned in Beaufort, North Carolina from 26 February to 2 March 1979. It was attended by 55 scientists from eleven countries. A total of 35 specially commissioned papers were circulated in advance to participants, and during most of the Workshop panels of 6-8 people discussed and prepared reports on biological monitoring techniques under seven headings: biochemistry, physiology, pathobiology, behaviour, ecology, genetics and bioassay. Each panel was able to make specific recommendations for the most suitable procedures which could be put into use immediately and also for others which might be worth developing. The Workshop, however, endorsed the view of the former Sub-Group on the Feasibility of Effects Monitoring that in most cases no single approach would be adequate in itself, but usually a package of procedures would be required. The ultimate result of the Workshop was to provide suggestions for the components of packages and to offer guidance as to how an appropriate package might be put together for particular situations. The outcome and recommendations of the Workshop will be discussed at the 1979 Statutory Meeting. The papers and proceedings of the Workshop will be published in a volume of the Rapports et Procès-Verbaux series.

### Symposium on Sediment and Pollutant Interchange in Shallow Seas

38. The Committee noted that this Symposium will be held in Texel on 24-26 September 1979. The Symposium, which is limited to invited participants, will consider the issue of sediment and pollutant interchange in shallow seas and the interpretation of data from such studies. One task

will be to give preliminary consideration to the outline planning of a pilot survey for selected offshore areas to study the process of pollutant accumulation in relation to sediment processes.

## MATTERS OF INTEREST ARISING FROM THE MARINE ENVIRONMENTAL QUALITY COMMITTEE

39. At the 1978 Statutory Meeting, the Marine Environmental Quality Committee considered papers on a number of topics but the main themes had been oil pollution and the use of organisms in monitoring contaminant levels in the marine environment. Since then, the ad hoc Group on Oil Pollution Incidents had met and the Workshop on Biological Effects Monitoring had been held, both of which are referred to earlier in this report. Two further events may be noted. First, an international (non-ICES) Workshop on Mussel Watch Programmes was held in Barcelona in December 1978 under the sponsorship, inter alia, of SCOR and the results will be reported and discussed at the 1979 Statutory Meeting. Second, a meeting of the ICES Working Group on the Effects on Fisheries of Marine Aggregate Extraction was held in the Hague on 21-23 March. While not exclusively concerned with pollution, the Working Group became involved in a discussion of harbour and channel dredging, since it noted that these dredgings were sometimes used in the same way as a primarily commercial aggregate. The Group also discussed marine disposal of dredge and other spoils and the biological effects of such disposal. The ACMP took note of this and agreed that the pollution aspects of such disposals should be considered at its next mid-term meeting.

ANNEX 1

# ICES INTERCALIBRATION EXERCISES *

by the

Environment Officer

## Introduction

In 1971 the Council established the Working Group for the Study of the Pollution of the North Sea; one of the aims of the Group was to study the levels of pollutants in the North Sea marine environment, including the biota, sea water, and sediments. In setting forth this goal, the Working Group agreed that a programme of intercalibration exercises for analyses of the contaminants to be studied was essential in order to determine whether the results produced by the various participating laboratories were comparable.

Similarly, the ICES/SCOR Working Group on the Study of the Pollution of the Baltic pointed out at its first meeting, in May 1972, that intercalibration exercises for analytical methods were vital for its programme of studying heavy metal and organochlorine levels in biota and sea water. The Group expressed its desire to participate in exercises conducted by the North Sea Working Group rather than to conduct any on its own.

## Intercalibrations concerning Biological Materials

In 1972 in connection with the baseline study of contaminant levels in fish and shellfish of the North Sea, the North Sea Working Group conducted two intercalibration exercises: one for analyses of heavy metals and the other for organochlorines. Due to the possibility that variable results in the heavy metals exercise were due to the type of fish flour used, a second exercise was conducted in 1973/74; Baltic laboratories participated in this exercise also.

In 1974 a second intercalibration exercise for organochlorine determinations was conducted utilising lower concentrations of spiked residues. An expanded number of laboratories from the North Atlantic, as well as laboratories from the Baltic, participated in this exercise.

In 1975, in preparation for the baseline study of contaminant levels in fish and shellfish in the North Atlantic and for a similar study in the Baltic, the third intercalibration exercise for heavy metals was conducted. Due to poor results for cadmium and lead, a fourth "intercomparison" study, using the same fish flour, was conducted for these two metals in 1977.

---

* Status as of October 1978.

In September 1978, samples of a new preparation of fish flour are being distributed for the fifth heavy metal intercalibration exercise; samples of a new fish oil solution are also being distributed for the third organochlorine intercalibration exercise. ICES-wide participation has been solicited for them.

These two series of intercalibration programmes have provided a valuable learning experience for both the coordinators and the participants. On the coordinators' side, each exercise has provided valuable feedback for the development of new and better reference samples. For the participants, the exercises have provided a means of determining how comparable their methods are with those of other laboratories and perhaps also of indicating how to improve their results.

From the early stages of this programme, the relevant Working Groups have shown great interest in the programme and have given their full support to it. They have stated that periodic intercalibration exercises (once every three to four years) are necessary parts of any programme to monitor levels of contaminants in biota; this recommendation is included in the sampling procedures for monitoring in the North Atlantic and the Baltic.

A summary of the exercises is given below.

A. Heavy Metals

First exercise (1972)

Coordinator: Dr G. Topping, DAFS Marine Laboratory, Aberdeen, Scotland.

Sample: fish flour prepared from commercial fish meal (consisting of 80% heads, skeletons and other waste) by MAFF Humber Laboratory, Hull, England.

Results: Reasonably good for Hg, Cu, Zn, Cd; extremely variable for Pb.

It was suggested that some of the variability in the results was due to the heterogeneity of the fish flour.

Second exercise (1973/74)

Coordinator: Dr G. Topping, DAFS Marine Laboratory, Aberdeen, Scotland.

Samples: (a) fish flour prepared using unskinned muscle filets from freshly caught inshore cod by MAFF Humber Laboratory.

(b) Acidified solution containing known (but undisclosed) quantities of dissolved Cu, Zn, Hg, Cd, and Pb.

Distribution: Samples were sent to laboratories in countries around the North Sea as well as the Baltic Sea. Each participant was asked to analyse the fish flour sample six times using his own method so that an estimate could be made of the precision of that method. One analysis was also to be done using a common method.

Results: In general, there was good agreement among analysts for copper, zinc, and mercury and the data were generally of high precision. For cadmium, the precision of the methods used was poor as was the agreement of results among laboratories; the results for lead were also poor.

Third exercise (1975)

Coordinator: Dr G. Topping, DAFS Marine Laboratory, Aberdeen, Scotland.

Samples: (a) skinned muscle filets from distant water cod were prepared into a fish flour after carefully cooking and drying.

(b) Individual reference standard solutions were provided for Cu, Zn, Pb, Cd, and Hg. Participants were requested to prepare working standards from these stock standards using exactly the same procedure.

Distribution: ICES-wide.

Results: Further improvement shown over the earlier exercises with overall coefficients of variation for Hg, Cu, and Zn reduced to single figures compared with the double figures produced earlier. Results for Cd and Pb were still unsatisfactory, due to a significant extent to the analytical methods used and their lack of sufficiently low limits of detection.

Fourth "intercomparison" exercise (1977)

Coordinator: Dr G. Topping, DAFS Marine Laboratory, Aberdeen, Scotland.

Samples: fish flour same as in third exercise analysed for Cd and Pb only.

Distribution: Participants of third exercise.

Results: The limited scope of this experiment was to obtain better results for Pb and Cd by attempting to improve the analytical methods used. Improved results were obtained, but it must be pointed out that, as the flour had been used in the previous exercise the appropriate concentration ranges were already known to participants. Thus, the exercise has been called an "intercomparison" rather than an "intercalibration," in which contaminant concentrations are unknown to participants.

Fifth intercalibration exercise (1978)

Coordinator: Dr G. Topping, DAFS Marine Laboratory, Aberdeen, Scotland.

Samples: (a) fish flour prepared from skinned muscle filets from cod taken in unpolluted waters; preparation includes freeze-drying of filets.

(b) The fish flour in (a) extracted to produce a lower Hg concentration.

Distribution: ICES-wide plus laboratories in JMG monitoring programme.

B. Organochlorines

First exercise (1972)

Coordinator: Mr A.V. Holden, DAFS Freshwater Laboratory, Pitlochry, Scotland.

Samples: (a) fish oil selected for its relatively low concentrations of the organochlorines under study.

(b) The fish oil in (a) spiked with quantities of selected (but undisclosed) organochlorine compounds at levels one order of magnitude higher

than in the original oil.

Distribution: North Sea laboratories participating in the baseline study.

Results: For the spiked samples, all participants were able to determine the appropriate residues ($\gamma$-HCH, Dieldrin, pp'-TDE, pp'-DDE, pp'-DDT, and PCBs) and the data showed a relatively high degree of agreement; however, results were very poor for op-DDT. For the unspiked samples, all participating laboratories were able to determine the three residues of the pp'-DDT and PCBs, but the results were poorer for the remaining residues.

Second exercise (1974)

Coordinator: Mr A.V. Holden, DAFS Freshwater Laboratory, Pitlochry, Scotland.

Samples: (a) unspiked maize oil containing very low concentrations of organochlorines.

(b) Maize oil spiked with organochlorines at concentrations one order of magnitude lower than in the first exercise.

Distribution: Laboratories from both the North Atlantic and the Baltic.

Results: The concentrations of residues in the unspiked oil were generally below the limits of detection attained by most participants. For the spiked sample, most participants were able to identify correctly and determine all residues except $\beta$-HCH. The level of agreement was generally good, particularly for the PCB and DDT group residues most commonly determined.

Third exercise (1978)

Coordinator: Mr A.V. Holden, DAFS Freshwater Laboratory, Pitlochry, Scotland.

Samples: fish oil samples.

Distribution: ICES-wide plus laboratories in the JMG monitoring programme.

## Sea Water

In the earlier studies of the pollution of the North Sea and the later studies of the North Atlantic, the Working Group hoped to eventually conduct a baseline study of the levels of trace metals in sea water. To carry out preparatory work and eventually this baseline study, the North Atlantic Working Group established a Sub-Group on Contaminant Levels in Sea Water.

It was recognised that the first step toward a baseline study was a programme of intercalibration exercises to promote comparability of results among laboratories. A small study, involving laboratories from the United Kingdom, the Netherlands, and Belgium, was undertaken in 1971/72. The ICES-wide intercalibration programme began in 1976 and has consisted of the following exercises: (1) the first round involved preparation, distribution, and analysis of standard solutions of trace metals in which the levels were higher than those normally found in sea water (1976); (2) the second round concerned the analysis of mercury in sea water--samples consisted of sea water and mercury-spiked sea water (1976); (3) in the third round, frozen sea water samples were

distributed and were analysed for trace metals other than mercury (1977). In this third exercise, the ranges of values reported for most of the metals were large and the coefficients of variation fell between 18% and 201%. Because of these variable results, the scientists involved felt that the best course of action would be to continue with further intercalibration exercises, which would be designed to elucidate the sources of error and, further, go beyond comparability of analytical procedures to study sources of error which may arise during sampling, filtering the sample, and storing it.

The fourth round intercalibration, presently underway, is designed to determine the analytical precisions for the analysis of each trace metal (except mercury) by each participating laboratory. The information to be gained will then be used to assess the suitability of the various analytical methodologies for metal analysis in sea water.

A fifth round exercise is now being planned to examine broad categories of sampling and storage procedures (e.g., type of sample bottle, means of deployment, type of storage bottle, filtration procedure, etc.) and assess systematic and random errors which they may introduce. It is intended that this exercise be conducted on a single ship.

To test the full series of procedures, a multi-ship exercise is envisaged in which each participant would utilise his own ship, sampling apparatus and procedures, sample treatment procedures, and analytical techniques. The ships would meet and sample from the same water mass, thus permitting a determination of comparability of results under field conditions.

First exercise (1976)

Coordinator: Dr P.G.W. Jones, MAFF Radiobiological Laboratory, Lowestoft, England.

Samples: two aqueous solutions containing Mn, Co, Cr, Cu, Ni, Zn, Cd, Pb and Hg at concentrations higher than those normally found in sea water.

Distribution: ICES-wide.

Results: Were generally good. 80% of the results were within $\pm$10% of the expected values.

Second exercise (1976)

Coordinator: Mr J. Ólafsson, Marine Research Institute, Reykjavik, Iceland.

Samples: two sea water samples and a mercury-spiked sea water sample.

Results: Showed that fewer than half of the participating laboratories had methods sensitive and accurate enough to determine mercury in unpolluted sea water with reasonable agreement. For high mercury levels, as in polluted sea water, more than 3/4 of the laboratories were able to determine mercury with reasonable agreement.

Third exercise (1977)

Coordinator: Dr P.G.W. Jones, MAFF Radiobiological Laboratory, Lowestoft, England.

Samples: two frozen samples of filtered sea water.

Results: Ranges of values were large for most metals and coefficients of variation were between 18% and 201%. Poorest results were for Cd, Pb, and Ni; best results were for Mn and Zn.

Fourth exercise (1978)

Coordinator: Dr J.M. Bewers, Bedford Institute of Oceanography, Halifax, Canada.

Samples: sets of six sea water samples, frozen or acidified according to request of participant.

A new possibility the North Atlantic Working Group is following concerns intercalibration of analyses of petroleum hydrocarbons in sea water. An Anglo-Norwegian intercalibration has been developing since around 1976, but the difficulties appear to be too large at present to expand the programme much beyond the two laboratories now collaborating.

- o - o -

ANNEX 2

# A BRIEF NOTE ON DISPERSION AND MIXING PROCESSES IN THE DEEP OCEAN WITH SPECIAL REFERENCE TO THE EASTERN ATLANTIC

In recent years, as the technical capability for measurement in the deep ocean has expanded, we have become aware of a range of processes which may affect the dispersion of a pollutant placed in the deep ocean. An empirical awareness of the processes involved does not always mean that we have a measure of these processes in a particular ocean area of interest, or even (in certain cases such as vertical diffusion and vertical advection) that we can measure these processes with any great precision. Thus, even in the case of the best-known of these processes (e.g., mean flow advection), we have only a poorly-formed impression of its temporal and spatial variability, and for a given location we are not yet able to order these various processes in terms of their significance for the dispersal of a pollutant. We merely know that the relative effectiveness of these processes will vary in space (including depth) and time. The following is an attempt to generalise the processes that might tend to disperse the pollutant; the reality will be very much more complex and site specific.

## 1. The Benthic Boundary Layer

A pollutant placed on the bed of the deep ocean lies within a layer of water which has distinct physical characteristics that are due to the proximity of the sea bed. Observations within this layer are difficult and scarce but tend to show that the benthic boundary layer is characterised by a uniform vertical distribution of properties (i.e., apparently well-mixed) with an adiabatic temperature gradient and a sharp discontinuity in properties at its upper boundary. In general, this layer extends some 50-100 m from the sea bed, but although we are aware that the thickness of this layer may vary rapidly in both space and time we are not yet sure what determines its thickness. On the Hatteras Abyssal Plain, however, the thickness is locally correlated with 1-day mean current speeds at the 4 000 m level and preliminary results suggest variability scales of 10 km and a few days. Since the structure of the benthic boundary layer suggests mixing by mechanical or perhaps convective turbulence, we assume that a pollutant in soluble form will mix rapidly throughout this layer but we also assume from the discontinuity at its upper boundary that mixing from the benthic boundary layer into the overlying water column will be extremely slow. Thus, once a pollutant is mixed throughout the benthic boundary layer its further dispersion is likely to involve predominantly horizontal rather than vertical movement. It has even been suggested that vertical mixing at the ocean boundaries can account for almost all the vertical diffusion in the deep ocean without any significant vertical diffusion in the interior.

## 2. The Abyssal Circulation

The abyssal circulation is composed of periodic (tidal), quasi-periodic (inertial) and aperiodic water movements whose relative importance once again varies in space and time. Outside a narrow layer within $\sim$ 1-2 m of the bed where the velocity profile decays logarithmically to zero due to the stress exerted by the ocean floor, the vertical velocity profile in the lower water column can be expected to be reasonably uniform at a given point and time.

The dominant short term variability experienced by a pollutant in the benthic boundary layer will arise from oscillatory tidal motions which act throughout the water depth. Their mean magnitude is of the order of 5 cm $sec^{-1}$ with instantaneous speeds of up to a few tens of cm $sec^{-1}$ but the net advection of a pollutant depends on the asymmetry of these rotary tidal motions and may be very much less rapid. It is the instantaneous speed which promotes mixing of the pollutant, however, and this will be especially pronounced when the tide interacts with rough topography.

Inertial motions are caused by the effect of the earth's rotation acting on a body of water that has already been set in motion, perhaps by a passing storm. These motions are also oscillatory; they act with a periodicity which depends on the sine of the latitude and may rival tidal motions in amplitude. They are, however, intermittent in occurrence and this intermittency is itself extremely variable; in some long-term current meter records from the deep ocean they are almost entirely absent, while in others episodes of inertial motion may persist for a few weeks at a time. While present they will produce horizontal advection and mixing effects similar to those of the tide.

While the two types of motion just described have been demonstrated within the benthic boundary layer, the effect of aperiodic mesoscale eddy motions on this layer has not yet been studied. However, it is possible that, analogous with atmospheric eddies, these mesoscale circulation features may be capable of relatively rapid vertical transport and mixing of water from the boundary layer. From the recent research effort on these features we know something of their characteristics and distribution. They average perhaps 100-200 km in width, may be cyclonic or anticyclonic in rotation with swirl speeds of up to a few tens of cm $sec^{-1}$; they propagate at a few cm $sec^{-1}$ and thus have periods of 1-3 months. Their generation may be due to a number of factors, but they tend to be associated with areas of strong mean flow and with certain areas of rough bottom topography. Thus in general terms, eddy activity is inherently lower in the eastern basin of the Atlantic than in the western, but within the eastern basin eddy activity appears to be locally enhanced along the eastern flanks of the mid-Atlantic ridge, along the European Continental slope and along the Azores-Biscay Rise. This is not to say that elsewhere in the eastern basin eddy motions will be unimportant for the dispersion of a pollutant, since the mean flows themselves may be very weak and/or random there. Ship-drift data suggest, for example, that while the ratio of mean to eddy kinetic energy may be as high as 1 or 2 in the major ocean currents (e.g., the Gulf Stream), this ratio may be as low as 1:40 in the central regions of the major gyres.

The abyssal mean flow is of course very different in character from the Atlantic surface circulation with which we are familiar. In the eastern basin the deep flow appears - both from simulation and observation - to be strongest and least random in direction along the slopes which form its western and eastern boundaries (the flanks of the mid-Atlantic Ridge and the European/African Continental Slope). Long-term current meter data from the North-East Atlantic Dynamics Study (NEADS) and data from other sources appear to show that the deep flow is predominantly southward along the western boundary and northward along the continental margin. In the interior the mean flow may be unpredictably weak and random.

## 3. Escape from the Benthic Boundary Layer

Thus far we have pointed out the generalised assumption that a pollutant released into the benthic boundary layer will not normally be diffused through the water column to the surface at the release point but will

tend to be moved horizontally to the edge of the ocean or into another ocean before this occurs. It has also been suggested that initially at any rate much of this horizontal movement will be within the benthic boundary layer. There are, however, processes which will lead to escape from the benthic boundary layer due to variations that occur in the properties and thickness of the benthic boundary layer itself. As one example, the collapse and spread of a mixed patch along a constant density surface may result in water becoming separated from the bed. This lateral intrusion of water still with its original properties will result in steps in the properties of the lower water column and such "steppiness" is frequently observed in field observations. Since diffusion along isopycnal surfaces is much more rapid than across them, continued dispersion to the ocean boundary is likely to be by advection along these surfaces and the "horizontal turbulence" represented by mesoscale eddy activity is likely to be important in this regard. In general, the rate of ascent through the water column will depend on the slope of these surfaces but since these slopes are usually rather small, dispersion will still be more horizontal than vertical. Locally the height of the isopycnal surfaces along which the water is mixing may rise and fall with variations in sea floor topography since the effect of isolated topographic features on isopycnal surfaces has been shown to extend to several times their height and approximately twice their diameter.

Thus, we have a simplistic picture of a pollutant mixing rapidly throughout the benthic boundary layer, spreading laterally within this layer due to the various components of the abyssal circulation, eventually escaping from this layer to the lower water column (slowly in general, but more rapidly where the behaviour of the benthic boundary layer and other factors such as mesoscale eddy activity prove favourable), and thereafter mixing along constant density surfaces towards the ocean boundaries. During this period, ascent through the water column will be slow, due in part to any rise in the isopycnals themselves and in part to the small-scale processes which promote mixing <u>across</u> isopycnals. (The effect of the latter will be extremely slow, estimated at about 4.4 m $yr^{-1}$ for the North Pacific as a whole.) From the estimated volume transports into and out of the European Basin and the appropriate water volumes, Worthington has calculated the following <u>mean</u> residence times for water in this basin, according to four separate temperature bands:

| Temperature Band (°C) | Water Vol. ($10^6 km^3$) | Mean Residence Time (Yrs) |
|---|---|---|
| 17 - 12° | 0.2 | 2 |
| 12 - 7° | 2.1 | 8 |
| 7 - 4° | 1.4 | 6 |
| < 4° | 4.5 | 13 |

## 4. Slope Processes

By and large the residence times in the different layers of the water column are controlled by horizontal rather than vertical rates of transfer in the Eastern Atlantic. However, in relative terms we suspect that vertical mixing may be enhanced when the pollutant arrives at the ocean boundary. There are many possible causes of enhanced slope mixing, for example the generation of internal tides through the interaction of surface tides with the slope itself, breaking of internal waves against the slope, extreme bottom roughness and the presence of (relatively) large mean currents. The dominant process or processes

at work may of course vary from area to area. As already stated, long-term current meter and ship drift records suggest that the European continental slope from Brittany to Porcupine Bank is associated with high mesoscale eddy activity and this may locally be of great significance to mixing in this particular area. However, although the dominant process may vary, the available evidence appears to indicate that slope processes as a class promote a more effective vertical exchange at the ocean's boundaries than that which occurs in the interior. Perhaps the most tangible evidence of this is seen in the increased "steppiness" of water column properties as one approaches isolated islands or certain areas of the continental slope (e.g., in the Gulf of Cadiz), suggesting enhanced mixing with subsequent intrusive spreading along isopycnal surfaces.

Reference

Worthington, L V (1976). On the North Atlantic Circulation. John Hopkins Univ. Press, Baltimore, USA.

## ANNEX 3

## RECOMMENDED METHOD FOR CLEANSING MUSSELS PRIOR TO ANALYSIS*

1. Scrub the mussels free of any attached organisms and especially remove all sand, mud, etc. from the external surfaces. In handling the mussels, care should be taken to follow the recommendations contained in para. 1 of the Procedures for Preparation of Samples for Analysis (Annex II, App.I, of ACMP Report, Coop.Res.Rep., No.84).

2. Ideally, the cleansing operation should be done in the laboratory. In all but the warmest weather, mussels which have been suitably wrapped in wet paper and placed in two separate double-tied polyethylene bags in a strong cardboard box can survive up to 2 days in the post back to the base laboratory.

3. In situations where postal transfer of the samples is not possible or where it is considered unsafe, the following procedure may be followed for road transport. This has been found satisfactory for periods of up to 5 days.

   Place the mussels in plastic bags in an insulated container. Keep the bags open and ensure that there is no water in the bags - failure to do so leads to rapid accumulation of excretion products which can kill the mussels. In warm weather, place ice around the bags in the container.

4. Whenever possible, water from the general sampling area should be used for the cleansing procedure to avoid uptake or loss of contaminants from the mussels. Settle and decant or preferably filter the water to remove most of the suspended matter (for filtering pass through a commercially available large scale fibre filter, e.g., a filter similar to Acroflow II). In general, the cleansing water should be checked for gross contamination in relation to the substances being studied.

5. Stir the water thoroughly to ensure that it is well aerated and place the mussel sample in it. Leave the mussels undisturbed for 24 hours. The volume of water used should be sufficient to cover the mussels in a single layer and leave at least 5 cm of water over them.

6. At the end of 24 hours, the mussels should have freed themselves of all adventitious shell cavity silt which will have been evacuated as pseudofaeces. Usually the majority of the gut contents will also have been evacuated.

7. The mussels can be removed from the water after the 24-hour period and be prepared for analysis or preservation as previously outlined.

---

* These procedures are intended to clarify and extend the procedures to be followed for sampling and preparation of fish and shellfish to be used in monitoring programmes in the North Atlantic Area (Annex II, Coop.Res.Rep. No.84 (1979)).

ANNEX 4 *

FISHERIES ASPECTS CONCERNING THE SUITABILITY OF ALTERNATIVE SITES FOR THE INCINERATION OF WASTES IN THE NORTH SEA

As a result of discussions at its meeting in November 1978, the Oslo Commission requested the International Council for the Exploration of the Sea to provide information, particularly regarding fisheries issues, relevant to the selection of a common incineration site in the North Sea. In particular, answers to the following questions were requested:

a) what are the inter-relations of incineration of wastes at one of these sites (carried out in accordance with the London Dumping Convention's "Regulations" and "Technical Guidelines for the Control of Incineration of Wastes and other Matters at Sea") with the presence of spawning grounds, migration routes, etc.;

b) what is the relative importance of the areas with respect to fisheries activities (also based on catch statistics).

The ICES Advisory Committee on Fishery Management and the Advisory Committee on Marine Pollution considered these questions and submit the following information.

The Advisory Committee on Fishery Management and the Advisory Committee on Marine Pollution were not in a position to say whether any potential pollution as a result of the incineration process would result in adverse effects on fishery biological resources, but if there were any effects, they would most likely be on biological resources distributed in the surface or immediate sub-surface layers. This would restrict the effects to the planktonic early life-history stages of all fishery resources in the areas under consideration, and to the exploited stages of the pelagic species - primarily herring, sprat and mackerel. All of the three potential sites are within areas where mackerel and sprat spawning takes place, but are of relatively minor importance in relation to the total distribution of spawning of these species in the southern North Sea. The two alternative sites envisaged are probably less objectionable from the viewpoints of both the spawning and adult distributions of these two species than E 15. Neither the presently designated area, nor either of the proposed alternatives, is of any importance for herring at any stage of its life cycle.

As regards the early life-history stages of the demersal species, E 15 and VP 10 are both areas where some cod spawning takes place, but are relatively small in relation to the total distribution of spawning of cod in the central and southern North Sea. All three possible sites are of some importance for plaice spawning and in this respect VP 2 would seem the least objectionable. But again all three sites are small relative to the total distribution of plaice spawning.

On balance it would appear that the direct effects of potential pollution on the fishery resources are likely to be relatively small

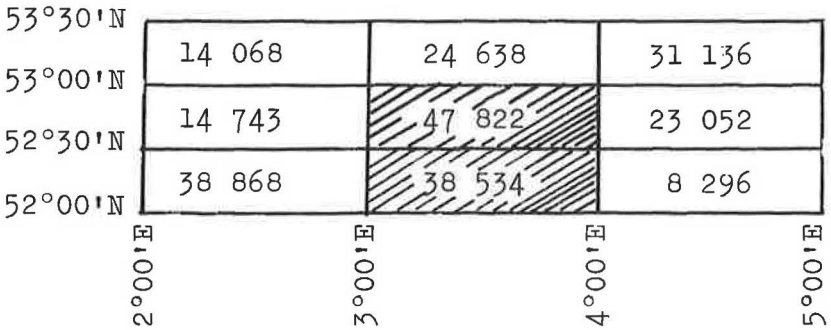
* The Advisory Committee on Marine Pollution agreed at its meeting on 6 October 1979 to add Annexes 4, 5 and 6 to the present report.

at all three sites. In this respect there is no sound basis for selecting one of the three alternatives as preferable, although VP 2 may be marginally so.

As regards direct interference with fishing activities, the data available to ICES are unsatisfactory to discriminate among the three alternatives because: 1) the data are only available for larger areas than the current or alternative sites, and 2) even within these larger areas data are available only for some of the countries which are known to fish within the southern and central North Sea.

Within these limitations, the data available to ICES would suggest that there are no significant differences in fishing effort among the three alternative sites considered. The mean annual fishing effort, measured as hours of fishing annually for ICES statistical rectangles, for the three most recent years for which there are adequate statistical data are: VE 15 - 32 800 hours; VP 10 - 47 800 hours; VP 2 - 43 000 hours. Although these values might suggest that fishing effort was higher in VP 10 than in the other areas, the year to year variation in fishing effort within areas is high, and the differences between the mean values given above are not statistically significant. On the same basis, the mean total catches taken annually within the relevant statistical squares over the same period are: VE 15 - 2 644 tonnes, VP 10 - 3 027 tonnes, VP 2 - 2 917 tonnes. The dominant species in these catches in all three areas are sole and plaice. Again VP 10 shows the highest value, but the differences between areas are not significant.

It might also be relevant to consider the mean fishing effort values over the same period compared with adjacent rectangles, which might be regarded as potential alternative sites for incineration. The values are shown below, with those rectangles cross-hatched for which VP 10 and VP 2 are sited:




Although the differences in fishing intensity between squares in the total area shown above may not be significant, it would appear that the two alternative sites selected are within squares with higher mean values than in the majority of adjacent squares. Purely on considerations of interference with fishing activities, it might be advisable to consider potential sites about 30 miles further north in the same longitude, or slightly further west.

The prevalence of south-westerly winds in the area under consideration might be an additional reason for preferring a more northerly located site than either VP 2 or VP 10.

ANNEX 5 *

# REPORT ON THE WORKSHOP ON THE PROBLEMS OF MONITORING BIOLOGICAL EFFECTS OF POLLUTION IN THE SEA

Beaufort, 26 February - 3 March 1979

by

A D McIntyre

In accordance with C.Res.1977/2:4, a Workshop was held at Duke University Marine Laboratory, Beaufort, North Carolina, during the week beginning 26 February 1979. It was attended by 54 invited scientists from 11 countries.

The aim was to examine possible approaches to monitoring biological effects; to identify those which could be recommended for immediate use, and to make proposals for their application. Thirty-six of the participants contributed papers commissioned by the Steering Group, dealing with a range of techniques, experimental procedures and field studies relevant to pollution monitoring. These papers were circulated before the Workshop and were designed to bring all members to the same level of information, and to set the scene for the discussions.

Seven themes were selected for special attention: Biochemistry, Physiology, Pathobiology, Genetics, Behaviour, Ecology and Bioassay. The first day was devoted to a plenary session at which seven papers were presented and discussed, one on each of the themes, stimulating a general exchange of ideas and comment.

The Workshop then broke up into seven panels which met separately during the following three days. Each panel was charged with examining those biological monitoring procedures relevant to its theme, assessing their usefulness, and making appropriate recommendations. On the final day the Workshop again met in plenary session and discussed the panel reports.

Brief notes are provided below on each panel's conclusions.

Biochemistry Nine techniques were discussed in detail and ranked according to nine criteria including specificity of response, signal-to-noise ratio and cost. It was suggested that the tests best suited for use in biological monitoring involved studies of adenylate energy charge ratio, lysosomal changes, heavy metal binding protein production, mixed function oxygenase induction and steroid metabolism changes. It was however pointed out that not all of these approaches had been extensively tested under a range of field conditions by a number of laboratories.

Physiology The use of growth, feeding, oxygen consumption, fecundity/reproduction, osmotic/ionic regulation, haematology, nitrogen-balance/excretion and heartbeat/ventilation rate were all examined. The panel emphasised that experience and judgment were needed in arguing from a rate or steady state measurement to a diagnosis of animal performance. It was concluded that the measurement of feeding rates (either directly or through faecal production) can provide an index of the physiological effect of

* The Advisory Committee on Marine Pollution agreed at its meeting on 6 October 1979 to add Annexes 4, 5 and 6 to the present report.

environmental contamination and that an index such as scope for growth which integrates a number of physiological measurements can provide much information on the condition or health of the individual.

Pathobiology The panel considered that no single disease or pathological sign could serve as a universal indicator of pollution, but that an effective approach to monitoring could be achieved by associating observations on pathology with biochemical, physiological, genetic and ecological parameters. Of the disease categories considered available for near-term application to monitoring programmes, the following were named - ulcers, fin erosion, tumours and skeletal anomalies.

Behaviour Three primary approaches were recognised. First, to test animals from the field, second to place animals from the laboratory or control areas into the field for a time before testing, and third to introduce water and sediment from the field into the tanks where the test animals are residing. A number of possible behavioural tests are described, including the antennular flicking rate of crabs, the closure response of mussels, the feeding behaviour of mud snails and the swimming behaviour of plankton. It was concluded that while behavioural bioassays can provide highly sensitive measures of pollution effects, their application to monitoring has yet to be fully tested.

Genetics The panel was particularly concerned with effects detectable in the genetic material itself and its immediate manifestation. It considered that monitoring allele frequencies, chromosomal anomalies and the mutagenicity of water and sediments could provide an early warning system for biological effects and it lists a battery of appropriate test systems.

Ecology The advantages of being able to measure population and community changes directly over long periods, and to work in all habitats from the intertidal zone to the deep sea, were emphasised. Ecological monitoring could deal with acute local, short-term effects, as well as chronic broad-scale changes over many decades, but the different situations require different sample designs. The panel noted the advantages of using benthic organisms in monitoring programmes, but recognised cases where plankton was preferable. While growth rate comparisons were regarded as highly effective measures, structural rather than functional parameters were in general preferred. For communities, biomass, abundance, species richness and the number of high taxa were listed, and for populations, distribution, abundance and structure were proposed. Finally, attention was drawn to the use of time-series analysis.

Bioassay The panel was concerned with techniques for assessing the biological quality of water using responses of organisms. It agreed on a number of essential requirements which the techniques must satisfy and thereafter identified the following as viable monitoring tests: oyster larval bioassay; sea urchin larval bioassay; microalgal static bioassay; and microalgal bioassays in dialysis bags. Each test is described and discussed in detail. A number of manipulative techniques are discussed (removal or breakdown of organics; removal of divalent metals; binding of metals; removal of chlorinated hydrocarbons) and while it was not felt that these could be specifically recommended at present, their possible value in identifying toxic contaminants was noted.

It was noteworthy that every panel stressed that no single procedure would be fully satisfactory for biological effects monitoring. A package of procedures is required and because of the wide range and diversity of situations it may be that a number of separate packages containing different suites of procedures should be constructed. The results of the Workshop provide suggestions for the components of such packages and give guidance as to how they may best be put together for particular situations.

It is important that biological monitoring be initiated as soon as possible and that user experience be accumulated. Only then will it be possible to assess the effectiveness of the proposals. With this in view, the proceedings of the Workshop will be published in a volume of the Rapports et Procès-Verbaux, which will include updated versions of the contributed papers along with the seven panel reports. In the meantime, the details of the Workshop will also be discussed in appropriate ICES groups - the Marine Environmental Quality Committee and the Working Group on Baseline and Monitoring Studies in the North Atlantic, with a view to producing brief specific recommendations.

## ANNEX 6 *

## ICES WORKSHOP ON POLLUTANTS AND SEDIMENTS, 24-26 SEPTEMBER 1979

1. The Workshop provided an opportunity to review 15 technical papers and to discuss technical results, varied view-points and interpretations and to compare results from different coastal environments.

   Not all pollutants could be covered; most papers covered heavy metals. These are the best known and associated with the general geochemistry of sediments. Few papers covered organic compounds, chlorinated hydrocarbons and radionuclides, although the meeting recognised their importance. Much information was reported from polluted estuaries but nothing on sediments from dump sites and drilling muds in the North Sea. Most studies covered pollution of bed sediments whereas few covered polluted suspended sediments. Also, data on fluxes of pollutants were scarce and biological effects of sediment pollutants was lacking.

   To fulfill the aims of the Workshop and develop a pilot programme sub-groups were established for the discussion of:

   1. Standardization and Intercalibration of Heavy Metal Analysis of Sediments

   The discussions on the standardization and intercalibration techniques for heavy metal analysis of sediments covered the following topics: (1) sediment sampling and preservation; (2) methods of chemical analysis for total and leachable metal concentrations; (3) standardized presentations of analytical results; and (4) intercalibration procedures. The results of these discussions are summarised below.

---

* The Advisory Committee on Marine Pollution agreed at its meeting on 6 October 1979 to add Annexes 4, 5 and 6 to the present report.

Sample Collection and Preservation

This topic was not dealt with in detail as to the type of sampling device to be used, other than to indicate that (1) undisturbed samples of the uppermost skin of the bottom sediments are required for studies of the metal concentrations in the most recently deposited material and the interactions of metallic constituents across the sediment-water interface and (2) undisturbed core samples are required for stratigraphic and geochronological studies of sediment and metal deposition at selected sites.

The samples should be collected and preserved in such a way as to avoid metallic contamination and loss of constituents before analysis. Cold storage in some form appears to be necessary as soon as possible to hinder biological activity and some chemical transformation in the sediments before sub-sampling for physical and chemical analysis of the material. Some discussions centered around the effect of freeze-drying on the sediment structure and composition but no definite conclusions were reached on the changes that might occur in the material.

Chemical Analysis of Heavy Metals

Most of the discussions centered on the methods of analysis because it was recognised that comparison of results between laboratories could only be possible if there was an agreement on the type of chemical treatment that released the total metal and leachable metal concentrations from the sediments.

Total Metal Determination

It was agreed that digestion of the samples in hydrofluoric acid (HF) in combination with strong acids (e.g., aqua regia) was the best means of extracting the total metal concentrations from the samples. Other methods that also might provide reliable total metal concentrations were considered to be (1) X-ray fluorescence (XRF), Neutron Activation analysis, and Emission Spectrographic techniques.

Chemical Partition

It was recognised that chemical partition of samples using specific extractants provides some insight into the source, carriers, and pathways of metallic constituents to their depositional site as well as the potential availability of the metals to the biota.

After some intensive discussion, a simplified extraction procedure for elemental partition was proposed involving the following steps: (1) an extraction with 0.1 M hydroxylamine-HCl for the acid-reducible fraction, (2) an extraction with $H_2O_2$ (30%) for the acid oxidizable fraction, and (3) dissolution of the remaining sample with HF to provide the metal concentrations left in the residual fraction. This technique could be further simplified by a two-step procedure which might involve for example an extraction with 25% V/V HAc for the "available" fraction followed by complete digestion in HF and aqua regia to determine the amounts of the metals in the residual or detrital fraction.

It was also suggested that various investigations be carried out to determine the potential or actual availability of the metal concentrations released by the various chemical extractants to the biota in general or to specific organisms in the sediments.

Presentation of Analytical Results

It was recognised that one of the greatest problems encountered in the comparison of published results on heavy metal concentrations in sediments is that of grain size. This is because the metal concentrations

vary with grain size in that most metals increase with decreasing grain size of the material. As a result, direct comparisons are only possible between texturally equivalent sediments of specific size fractions of the sediments. After some discussion, the group proposed that the < 63 micron-size fraction of the sediments be used for national and international comparisons of metallic contents bearing in mind that this problem requires further study.

Baseline Levels

The problem of establishing baseline levels was also considered. Where possible, it was decided that the total metal concentrations in sediment samples collected at a certain time, e.g. 1920, provided the best "base" from which to evaluate changes in metallic concentrations. Where such samples are not available, the baseline levels might be established by radiometric dating techniques in undisturbed sediment cores.

Intercalibration Procedures

In order to compare results amongst various laboratories, it was felt that some intercalibration among the laboratories was necessary to estimate the accuracy and reproducibility of the various techniques used for heavy metal analysis of sediments. The following samples were suggested for this purpose:

(1) the U.S.G.S. standard Marine Mud (MAG-a)

(2) the N.B.S.-1 river mud

(3) an unknown sandy sediment containing low levels of metals

(4) an unknown fine-grained sediment containing relatively high levels of metals.

The elements initially suggested for this intercalibration exercise were Hg, Cd, Pb, Cu, Zn, Cr, Fe, and Mn and perhaps some of the radionuclides.

Contamination of samples taken for organochlorine analysis should be avoided by proper selection and treatment of equipment in all stages of the analytical procedure including sampling.

Attempts should be made to determine the distribution of organochlorines over the various sediment constituents, both with respect to inorganic/organic fractions and grain size distribution. Attempts should be made to quantify concentrations of as many organochlorines as can be positively identified with the use of chromatographic and mass spectrometric techniques.

2. Guidelines for a pilot survey

There are a number of areas in and around the North Sea where recent deposition of fine-grained sediment takes place. These include coastal regions, such as the Wadden Sea mud flats and marshes, and offshore mud areas. In the coastal areas several institutions carry out work on sediments and pollutants which ICES could support by facilitating exchanges between scientists and by placing their activities in an international framework. In the open North Sea a number of areas with fine-grained deposits are indicated which should be investigated in the first phase of an international cooperative programme. These are:

German Bight SE of Helgoland
Zeebrugge area
English coast near the Yare
Outer Silver Pit area
Skagerrak and Norwegian Deeps

In addition, a similar site on the North American shelf such as the Gulf of Maine or the outer St. Lawrence ought to be added for comparison.

The survey techniques of the first phase should include stratigraphy studies by seismic work and side scan sonar, surface sediment distribution determinations by grab sampling, collection of box samples in at least ten places per mud area and a few piston cores. These would have to be X-rayed and their mineralogy should be determined. Surface layer conditions should be inspected with underwater cameras. Rates of deposition and influence of bioturbation should be determined by suitable radiometric and other dating techniques. A number of pollutants should be selected and determined down to unpolluted depths in the sediment.

3. Outline of a process study of pollutant dynamics in relation to bed, suspended sediment and water properties

1. Area An appropriate area with demonstrated deposition of fine-grained sediment containing one or more of the "black-list" components will be selected on the basis of preceeding regional surveys.

2. Box monitoring of fluxes A nested box approach is appropriate. The gross fluxes from adjacent rivers, coastal sources and dumping should be identified and an estimate of the flux to the sea surface from atmospheric sources of the components of interest must also be made. This will provide the basic knowledge of the overall fluxes in the region of the box selected for detailed measurement. A site for detailed monitoring should be instrumented to determine fluxes. We suggest a minimum of three moored arrays each containing at least two current meters and two transmissometers and one with a pressure transducer for waves. From these moorings, with appropriate calibration factors for transmissometers determined from gravimetric surveys, the fluxes through the area can be determined. The site of the moored arrays must be visited periodically - at least seasonally - to make measurements of the regional T, S and turbidity distribution as well as in the vertical profile over 25-hour tidal cycles at the mooring site. Parameters to be measured include velocity, temperature, salinity and turbidity (% transmission) using profiling instruments. Water samples should be taken for separation of fluid and solid, and determination of chemical components. The biota, zoo- and phytoplankton, should also be determined paying special attention to those likely to be involved in particle aggregation. Sediment traps would be useful for collection of relatively rare large particles, produced by particle (bio)aggregation that may be important in sedimentation of pollutants. Size distributions of suspended material by Coulter counter and, ideally, settling velocity distribution by in situ techniques should be determined. A box-core should be taken at the time of each survey for the measurement of gradients in properties and chemistry of surface sediment and interstitial waters. A value for the critical erosion stress for the bed should be obtained, preferably by in situ methods.

A pilot survey study as proposed here requires a coordinating group of scientists representing the various disciplines involved. This group must be given administrative and logistic support. The first phase of the proposed investigations could be carried out without immediate commitments for the second phase but it should be realised that some observations, such as current measurements and seasonal variations in suspensions, would have to be continued over prolonged periods.

The Workshop recommends that:

1. the papers will be published by ICES
2. a pilot study should be undertaken along the guidelines given above
3. a group will be established in order to coordinate this survey as well as a process study of pollutant dynamics in relation to bed, suspended sediment and water properties.

## Indication of spine colours

| | |
|---|---|
| Reports of the Advisory Committee on Fishery Management ..... | Red |
| Reports of the Advisory Committee on Marine Pollution ..... | Yellow |
| Fish Assessment Reports ..... | Grey |
| Pollution Studies ..... | Green |
| Others ..... | Black |

-o-o-o-