Intergovernmental Oceanographic Commission
Reports of Meetings of Experts and Equivalent Bodies

IOC-UNEP-IMO Group of Experts on Effects of Pollutants

Fifth Session

London, 17-20 April 1989

Unesco

In this Series, entitled

Reports of Meetings of Experts and Equivalent Bodies, which was initiated in 1984 and which is published in English only, unless otherwise specified, the reports of the following meetings have already been issued:

1. Third Meeting of the Central Editorial Board for the Geological/Geophysical Atlases of the Atlantic and Pacific Oceans
2. Fourth Meeting of the Central Editorial Board for the Geological/Geophysical Atlases of the Atlantic and Pacific Oceans
3. Fourth Session of the Joint IOC-WMO-CPPS Working Group on the Investigations of «El Niño» *(Also printed in Spanish)*
4. First Session of the IOC-FAO Guiding Group of Experts on the Programme of Ocean Science in relation to Living Resources
5. First Session of the IOC-UN(OETB) Guiding Group of Experts on the Programme of Ocean Science in relation to Non-Living Resources
6. First Session of the Editorial Board for the International Bathymetric Chart of the Mediterranean and Overlay Sheets
7. First Session of the Joint CCOP(SOPAC)-IOC Working Group on South Pacific Tectonics and Resources
8. First Session of the IODE Group of Experts on Marine Information Management
9. Tenth Session of the Joint CCOP-IOC Working Group on Post-IDOE Studies in East Asian Tectonics and Resources
10. Sixth Session of the IOC-UNEP Group of Experts on Methods, Standards and Intercalibration
11. First Session of the IOC Consultative Group on Ocean Mapping *(Also printed in French and Spanish)*
12. Joint IOC-WMO Meeting for Implementation of IGOSS XBT Ships-of-Opportunity Programmes
13. Second Session of the Joint CCOP/SOPAC-IOC Working Group on South Pacific Tectonics and Resources
14. Third Session of the Group of Experts on Format Development
15. Eleventh Session of the Joint CCOP-IOC Working Group on Post-IDOE Studies of South-East Asian Tectonics and Resources
16. Second Session of the IOC Editorial Board for the International Bathymetric Chart of the Mediterranean and Overlay Sheets
17. Seventh Session of the IOC-UNEP Group of Experts on Methods, Standards and Intercalibration
18. Second Session of the IOC Group of Experts on Effects of Pollutants
19. Primera Reunión del Comité Editorial de la COI para la Carta Batimétrica Internacional del Mar Caribe y Parte del Océano Pacífico frente a Centroamérica *(Spanish only)*
20. Third Session of the Joint CCOP/SOPAC-IOC Working Group on South Pacific Tectonics and Resources
21. Twelfth Session of the Joint CCOP-IOC Working Group on Post-IDOE Studies of South-East Asian Tectonics and Resources
22. Second Session of the IODE Group of Experts on Marine Information Management
23. First Session of the IOC Group of Experts on Marine Geology and Geophysics in the Western Pacific
24. Second Session of the IOC-UN(OETB) Guiding Group of Experts on the Programme of Ocean Science in relation to Non-Living Resources *(Also printed in French and Spanish)*
25. Third Session of the IOC Group of Experts on Effects of Pollutants
26. Eighth Session of the IOC-UNEP Group of Experts on Methods, Standards and intercalibration
27. Eleventh Session of the Joint IOC-IHO Guiding Committee for the General Bathymetric Chart of the Oceans *(Also printed in French)*
28. Second Session of the IOC-FAO Guiding Group of Experts on the Programme of Ocean Science in Relation to Living Resources
29. First Session of the IOC-IAEA-UNEP Group of Experts on Standards and Reference Materials
30. First Session of the IOCARIBE Group of Experts on Recruitment in Tropical Coastal Demersal Communities *(Also printed in Spanish)*
31. Second IOC-WMO Meeting for Implementation of IGOSS XBT Ship-of-Opportunity Programmes
32. Thirteenth Session of the Joint CCOP-IOC Working Group on Post-IDOE Studies of East Asia Tectonics and Resources
33. Second Session of the IOC Task Team on the Global Sea-Level Observing System
34. Third Session of the IOC Editorial Board for the International Bathymetric Chart of the Mediterranean and Overlay Sheets
35. Fourth Session of the IOC-UNEP-IMO Group of Experts on Effects of Pollutants
36. First Consultative Meeting on RNODCs and Climate Data Services
37. Second Joint IOC-WMO Meeting of Experts on IGOSS-IODE Data Flow
38. Fourth Session of the Joint CCOP/SOPAC-IOC Working Group on South Pacific Tectonics and Resources
39. Fourth Session of the IODE Group of Experts on Technical Aspects of Data Exchange
40. Fourteenth Session of the Joint CCOP-IOC Working Group on Post IDOE Studies of East Asian Tectonics and Resources
41. Third Session of the IOC Consultative Group on Ocean Mapping
42. Sixth Session of the Joint IOC-WMO-CPPS Working Group on the Investigations of « El Niño » *(Also printed in Spanish)*
43. First Session of the IOC Editorial Board for the International Bathymetric Chart of the Western Indian Ocean
44. Third Session of the IOC-UN (OALOS) Guiding Group of Experts on the Programme of Ocean Science in Relation to Non-Living Resources
45. Ninth Session of the IOC-UNEP Group of Experts on Methods, Standards and Intercalibration
46. Second Session of the IOC Editorial Board for the International Bathymetric Chart of the Caribbean Sea and the Gulf of Mexico
47. First Session of the IOC Editorial Board for the International Bathymetric Chart of the Western Indian Ocean
48. Twelfth Session of the Joint IOC-IHO Guiding Committee for the General Bathymetric Chart of the Oceans
49. Fifteenth Session of the Joint CCOP-IOC Working Group on Post-IDOE Studies of East Asian Tectonics and Resources
50. Third Joint IOC-WMO Meeting for Implementation of IGOSS XBT Ship-of-Opportunity Programmes
51. First Session of the IOC Group of Experts on the Global Sea-Level Observing System
52. Fourth Session of the IOC Editorial Board for the International Bathymetric Chart of the Mediterranean
53. First Session of the IOC Editorial Board for the International Chart of the Central Eastern Atlantic *(Also printed in French)*
54. Third session of the IOC Editorial Board for the International Bathymetric Chart of the Caribbean Sea and the Gulf of Mexico *(Also printed in Spanish)*
55. Fifth Session of the IOC-UNEP-IMO Group of Experts on Effects of Pollutants

Intergovernmental Oceanographic Commission
Reports of Meetings of Experts and Equivalent Bodies

IOC-UNEP-IMO Group of Experts on Effects of Pollutants

Fifth Session

London, 17-20 April 1989

Unesco

IOC-UNEP-IMO/GEEP-V/3
Paris, 29 August 1990
English only

SC-90/WS/52

TABLE OF CONTENTS

SUMMARY REPORT

ANNEXES

1. OPENING OF THE SESSION

1 The Chairman of the Group of Experts on Effects of Pollutants (GEEP), Dr. Brian Bayne, opened the Fifth Session at 10.00 hours on 17 April 1989. The Chairman expressed appreciation on behalf of the Group for the invitation of the International Maritime Organization (IMO) to hold the Fifth Session at IMO Headquarters in London. He noted the challenge of the increasing number of tasks placed upon the Group as a result of UNEP and IMO having become co-sponsors and cautioned that there was a risk that the Group, with its limited resources, might be tempted to spread itself too thinly. The Group would have to be carefully selective in addressing the tasks placed before it, in order to maintain its essential purpose, which was to catalyse the development and evaluation of techniques for measuring the effects of pollutants on marine systems.

2 The Chairman noted with regret that, owing to no staff member presently employed in the programme area, the Secretariat of the Intergovernmental Oceanographic Commission (IOC) was not able to be represented. The United Nations Environment Programme (UNEP) Technical Secretary was also unable to attend. It was noted that Dr. L. Andren, Marine Environment Division of IMO, would act as Technical Secretary for the Session.

3 The Chairman then declared the Session open.

4 Dr. M. Nauke, Chief, Office for the London Dumping Convention, on behalf of the Secretary-General of IMO, welcomed the Group. He briefly outlined the work of IMO in the field of the prevention and control of pollution from maritime transport and waste disposal at sea. The work of the Group of Experts on Effects of Pollutants and its results had been highly appreciated by IMO in providing scientific advice on the effective implementation of IMO Conventions and the London Dumping Convention. A number of items had been identified for which further specific advice from the Group to IMO is needed and it was acknowledged that most of these were included in the agenda of this Session. IMO was very pleased that it had been given the opportunity to host this meeting of GEEP, and the IMO Secretariat would do its utmost to make this Session a successful event.

2. ADMINISTRATIVE MATTERS

2.1 ADOPTION OF THE AGENDA

5 The Provisional Agenda was adopted after some modifications. The Agenda is attached as Annex I. It was considered that intersessional activities would be covered in connection with the relevant agenda items, as they came up.

2.2 DESIGNATION OF THE RAPPORTEURS

6 It was agreed to assign individuals of the Group to the reporting of specific Agenda Items.

2.3 CONDUCT OF THE MEETING

7 The documentation was reviewed and it was noted that the present Session had encountered particularly big delays with the circulation of some documents. The Group hoped that such difficulties could be avoided to the extent possible at its next Session. It was agreed to conduct the Session in plenary, excepting the formation of ad hoc drafting groups as the need arose. The List of Participants is attached as Annex III.

3. _ WORKSHOPS ON BIOLOGICAL EFFECTS MEASUREMENTS

3.1 REPORT ON TRAINING WORKSHOPS

8 The Group discussed two training workshops that had taken place intersessionally, involving scientific input from GEEP.

9 An FAO-IOC-UNEP-sponsored Workshop on the Statistical Treatment and Interpretation of Marine Community Data had taken place at the Marine Biological Station of the University of Ljubljana, Piran, Yugoslavia, from 14 to 24 June 1988. It was attended by 26 participants from 10 Eastern Mediterranean countries engaged in the Long-term Programme for Pollution Monitoring and Research in the Mediterranean (MED POL - Phase II). Dr. G. Gabrielides of the FAO Athens office was in charge of the overall organisation but GEEP were asked to mount the scientific programme for the Workshop. IOC funding facilitated the production by Prof. J.S. Gray (assisted by Mr B. Reppe, University of Oslo) and Dr. K.R. Clarke of a series of lecture notes on univariate and multivariate statistical methods used in the treatment of community data. In addition to mounting the Workshop, FAO-UNEP funding contributed towards the cost of production of a range of modern multivariate software to run on IBM/PC compatible computers (under the direction of Mr. M.R. Carr, of the Plymouth Marine Laboratory).

10 The format of the Workshop was in line with GEEP's emphasis in its training activities on the use of field-based data. Lectures drew heavily on case studies of changes in benthic faunal composition associated with pollution impact gradients, and lectures were balanced by extensive practical PC computational sessions. A central feature was the analysis of field data from the MED POL Programme, brought to the Workshop by the participants themselves. The meeting is fully reported in document FIR/MEDPOL/TW/3 (FAO, Athens, December 1988). This includes the lecture notes and an evaluation of the success of the training based on questionnaires answered anonymously by all participants.

11 The report was tabled and, from feedback through several channels, the Group agreed that this Training Workshop had been a substantial success. Indeed, an informal approach had now been made from the FAO-UNEP Athens office for IOC/GEEP to provide the scientific programme for a series of Mediterranean workshops with similar format and content. The first of these was suggested for September 1989 in Athens for Greek trainees and a second national workshop in Yugoslavia a year later. The Group felt that it could contemplate mounting a further workshop of this nature in the Mediterranean region, conditional on it being fully funded by FAO-UNEP and administratively organised by the Athens office. However, there was seen to be a need to involve one or two selected individuals from the region in that workshop, with a view to them assisting in (and possibly even taking over the running of) the rolling training programme envisaged by FAO. GEEP was concerned that it may not have the resource base of experts to take on a longer-term commitment in this one region, in view of its wider plans within the IOC regional programmes.

12 Dr. Engler described the style of IMO-sponsored workshops mounted by the LDC, for example in Mexico City, Kingston (Jamaica) and planned for Dalian (China); whilst these were somewhat different in format (based on formal seminar series and with less emphasis on practical 'hands-on' training) there was felt to be much common ground in objectives and the potential here for a good interface with GEEP activities. The Chairman welcomed this expression of commonalty of purpose and suggested that one possible route forward would be for IMO sponsorship of expert/participating

representative(s) at one of the GEEP training worskhops now under consideration; Dr. Engler undertook to pursue this avenue further.

13 A report was tabled on GEEP participation in a further training workshop on evaluating the effects of contamination on benthic communities, this being in Guayaquil, Columbia, 19-28 October 1988, and organised by the Permanent Commission for the South Pacific (CPPS). Whilst the main thrust of the workshop had originally been conceived before the direct involvement of GEEP, the aims of the course were close to those of the earlier Piran workshop and request was made for the GEEP perspective to be presented through a number of guest lectures. These were given by Prof. J.S. Gray, collaborating closely with the course director, Prof J. Tarazona (Peru) and local CPPS organizer (Dr. J. Escobar). Again, the course appeared successful in very many respects and GEEP participation was widely welcomed. Preliminary discussions took place on the prospects for GEEP providing the scientific direction for a further workshop (Columbia was a prospective venue). This would extend training to additional techniques for benthic commmunity data analysis, and be presented in a format closer to that of the Piran workshop. CPPS are believed to be undertaking a submission to their relevant funding agencies for this purpose.

14 A verbal report was given to the Group on another CPPS activity, a water-quality bioassay workshop in Cartegena (April 1988). GEEP were asked to recommend an instructor and had done so. The participation of Mr. M. Huerta was again felt to be very beneficial, and a more advanced course is apparently being planned for June 1989. However, in common with the proposal for a benthic workshop in Columbia, GEEP needs to review more timely more information about the current status of this workshop. The Group retains its interest in CPPS activities, and is aware of their strong interest in the wider range of biological effects techniques that GEEP advocates, expressed at the fourth session of IOC-UNEP-IMO/GEEP and in subsequent discussions at Guayaquil. GEEP wishes to assist in further workshop planning in this region and would welcome more information on CPPS plans.

3.2 REPORT ON THE BERMUDA WORKSHOP

15 The Group discussed the outcome of the second major IOC/GEEP International Workshop on the Biological Effects of Pollutants, Bermuda, 10 Sept - 2 Oct., 1988, (IOC Workshop Report no. 61). The Workshop was held at the Bermuda Biological Station for Research (BBS) with IOC funding for 10 invited experts and 6 scientists from the IOC Regional Programmes (with 6 other technicians/scientists participating at their own expense). In keeping with previous GEEP activities, this was a practical workshop with a major field-based component. 'Hands-on' training played a central role, in conjunction with a major research activity, directed to establishing the basis for future GEEP recommendations on sensitive biological effects measures for use in sub-tropical ecosystems. Bermuda was an appropriate location not only in that well-proven techniques had to be adapted to previously little studied sub-tropical fauna, but also the sensitivity of those techniques was put severely to the test by the generally rather low levels of contaminant impact anticipated in the Bermudan marine environment.

16 A small number of techniques was selected from those of proven utility in the field studies of the first IOC workshop (Oslo 1986, IOC Workshop Report no. 53), and these were supplemented by the addition of water and sediment bioassays, which had not been assessed at Oslo. Three main categories of tests were deployed: biochemical (studies of the MFO system and metallothionein, MT, in reef fish), whole organism (scope for growth in

a bivalve species, bioassays and lipid determinations) and benthic macrofaunal and meiofaunal community studies. The biological studies were backed by a comprehensive suite of chemical measurements, in part through collaboration with GEMSI.

17 The field study took place along two putative contaminant gradients. In addition to practical experience of field and experimental work, the training element included a seminar lecture programme, giving a brief overview of all the topics under investigation at the Workshop.

18 The objectives of the Workshop were achieved, including the clear establishment of a contaminant gradient of hydrocarbons and TBT in Bermuda's main harbour (Hamilton) and its correlative link with a range of biological effects, notably depressed scope for growth in transplanted mussels (Arca zebra). Biological correlates (metallothionein and water-quality bioassay) of a heavy metal differential were detected at the other location. Experimental studies succeeded in their aim of showing that the mixed-function oxidase (MFO) systems of sub-tropical reef fish could be monitored in a parallel way to that of previously studied temperate species. Community studies were not only able to draw instructive inferences from the comparison of meiofaunal and macrofaunal data but were able to demonstrate that, when pitched at an appropriate level of taxonomic discrimination, field studies of this sort can be carried out from start to finish in much shorter periods than usually envisaged.

19 In discussion, Dr. Engler welcomed the success of this venture and expressed his feeling that the Scientific Group of the LDC would be very interested in the Workshop results, in particular those that came closest to relating biological effect to contaminant cause, and also data on TBT, the subject of much current regulatory interest. Dr. Stebbing pointed out that, as a direct result of the Workshop, the Bermudan authorities were now taking legislative steps to control the use of TBT as a biocide in anti-fouling paint.

20 Dates for preparation of material arising from the Bermuda workshop were agreed. In keeping with the pattern established by GEEP following the Oslo workshop, the results from Bermuda would be worked up as scientific papers. Eight or nine manuscripts were expected to result and, subject to normal refereeing procedures, would be published as a special issue of the Journal of Experimental Marine Biology and Ecology, probably to appear early in 1990. The deadline for submission of manuscripts to the Chairman was 30 May 1989. After that date, the current first draft of the report to IOC would need to be updated slightly to reflect the final conclusions, and an executive summary added. Apart from these changes, the Group agreed that the current form and content of the first draft were appropriate.

3.3 PLANNING OF THE XIAMEN WORKSHOP

21 The Group discussed the invitation to IOC/GEEP, from the State Oceanic Administration (SOA) of the People's Republic of China, to mount a workshop at the Third Institute of Oceanography in Xiamen, during 1991. From the experience of two previous major workshops (Oslo and Bermuda) both with research and training components, and the training workshops of Piran and Guayaquil, several conclusions were drawn about a suitable format for the Xiamen workshop.

22 Whilst the principle of 'hands on' training of bench scientists from the IOC regions was central to GEEP's approach, it was realised that a balance must be struck between field-based investigative training and more

conventional lectures and laboratory demonstrations. Particularly important in this context is the provision of adequate documentation in the form of manuals and lecture notes. These should cover not only how the methods are carried out but illustrate their performance (and limitations) in the context of previous contaminant impact studies.

23 Previous workshops have also demonstrated how necessary it is, for a balanced picture of environmental impact, to carry out a suite of biological effects measurements (matched by appropriate chemistry) rather than a single method. Training should therefore not be too 'narrow'. GEEP also has a commitment to encourage the foremost researchers in their fields to participate in IOC/GEEP workshops. This not only ensures the highest possible standards of training but also advances research in areas of relevance to field studies and establishes links between researchers in the various disciplines of biological effects studies.

24 The Group therefore agreed that this workshop should take the form of a combined training and research activity, with the following proposed features:

(i) It would last for 24 days (18 for trainees), with three phases: an initial exploratory/research period in which techniques are modified to suit local conditions and organisms, a formal training phase and finally a field-based study, putting the training into practice.

(ii) Three main areas of training are identified, corresponding to the three manuals that IOC has now commissioned (see section 4.1), covering: the mono-oxygenase (MFO) system in fish, scope for growth in bivalves and analysis of benthic community structure. The benthic training will also include sampling and analysis methods for meiofauna. Trainees will specialize in one of these main areas, appropriate to their background, but will receive some training also in the other two topics.

(iii) A wider range of methods will be the subject of research and some introductory training. It is timely to assess these techniques in this context but too early to embark on manual preparation. They include metallothionein, immunochemical analyses and cellular pathology in fish (the latter also in bivalves) and the study of bioavailability of contaminants in the context of sediment bioassays.

(iv) For the three main topics, manuals and lecture notes will be prepared by January and March 1990 respectively. Introductory lectures will be given on all other topics being studied at the workshop, and notes for these will be prepared by July 1990. All written material will be received in Xiamen by September 1990, for translation into Chinese and reproduction and distribution to all Chinese-speaking participants.

(v) Fifteen instructors/researchers will be required to mount the programme: four in each of a) benthos, b) whole organism/ bioassay/cellular pathology studies and c) biochemistry, with an essential support team of three people in computing, field sampling logistics and co-ordination of chemical analyses. Up to 25-30 trainees could be supported on this basis, some of whom may be from outside China (WESTPAC). The much greater emphasis given

to training than in the Bermuda workshop is reflected in the ratio of students to experts; here this is 2:1 compared with 1:2 in Bermuda.

(vi) The field study will consist of one or more transects in Xiamen Harbour, reflecting impact gradients of organic enrichment and/or chemical contamination. Detailed planning has commenced and will need to be finalised (as well as facilities assessed) by a visit of a GEEP representative to Xiamen in 1990, when the main macrofauna sampling in preparation for the workshop may also take place.

(vii) The approximate cost of the Xiamen workshop is estimated (at 1989 prices) as $60K. This consists of travel costs ($38K) and 50% of accommodation costs ($12K) for the experts, and the costs of shipping equipment ($5K) and purchasing consumables ($5K). No allowance is made in these figures for ship-time, costs of Xiamen staff involved in chemical support, collection of field material, translation and reproduction of written material, hire of personal computers etc. Costs of trainees are also excluded in the above; it is assumed that Chinese students will be funded by the host nation and that both IOC and UNEP will wish to sponsor additional trainees from the WESTPAC region.

25 A preliminary proposal for this Workshop is given in Annex IV.

3.4 PLANNING OF THE BREMERHAVEN WORKSHOP

26 An overview of the draft plan for the IOC-ICES Workshop on Biological Effects of Contaminants to be held in Bremerhaven, Federal Republic of Germany, 12-20 March 1990, was given by Dr Stebbing (Annex V). Discussion led to the decision to amplify the overall strategy within the proposal and participants will be asked to emphasise coordination between different approaches that the workshop offers (e.g. the integration of fish and tissue pathology, sensitive indicators of cellular and biochemical damage and sediment chemistry).

27 The Planning Group for the Workshop has identified coordinators for each topic who will have an important role. Letters of invitation will be sent to them soon, outlining their perceived role, which is primarily one of coordinating the research effort in each topic area, overseeing the logistics of the work within the topic during the Workshop and preliminary editing of the papers once they have been prepared for publication.

28 A key factor in planning the Workshop is the selection of appropriate contamination gradients on which to deploy biological effects techniques. A track running north-west from Bremerhaven out into the German Bight has been proposed for the gradient for fish and benthic studies, while the incineration area has been selected for water quality bioassays related to the surface film.

29 An oil platform gradient has also been proposed for some benthic community studies linked to the deployment of sediment bioassays, biochemical studies on fish, and appropriate chemical analyses of hydrocarbons in sediments. While it was recognised that Shell might provide access to a suitable oil platform, historical data are already available for oil platforms in the Norwegian sector (e.g. those belonging to Phillips Petroleum). Given the importance that GEEP attaches to working along clearly defined benthic gradients, with uniform sediment characteristics and a known

and limited suite of contaminants, it would be prudent to seek consent to work near an additional rig, preferably one for which there are existing chemical data indicating a clear gradient.

30 Following the pattern set at the Oslo Workshop and the importance attached to statistical design, overall statistical standards will be maintained by a scientist who will be linked primarily to the benthic group, but who will also provide advice and assistance on statistics and data handling for the whole workshop.

31 Dissemination of the results of the Workshop will be through an ICES report in the first instance but as a linked series of papers in the open literature, probably as a special issue of a journal (as for the Oslo workshop in Mar. Ecol. Prog. Ser. and the Bermuda Workshop in J. Exp. Mar. Biol.Ecol.).

32 The estimated additional costs of the Workshop above those cost covered by the participants, is approximately $45K. It is important to consider several possible sources of funding to cover travel, subsistance and consumables in particular. The proposal will be submitted to IOC with a request for support for the research component integrating studies of fish pathology, to include gross pathology and sensitive indicators of biochemical and cellular damage. This subset of proposals is consistent with the goals of GIPME and two of its working groups, GEEP and GEMSI, in integrating sensitive indices of biological effects with sensitive chemical analyses. This work focuses on a gap identified in the Oslo Workshop.

33 IMO expressed a particular interest in aspects of the Workshop related to pollution gradients associated with oil platforms and the biological impact and chemical fate of contaminants in incineration areas. The London Dumping Convention does not itself have funds to support such work, but it is understood that they will channel the proposal to industrial sources with particular interest in these activities; IMO will also be approached directly for help in funding elements of the proposal concerned with incineration.

34 In concluding the discussion on this topic, the meeting approved the content and orientation of the most recent draft of the Workshop plans which will be submitted to IOC, requesting financial support.

35 A detailed plan for this Workshop is included as Annex V.

4. METHODS DEVELOPMENTS

4.1 MANUALS AND REFERENCE METHODS

36 GEEP has agreed to prepare Manuals describing procedures for measuring the biological effects of pollutants. These Manuals will be based on the experiences of members of GEEP in two practical workshops (Oslo and Bermuda), and general familiarity with the appropriate experimental protocols. The Manuals will be aimed at scientists with a practical scientific background who wish to undertake the biological effects measurements which have been evaluated through the Group's workshop activities. GEEP considers it best not to lay down strict guidelines as to format or content of the manuals at this stage, preferring that the author(s) of each Manual treat the subject in a manner deemed most suitable to the particular technique. However, each Manual will comprise an introduction to the scientific rationale of the procedure, a detailed

practical guide to carrying out the analyses, reference to suitable case histories to illustrate the proper interpretation of the results of the procedure, and a bibliography for further reference.

37 Three Manuals will be produced by the end of the year, with the following provisional titles:

(i) Statistical Analysis and Interpretation of Marine Benthic Community Structure;
(ii) The Mixed-Function Oxidase System in Fish;
(iii) Scope for Growth Determination in Bivalve Molluscs.

38 Draft copies of each Manual will be circulated amongst GEEP members for comment, and then sent to one or two laboratories for review including practical assessment of the procedures as described. They will then be revised as necessary and printed in the appropriate IOC format for wider circulation. However, in order that these three Manuals will comprise the basic training materials for the proposed IOC/GEEP Xiamen Workshop in 1991 (see Annex IV), the drafts will be sent to the Chinese authorities in the autumn, 1990, for translation into Chinese. Experience gained in China during this Workshop may then also be used in preparing the final drafts for publication.

39 The Group anticipates that two further Manuals may be relevant for preparation over a slightly longer time-scale, viz.

(i) Metallothionein Determination in Fish Tissues
(ii) Histopathology of Benthic Molluscs

40 These Manuals will be written by members of GEEP or on sub-contract to individuals known to the Group. It is estimated that a contract fee of $5000 per Manual would be appropriate, and would be consistent with fee schedules of other intergovernmental organizations.

41 The representatives of ICES and IMO informed the Group of their efforts along similar lines. ICES has similar targets and motivations to GEEP, and will be adopting similar procedures. Collaboration is therefore essential and welcomed by both parties. ICES has plans to produce manuals on water-quality bioassay (oyster larvae) and on the gross pathology of fish. These will be complementary to GEEP's efforts. IMO also is considering producing manuals as guidance documents to their members. These will fall into two categories: (i) descriptions of the strategies and fundamental rationale underpinning certain monitoring procedures, and (ii) more specific descriptions of particular techniques, aimed at guidance to agencies involved in carrying out LDC-recommended regulatory programmes. Manuals in this second category are similar in intention to those being prepared by GEEP and by ICES, and the meeting agreed to maintain collaboration in these efforts in order to sustain continuing complementarity.

4.2 MUSSEL WATCH BIOLOGICAL EFFECTS STUDIES

42 Dr. Capuzzo informed the meeting of progress in the preparation of a master plan for a global musselwatch programme with which she was familiar viz. continuing efforts to develop techniques for preparation and storage of mussel tissue suitable for transportation prior to chemical analysis, and plans to hold a workshop on future developments within the Mussel Watch component of the US Status and Trends Programme. It was agreed that Dr Capuzzo, who has been invited to participate in this workshop, would monitor developments on behalf of GEEP.

43 However, the Group expressed the view that an opportunity would be provided by Global Mussel Watch to incorporate appropriate biological effects techniques, and expressed a certain regret that plans for doing this were apparently not being pursued by the organizing committee. The Chairman of GEEP had recent experience of running a practical workshop in India (under the auspices of the British Council and the Government of India) on biological techniques in mussel watch programmes, and reported the success of this venture. Regional involvement in making biological measurements to complement chemical tissue analyses could represent a useful extension to the Global Mussel Watch. It was agreed that Dr Capuzzo would draw this, as well as GEEP's willingness to participate,to the attention of members of the organizing committee.

4.3 BIOASSAY TECHNIQUES

44 During discussions at both GEEP-III and GEEP-IV, the Group reviewed general aspects of bioassays, their utility in biological effects monitoring programs, and how bioassays may be used in conjunction with sediment chemistry monitoring to assess bioavailability of contaminants (See GEEP IV, Annex VII). At GEEP-V, the Group discussed the role of sediment bioassays in monitoring at some length. Appropriate choice of the test organism as well as an understanding of the biogeochemical processes that influence contaminant bioavailability are critical factors that need to be addressed before deploying sediment bioassays in conjunction with monitoring sediment chemistry and benthic community analysis. Future GEEP workshop activities focused on assessing sediment bioassays should emphasize the integration of such tests with studies of biogeochemical processes to assist in the interpretation of bioassay results. An intersessional activity is proposed (Annex II) to review the design of sediment bioassays and their utility in assessing contaminant bioavailability and interpreting changes in benthic community structure associated with contaminated sediments.

45 Bioassays to assess potential toxic effects of contaminants at the surface microlayer or at the sediment-water interface require further development. To this aim a suite of bioassay procedures was tested at the Bermuda Workshop (Section 3.2) and are proposed for both the Bremerhaven Workshop (Annex V) and the Xiamen Workshop (Annex IV). At the Bremerhaven Workshop, bioassays to assess both lethal and sublethal effects (including genotoxic effects) will be evaluated along contaminant gradients, such as those in the vicinity of an oil platform (sediment bioassays) and an incineration site (surface microlayer bioassays). GEEP welcomes specific questions from its sponsoring agencies related to the use of bioassays for assessment of environmental problems, including those associated with incineration at sea and ocean dumping. In this context, the Group welcomes the participation of the Chairman of the Scientific Committee of the LDC at GEEP meetings.

5. VULNERABLE AREAS

46 Previous discussions on this item within GEEP have focussed on coastal mapping (GEEP-III) and the need for adequate dose-response relationships (GEEP IV). As an intersessional activity between GEEP-IV and GEEP-V, an ad hoc group prepared a discussion paper on "The Measurement of Vulnerability in the Designation of Ocean Areas" (Annex VI), which draws attention to the increasing sensitivity and integration amongst measures of pollution impact which may be used to assess the response of marine systems to disturbance.

Discussion centred on formulating a response to IMO's request for comment and guidance on criteria for the designation of Special Area Status and Particularly Sensitive Sea Areas, as described Annex 10 of MEPC 26/25; discussion was confined to the ecological and scientific aspects of this topic, and is summarised below under the same headings as the MEPC paper.

5.1 CRITERIA FOR DESIGNATION OF SPECIAL AREA STATUS

Oceanographic conditions

47 GEEP considered that the four oceanographic conditions proposed in MEPC 26/25 were appropriate and correct.

Ecological conditions

48 GEEP considered that the conditions proposed were appropriate but would urge amendment of ".3 areas of high productivity" to read as follows:

".3 areas of high productivity (such as fronts, upwelling areas, gyres)"

and add a further item to this list (with subsequent modification to numbering):

".4 spawning, breeding and nursery areas for important marine species and areas representing migratory routes for sea-birds and mammals."

49 Rationale: spawning, breeding and nursery areas are not necessarily high productivity areas and yet the high productivity areas need to be considered per se.

5.2 CRITERIA FOR PARTICULARLY SENSITIVE SEA AREAS

50 GEEP considered carefully the characteristics which contribute to giving an area particularly sensitive sea area status which were proposed by MEPC. The Group was guided in this discussion by the book (see Annex VII) published by the International Union for Conservation of Nature and Natural Resources (1984) entitled: "Marine and Coastal Protection Areas: A Guide for Planners and Managers", by R.V. Salm and J.R. Clark. This publication offers a comprehensive and up-to-date analysis of the ecological context to the identification and designation of ecosystems which may be vulnerable to disturbance and stress.

51 The MEPC definition of a Particularly Sensitive Area (MEPC 26/INF.20) comprised areas that "because of their significance for recognized ecological or socio-economic or scientific reasons may be vulnerable to damage by maritime activities". In order to be designated, an area should meet one of a number of criteria, which are listed below with comments.

Ecological Criteria

52 Rare and fragile ecosystems This is an acceptable criterion and is in part equivalent to IUCN's item No. 5 "Uniqueness". The IUCN definition is fuller, and GEEP believes more explanatory; "Uniqueness is whether an area is 'one of a kind'. Habitats of endangered species occurring only in one area are an example. The interest in uniqueness may extend beyond country borders, assuming regional or international significance. Unique sites should always have a high rating".

53 Dependency GEEP does not believe that this criterion, as stated, reflects current scientific perception. As written, the statement would apply to all ecosystems everywhere. GEEP proposes an amendment to:

"The degree to which the ecological processes of an area are dependent on biotically structured systems (e.g. coral reefs, kelp forests, mangrove forests, sea-grass beds). Such biotically structured ecosystems often have high diversity, which is dependent on the structuring organisms. Dependency also embraces areas representing the migratory routes of marine birds and mammals".

54 Representativeness GEEP believes that the definition is imprecise.

55 Representativeness is "the degree to which an area represents a habitat type, ecological process, biological community, physiographic feature or other natural characteristic. If a habitat of a particular type has not been protected, it should have a high rating. (A classification scheme for coastal and marine areas is desirable in applying this criterion.)", (IUCN, 1984).

56 Diversity Again GEEP believes that the MEPC criterion is too imprecise and prefers the IUCN definition.

57 Diversity encompasses "the variety of richness of ecosystems, habitats, communities, and species. Areas having the greatest variety should receive higher ratings. However, this criterion may not apply to simplified ecosystems, such as some pioneer or climax communities, or areas subject to disruptive forces, such as shores exposed to high energy wave action".

58 Productivity High productivity can in fact be deleterious (e.g. anoxic sea-beds in the Kattegat due to eutrophication). GEEP believes therefore, that the criterion should be amended.

59 "Production is the net result of biological processes which result in an increase in biomass. Areas of high natural productivity (e.g. oceanic fronts, upwelling areas and some gyres) should receive a high rating".

60 GEEP noted that the IUCN document includes three criteria which were not included in the MEPC criteria, Naturalness, Integrity and Vulnerability. These are defined as:

"Naturalness; the lack of disturbance or degradation. Degraded systems will have little value to fisheries or tourism, and make little biological contribution to these. A high degree of naturalness scores highly. If restoring degraded habitats is a priority, a high degree of degradation may score highly."

"Integrity; the degree to which the area is a functional unit - an effective, self-sustaining ecological entity". The more ecologically self-contained the area the higher the rating that should be given."

"Vulnerability is defined as "the area's susceptibility to degradation by natural events or the activities of people. Biotic communities associated with coastal habitats may have a low tolerance to changes in environmental conditions, or they may exist close to the limits of their tolerance (defined by water temperature, salinity, turbidity or depth). They may suffer such natural stresses as storms or prolonged emersion that determine the extent of their development. Additional stress (such as domestic or industrial pollution, excessive reduction in salinity, and increases in

turbidity from watershed mismanagement) may determine whether there is total, partial, or no recovery from natural stress, or the area is totally destroyed".

61 GEEP believes that these criteria should be included by the MEPC and considers that Integrity is particularly important (see report GEEP II). In designating Particularly Sensitive Sea Areas it is essential that such areas should be functional units and not simply convenient geographical entities.

Scientific and educational criteria

62 GEEP accepts the criteria posed and notes the similarity to IUCN criterion No. 10.

General comments

63 GEEP believes that the requirement in MEPC 26/25, annex 2, page 2 that "in order to be designated as a Particularly Sensitive Sea Area, the area must meet one of the criteria listed" is inadequate. Care must be taken in the interpretation of the criteria. For example, a habitat with high diversity in a highly productive area (two criteria) may simply represent a widespread biological system that is not unique (e.g. kelp forests). Conversely, a low diversity, low productivity site which does not contain rare species may nevertheless represent a unique habitat.

64 GEEP would draw the attention of MEPC to the thorough appraisal of criteria for identifying and selecting coastal and marine protected areas by IUCN (1984; see Annex VII). The report considers carefully social, economic, ecological, regional and pragmatic criteria, and the analysis is therefore considerably more comprehensive than that offered by MEPC.

65 In the opinion of GEEP, the IUCN document gives a first-class, competent, up-to-date coverage of the topic and recommends that IMO seek the advice of IUCN in further deliberations on this topic.

5.3 FURTHER DISCUSSION OF VULNERABLE AREAS

66 The Group considered the use of sensitive biological effects techniques in establishing dose-response relationships as a means of comparing the vulnerability of different marine benthic communities to contaminant-induced perturbations (Annex VI). To extend this comparison further, GEEP proposes to examine specific case histories of oil spills and chronic petroleum pollution to assess whether or not the recoverability of an ecosystem can be equated with its vulnerability. If an equivalence were to be demonstrated, this would create many possibilities for detailed investigation of the ecosystem properties that define vulnerability. In such an analysis the Group will evaluate the degree to which habitats that are vulnerable to oil exposure may be ranked in terms of the likely persistence of petroleum hydrocarbons, the physical characteristics of the habitat, and the biological characteristics of the dominant flora and fauna. Furthermore, the Group will test the null hypothesis that:

67 **Following disturbance, functional attributes of communities are altered to the same degree as structural attributes.**

68 These comparisons will include:

(i) comparison of sensitive indices of community structure over a time-course of contaminant persistence;

(ii) examination of functional properties of the community over the same time-course; and

(iii) integration of both structural and functional properties in determining the resilience of communities to further stress and the recoverability following disturbance.

69 Case histories will be chosen from different environmental regimes (e.g., boreal, temperate, sub-tropical, etc.) and different habitat types (coral reef, soft-sediment, natural seeps etc.). Some of the features known to affect the sensitivity of communities to petroleum hydrocarbons vary along a geographical axis, through gradients in the degree of biogenic interactions within communities and the significance of seasonal factors in production, energy flow, and nutrient cycling. This analysis will provide GEEP with a focus for future studies in expanding the integration of functional and structural properties of communities to assess the effects of low-level contamination in the marine environment. The Group therefore recommends that an intersessional ad hoc group be convened to undertake the analysis of appropriate case histories (Annex II).

6. PLANKTON BLOOMS AND EUTROPHICATION

70 As in previous years, the Group briefly discussed recent developments in this topic. In particular, during 1988 two blooms occured for which members had personal experience. In one case, significant ecological and economic problems resulted (**Chrysochromulina polylepis** in Scandinavia) and in the other case significant human health problems followed (**Nitzschia pungens** at Prince Edward Island, Atlantic coast of Canada). The C. **polylepis** bloom arose off the Swedish coast and spread along the south coast of Norway (a distance of 200 km) causing mortalities, from the intertidal to the depth of the picnocline at 15-20 m, to algae, benthic animals and fish. There were large mortalities in commercial salmon and trout farms (value US$ 10 million). In Canada, the N. pungens bloom led to severe shellfish poisoning by domoic acid accumulation in the common mussel (**Mytilus edulis**) and to three deaths - over 100 people being hospitalized.

71 A link is often assumed to exist between plankton blooms and the degree of eutrophication. Yet in both the above cases the link to eutrophication is not well-founded. In the case of C. **polylepis**, although nitrogen levels were abnormally high and can be traced to high fresh-water flow from German rivers, studies in Norway showed that the nitrogen requirement of C. **polylepis** at its maximum density could be met by normal nutrient levels. In Canada traditional nutrient measurements prior to the bloom did not record abnormal values.

72 In enclosed sea areas (e.g. the Kattegat, the inner Oslo fjord, the northern Adriatic), there is little doubt that increased nutrient discharge is associated with abnormal plankton blooms and development of anoxic waters. There is also strong evidence that nutrient levels are linked to **Phaeocystis pouchetti** blooms along the eastern seaboard of the North Sea. On the other hand there is no evidence that open areas of the North Sea are eutrophic.

73 GEEP endorses the need to establish a better understanding between nutrient inputs and abnormal plankton blooms. Research programmes already established in the North Sea, Scandinavia and Canada, amongst others, are designed to elucidate the relationships between nutrient dynamics in coastal and shelf waters and the development of phytoplankton blooms. At the present

time there is little that the Group can do to enhance or complement these initiatives, although a 'watching brief' for GEEP was considered to be appropriate.

7. MARINE MAMMALS

74 The ICES-IOC Working Group on Effects of Pollutants on Marine Mammals met in Spring 1987 and its final report had been accepted by ICES/ACMP in 1988. A background paper written for this report by the IOC representative was recast as a review article ("**Organochlorines and Marine Mammal Reproduction**") and published (Addison, R.F., Can. J. Fish. Aquat. Sci., 46: 360 - 368, 1989).

75 Dr. Addison had been involved informally in several studies related to the outbreak of phocine distemper virus (PDV) in North Sea common seals. At the time of writing, the situation was that PDV had infected large numbers of southern North Sea common seals during spring and summer 1988; other seal species seem not to have been significantly affected, although antibodies to PDV had been detected in western North Atlantic grey seals, indicating their previous exposure to the virus. (No mortality attributable to PDV has been observed in this group.) Though PDV was widespread, and was the primary infection, most deaths in North Sea common seals resulted from secondary infections mainly of the respiratory system. The distribution of seal deaths, which were concentrated in southern North Sea animals, suggested that the agent responsible was associated with some environmental factor. One such factor may be temperature, which may have allowed the growth of a particular pathogen. Another possibility is that the presence of organochlorine pollutants, which may be higher in southern than in northern North Sea animals, may have interfered with the normal functioning of the animalsy'immune system. This is being studied at present.

76 In view of the complexity of variables (including pollutant burdens) that may be associated with dysfunction of the immune system or with other effects, the best approach to defining the role (if any) of pollutants in the epizootic would be experimental rather than observational. An experimental study which attempts to relate organochlorine exposure to immune response and other biological effects will be carried out during the next couple of years by Dutch scientists, in collaboration with scientists from the U.K. and Canada. The Group approved this experimental approach.

8. INTERACTIONS WITH OTHER BODIES

8.1 WITHIN GIPME

77 Unfortunately it was not possible to arrange for GEMSI attendance at GEEP-V. Consequently activities of joint interest were briefly reviewed. Chemical analyses carried out by GEMSI in Bermuda had, as in Oslo, proved to be an essential component to the success of the workshop, and a paper describing these results would be published along with the more biological data in the final report. The Group re-stated its view that close liason between chemists and biologists was an essential requirement for effective pollution impact studies. Accordingly, in the plans for a workshop in Xiamen (Section 3.3 and Annex IV) GEEP was proposing attendance of a chemist who would coordinate the analytical chemistry of the samples, liasing with scientists within Xiamen. As these plans are developed in detail, the Group would welcome discussions with GEMSI. The Chairman would arrange a meeting with the Chairman of GEMSI to discuss these and other matters.

8.2 OTHER ORGANISATIONS

78 GEEP-V benefited from the attendance of the ICES representative, Dr F Thurberg, particularly in the light of planning for the joint ICES-IOC Bremerhaven Workshop (Section 3.4 and Annex V). It is essential that ICES and IOC maintain close collaboration in their joint efforts to develop procedures for measuring the effects of pollutants on marine systems e.g. the production of practical manuals and reference methods (Section 4.1). At an appropriate time following the Bremerhaven field programme a joint seminar between ICES and IOC/GEEP would be welcome to discuss developments and future plans.

79 The Session also benefitted from the attendance of the Chairman of the IMO/LDC Scientific Advisory Committee, Dr R Engler, who was able to report directly on the SAC's discussions on bioassays, manuals and training seminars. The Group found this contact immensely valuable and urge that a member of this Committee regularly attend GEEP meetings.

9. FUTURE TRAINING ACTIVITIES

80 By the end of 1991 GEEP will have run, or participated in, at least three "research" Workshops (Oslo, Bermuda and Bremerhaven) and three "training" Workshops (Piran, Guayaquil and Xiamen). These Workshops should have established the utility of some core methods for biological effects monitoring, particularly hepatic MFO induction, scope for growth, and multivariate analysis of community structure. The training workshops in particular should have introduced these approaches to "Third World" scientists as monitoring techniques to assess the effects of marine pollution.

81 Although formal "training" of environmental regulators in developed countries is hardly within IOC's remit, Group members felt that GEEP should investigate methods of disseminating to this audience information about approaches developed and evaluated during GEEP workshops. One method might be to hold a Workshop in which the GEEP approaches were evaluated "blind" on samples provided by the "audience" (within constraints suggested by GEEP) but this was probably a relatively expensive though convincing way of achieving the objective. A more practical approach might be to review the results of the Oslo, Bermuda and Bremerhaven workshops by mid-1990, with a view to publishing the overall conclusions in the appropriate literature, perhaps Marine Pollution Bulletin. Another procedure, suggested by the IMO representative, would be to make a presentation to (perhaps) the Scientific Advisory Committee to the London Dumping Convention, as this body had already expressed its interest in GEEP's philosophy and methods. In that context, the value was emphasised of producing <u>professional</u> visual aids (slides, overheads etc.) as a method of creating the correct impression on the targeted audience. There was general agreement among the Group that such documentation of GEEP's successes was probably the most practicable and desirable way to advertise the GEEP philosophy to a scientifically literate, but non-specialist audience. Members of the Group would continue to explore opportunities to communicate the results of GEEP activities as widely as possible within their individual spheres of influence.

10. ADOPTION OF THE INTERSESSIONAL PROGRAMME

82 Five intersessional activities were agreed as follows.

(i) The Planning Group for the Bremerhaven Workshop will continue to meet to carry out the detailed planning (see Annex V), in

consultation with the coordinators, some of whom will be closely associated with GEEP. Dr Capuzzo will continue to act as GEEP representative both on the Planning Group and on the ICES Biological Effects Working Party.

(ii) The planning of the Xiamen Workshop (see Annex IV) will also be a priority. Immediate action was agreed for the Chairman to write to the Director of Third Institute in Xiamen, and the Vice-Chairman of the PRC State Oceanographic Administration, to resolve outstanding financial questions, in order that a final budget may be agreed with IOC. It is recommended that a member of GEEP (Dr K R Clarke) travel to Xiamen in the spring, 1990, for detailed discussions with the local scientists to complete the science plan for the Workshop.

(iii) The preparation of three Manuals (Section 4) will proceed during the inter-sessional period, on contract to IOC, for completion of first drafts by the end of the year (Drs Addison, Bayne and Clarke).

(iv) A review is planned (Annex II) of the design of sediment bioassays and their utility for interpreting changes in benthic community structure associated with contaminated sediments (Professor J Gray).

(v) An analysis of case histories of oil spills and chronic petroleum pollution to assess whether the recoverability of a community or ecosystem may be equated with its vulnerability, and whether structural and functional attributes of communities are equally affected by contamination (Annex II). Dr Capuzzo and Professor Gray will coordinate this activity, in consultation with Dr Bayne and co-opted members.

11. ELECTION OF OFFICERS

83 It was agreed that Dr Bayne and Dr Capuzzo would continue to serve as Chairman and Vice-Chairman, respectively.

12. ADOPTION OF THE REPORT AND CLOSURE OF THE SESSION

84 The draft report was discussed and adopted in plenary session on 20 April and the Chairman, having thanked the IMO officers for their hospitality in hosting the meeting, and the members of the Group for their continued commitment to GEEP, closed the Session at 18.00 hours on 20 April.

ANNEX I

AGENDA

1. OPENING OF THE SESSION

2. ADMINISTRATIVE MATTERS

   2.1 ADOPTION OF THE AGENDA
   2.2 DESIGNATION OF THE RAPPORTEURS
   2.3 CONDUCT OF THE MEETING

3. WORKSHOP ON BIOLOGICAL EFFECTS MEASUREMENTS

   3.1 REPORT ON TRAINING WORKSHOPS
   3.2 REPORT ON THE BERMUDA WORKSHOP
   3.3 PLANNING OF THE XIAMEN WORKSHOP
   3.4 PLANNING OF THE BREMERHAVEN WORKSHOP

4. METHODS DEVELOPMENTS

   4.1 MANUALS AND REFERENCE METHODS
   4.2 MUSSEL WATCH BIOLOGICAL EFFECTS STUDIES
   4.3 BIOASSAY TECHNIQUES

5. VULNERABLE AREAS

   5.1 CRITERIA FOR DESIGNATION OF SPECIAL AREA STATUS
   5.2 CRITERIA FOR IDENTIFICATION OF PARTICULARLY SENSITIVE SEA AREAS
   5.3 FURTHER DISCUSSION OF VULNERABLE AREAS

6. PLANKTON BLOOMS AND EUTROPHICATION

7. MARINE MAMMALS

8. INTERACTION WITH OTHER BODIES

   8.1 WITHIN GIPME (GEMSI, GESREM)
   8.2 OTHER ORGANIZATIONS (LDC/SGD, GESAMP, ICES AND OTHER INTERNATIONAL BODIES)

9. TRAINING AND OTHER REGIONAL ACTIVITIES

10. ADOPTION OF INTERSESSIONAL WORK PROGRAMME

11. ELECTION OF OFFICERS

12. ADOPTION OF THE SUMMARY REPORT AND CLOSURE OF THE SESSION

ANNEX II

RECOMMENDATIONS

Recommendation GEEP-V.1

PRACTICAL WORKSHOP ON BIOLOGICAL EFFECTS MEASUREMENTS

Mindful of the continuing need to develop, apply and effect training in the use of biological effects measurements,

Noting the interest expressed by the People's Republic of China in this subject, and their invitation to IOC to host a Practical Workshop,

Noting further the stated commitment by GIPME that regional practical workshops on biological effects techniques be organized,

GEEP recommends that a practical workshop on biological effects be organised in Xiamen, China in 1991, with the aims of achieving further evaluation of, and training in, the developing suite of techniques of biological impact analysis.

Recommendation GEEP-V.2

VULNERABLE AREAS

Recalling that one of GEEP's main objectives is to expand the scientific understanding of the concept of vulnerable areas,

Noting progress that has been achieved in this area by dialogue with IMO and others,

Considering that further analysis of available case histories will yield further scientific insight,

GEEP recommends that an intersessional ad hoc group be set up, comprising the Vice-Chairman, Professor Gray and one other member, in order to examine case histories of oil spills and chronic petroleum pollution to assess whether the recoverability of an ecosystem can be equated with its vulnerability.

Recommendation GEEP-V.3

THE SIXTH SESSION OF THE IOC-UNEP-IMO GROUP OF EXPERTS ON EFFECTS OF POLLUTANTS

Noting that considerable intersessional activity is proposed for 1989 and 1990,

Noting further that the joint ICES-IOC Bremerhaven Workshop is planned for March 1990,

GEEP recommends that the Sixth Session of the Group of Experts on the Effects of Pollutants be held in the summer 1990, in order to review the results of the Bremerhaven Workshop, consider progress in the preparation of the practical manuals, effect further planning for the proposed Xiamen Workshop, and evaluate progress in formulating scientific guidelines on vulnerable areas.

ANNEX III

LIST OF PARTICIPANTS

INVITED EXPERTS

Dr. R. Addison
Bedford Institute of Oceanography
PO Box 1006
Dartmouth N.S.
Canada B2Y 4A2
Tel: (902) 426-32-79
Telemail:Bedford.Inst

Dr. B.L. Bayne (Chairman)
Director
Plymouth Marine Laboratory
Prospect Place, West Hoe
Plymouth, PL1 3DH
United Kingdom
Tel: (0752) 222772
Telemail: B.Bayne

Dr. J. McDowell Capuzzo (Vice-Chairman)
Woods Hole Oceanographic Institution
Department of Biology
Woods Hole
MA 02543
USA
Tel: (617) 548-1400
(ext. 2557)
Telemail: J.Capuzzo

Dr. K.R. Clarke
Plymouth Marine Laboratory
Prospect Place, West Hoe
Plymouth, PL1 3DH
United Kingdom
Tel: (0752) 222772
Telemail: PML.UK

Dr. J.S. Gray
Universitet I Oslo
Institutt for Marin Biologi og Limnologi
Avd. for Marine Zoology og Marin Kjemi
PO Box 1064
0316 Blindern
Oslo 3
Norway
Tel: (472) 45-45-10

Dr. A.R.D. Stebbing
Plymouth Marine Laboratory
Prospect Place, West Hoe
Plymouth, PL1 3DH
United Kingdom
Tel: (0752) 222772
Telemail: PML.UK

Dr. Zhang Yusheng
Third Institute of Oceanography
State Oceanic Administration
PO Box 70
Xiamen - Fujian
China
Tel: 24880
Tlx: 22536 NBO CN

INTERNATIONAL COUNCIL FOR THE EXPLORATION OF THE SEA

Dr. F. Thurberg
Milford Laboratory
NEFC/NMFS
212 Rogers Ave.
Milford, CT.06460
USA
Tel: (203) 783-4244

INTERNATIONAL MARITIME ORGANIZATION

Dr. M. Nauke
Marine Environment Division
4 Albert Embankment
London
Tel: (01) 735-76-11
Tlx 23588

Dr. L. Andren (Technical Secretary)
Marine Environment Division
4 Albert Embankment
London
United Kingdom
Tel: (01) 735-76-11
Tlx 23588

Dr R. Engler
CEWES EP-D
USAE Waterways Experiment Station
P O Box 631
Vicksburg
MS 39180
USA

ANNEX IV

PRELIMINARY PROPOSAL FOR A GEEP WORKSHOP IN XIAMEN, PRC, IN 1991

The results of the two previous GEEP Research and Training Workshops at Oslo and Bermuda have shown that a number of sensitive approaches exist which can indicate reliably the biological effects of pollution at sub-acute levels. Such approaches include biochemical measurements, especially of the hepatic mixed function oxidase enzyme system in fish; physiological measurements, especially of scope for growth in bivalves; and multivariate statistical analyses of benthic community structure. GEEP intends to disseminate these approaches to a wider scientific community, initially through an invitation from the State Oceanic Administration, PRC, to mount a combined training and research workshop in Xiamen. The format of this Workshop will be based on GEEP's experience in the Oslo and Bermuda Workshops, and on experience of two exclusively training Workshops in Piran, Yugoslavia, and in Guayaquil, Ecuador. The following arrangements are proposed:

(i) The Workshop would need to extend over a total period of about 24 days, though it is envisaged that the trainees would need to be present for at most 18 days. There would be three main phases.

a) An initial exploratory/research period is necessary in order that techniques which have been developed mainly in temperate waters can be modified slightly for use with local organisms and with the equipment available to the Workshop. This is an essential first stage if the practical training of the workshop is to be effective. However, there can be confidence that adjustment to local fauna will not be a significant problem; this was the main aim of the Bermuda workshop, and it was seen there that the techniques that will form the core of training at Xiamen were readily adaptable to sub-tropical environments. Also during the first week, the intention is to give some preliminary lectures on basic (univariate) statistical analysis for biological effects data, and some sampling design considerations for such studies. This would be appropriate to all trainees (though they would not need to attend this part of the workshop if they already had a background in basic statistics).

b) Training proper will start at the beginning of the second week. Week 2 will be devoted to a formal training phase, focussed on lectures and practical demonstrations on the three main topics: the MFO system in a sedentary bottom-living fish, 'scope for growth' in a bivalve species (possibly **Perna viridis**) and benthic community analysis. The benthic training will be principally on the use of modern methods of multivariate statistical analysis to analyse species abundance and biomass data, with practical sessions analysing literature data from pollution gradients (and any data of this sort that trainees may bring to the workshop). There will also be some training on sampling and identifying meiofauna.

c) The third week will consist of the field-based study, putting the training into practice on a range of material collected from Xiamen Harbour, either prior to or during the workshop.

A sketch timetable can be found in the attached table. Note that though individual trainees will need to specialise in one of the

three main training areas (lectures and practical demonstrations in Week 2 will take place in parallel for the three areas) there will be an opportunity at the end of that week for less detailed training in the other two main areas.

(ii) An important feature of GEEP workshops is the participation of experts who are advancing the range of biological effects techniques available for practical deployment. Not only does this encourage research in directions which are appropriate to the GIPME programme, and promote links between biological disciplines, but the incorporation of such research activity within a training workshop leads to the breadth and depth of quality of training which seems appropriate to the IOC regional programmes. Thus, several other techniques would be the subject of research and some introductory training. These are methods which it is timely to assess in this context, but for which it is too early to embark on preparation of manuals and full-scale training courses. The proposal is that they include metallothionein measurement, immunochemical analyses and cellular pathology for the same bottom-living fish species used for the MFO training (and possibly cellular pathology in the same bivalve species as used for scope for growth), and the study of bioavailability of contaminants in the context of sediment bioassays.

(iii) Over the coming months, a number of possible researchers/instructors would need to be contacted, and consultations take place on equipment needs and the detailed facilities that the Third Institute at Xiamen could provide. The State Oceanic Administration has confirmed that the host institute at Xiamen will be in a position to provide general facilities, such as a research vessel, laboratory space, common chemicals etc., and the Third Institute is also rather well-equipped in certain specialist areas.

(iv) Feedback from previous workshops has emphasised the importance of adequate written material, for efficient assimilation (and later use) of the methods which are the subject of training. It is therefore an essential feature that the core subjects are those for which an IOC/GEEP manual is available. Lecture notes would Also need to be prepared for all lectures. Manuals and lecture notes for the three main topics will be prepared by January and March 1990 respectively. Each manual will comprise an introduction and rationale for the procedures, a detailed guide to carrying out analyses, reference to suitable case histories to illustrate the proper interpretation of results, and a bibliography for further reference. Lecture notes will be in the form of the content of overhead projector transparencies used to give the lectures. In addition, introductory lectures will also be given on all methods being examined at the workshop (these will be spread out over the training period as appropriate and scheduled so that they can be attended by all trainees, if they so wish). Lecture notes for these, again in the form of content of overheads, will be prepared by July 1990, and both manuals and lecture notes will be received in Xiamen by September 1990, for translation into Chinese by the host institute and reproduction of enough copies to distribute to all Chinese-speaking participants. Lectures will be given in English and the intention is that trainees will be selected who have a minimal grasp of English, sufficient to follow the lectures from the translated lecture overheads, without requiring simultaneous translation.

(Translators would still need to be present for question and answer sessions during lectures, and for practical demonstrations.)

(v) The proposal is that fifteen GEEP instructors/researchers would be needed to mount the training/research programme of the workshop, probably all of them needing to be in Xiamen for the full 24 day period. Five instructors in benthos/statistics/computing willmount the pre-course statistics training, the main statistical training for benthic community analysis and training ofmeiofaunal sampling, identification and analysis. Up to 15 students could be trained in this way (on the assumption that enough IBM/PC compatibles are made available by Xiamen for the Workshop - a ratio of no worse than three students to one machine is desirable). Four instructors/researchers will particpate in each of the individual organism and biochemical training programmes, and will be able to train up to 6-8 students in each topic. At the present time, it is unclear how many WESTPAC trainees might be expected to come from outside China, but the majority of them would be expected to be from within China. The final two instructors will have the role of logistical co-ordinators, firstly to co- ordinate the field sampling (and collaborate with local Xiamen staff on general matters to do with facilities), and secondly to co-ordinate chemical analyses. As proven in previous practical workshops, close linking of relevant chemical analysis with the biological techniques is essential for proper interpretation, and this is therefore an important constituent in the Xiamen plans. Manpower to undertake some chemical analysis is being provided by the host institute.

(vi) A field survey of a spatial pollution gradient, examined at one point in time, has proved to be a viable format for previous practical assessment/training in biological effects techniques and a similar approach is proposed here. One or more transects will be taken in Xiamen Harbour, reflecting impact gradients of organic enrichment and/or chemical contamination. Published information on the background physical variables (hydrography, sedimentology, particulate load etc.), chemical contaminants (information mainly on metals) and the results of preliminary macrofaunal surveys have already been studied, and several recommendations have been made to the host for further preliminary study. Of particular importance is the need for an adequate control ('reference') site with lower levels of pollution impact, so that the biological effects of contaminants can be properly assessed; a location near the south or south-eastern coastline of Xiamen Island has been suggested. However, this should also satisfy the central criterion that the sites selected for the workshop field study are as similar as possible in terms of background physical environment, i.e. have the same water depth and sediment grain size, and not too dissimilar salinity ranges, current strengths etc. It must be possible to catch some species of bottom-living fish at most of the sites (including the control site) and preferably find native bivalve populations (perhaps **Perna viridis**). A transplantation experiment over a 2-week period during the course of the workshop is suggested if native bivalve populations are not available at most sites.

(vii) Preliminary discussions will be held in due course with instructors/researchers who may be asked to participate in this workshop, to ascertain what scale of field sampling will be

necessary (how many organisms will be needed, of what type, and at what stages of the workshop, what the best sampling sites might be in view of the preliminary chemical and physical data we now have from Xiamen, etc.). Ultimately, a detailed document will be prepared laying out sampling requirements and equipment needs, andthese would need to be discussed in detail during a proposed visit of a GEEP representative to Xiamen (and possibly SOA) in 1990.

(viii) An initial estimate of the likely costs, at 1989 prices, of mounting the Xiamen Workshop is as follows:

	$k
Travel for instructors/researchers	38
Accommodation for instructors/researchers (50%)	12
Shipping of equipment	5
Specialist chemical consumables	5
	$60k

(There would be an additional $3k, approximately, falling in 1990 rather than 1991, for the visit of a GEEP representative to Xiamen). The above costings assume that, as agreed with the Deputy Director of the National Bureau of Oceanography, Beijing, the host institute will provide research vessel time, local manpower (e.g. for the sampling programme and some chemical analyses), laboratories, meeting rooms, local transportation, translators, common chemicals, photocopying, computers, etc., at no charge. They would also provide 50% of the local accommodation costs for the instructors/researchers (total estimated at $24k). The institute has also undertaken to perform macrofauna sampling and work up the data (sorting, identifying, counting and weighing) in advance of the workshop. (Meiofauna sampling and analysis will be carried out by two GEEP instructors during the workshop). Note that the above estimates do not include costs of trainees.

Table: Sketch of proposed timetable for the Xiamen Workshop.

	Sat	Trainers/researchers arrive and set up labs.	
	Sun		
Week 1 Research and pre-course training	*Mon*	Field sampling for research phase (including meiofaunal sampling & initiating transplants).	Research continues throughout period of Workshop between formal teaching periods. (Latter have priority for equipment and staff, when scheduled).
	Tue		
	Wed	Trainees arrive.	
	Thu	Lectures on basic statistics (ANOVA etc.) and	
	Fri	PC practical sessions on these (Statgraphics).	
	Sat	Lectures on sampling design for 'effects' studies.	
	Sun	Free	
Week 2 Formal training	*Mon*	Trainees split into 3 main areas: sub-organismal, whole organism, and community. Lectures and practical demonstrations on topics in their main area.	
	Tue		
	Wed		
	Thu		
	Fri	Lectures and demonstrations on the two areas that trainees are not specialising in (1 day each).	
	Sat		
	Sun	Free	
Week 3 Field study and training wind-up	*Mon*	Field sampling & transplant recovery (Mon & Weds). Community group analyses current macrofaunal & meiofaunal data, and any own data brought to the Workshop. Other groups carry out lab experiments and analyse Workshop field samples.	
	Tue		
	Wed		
	Thu		
	Fri		
	Sat	Wind-up for trainees (groups present findings).	
	Sun	Trainees depart.	
Research wind-up	*Mon*	Writing days for researchers/trainers (including reports on how well training received). Pack up.	
	Tue		
	Wed	Researchers/trainers depart (earliest).	

Notes:

(i) Week 1. The intention is to give the researchers/trainers (with the exception of the statistical instructors) a clear period of initial research/adaptation of methods etc. in Week 1, with no contact whatever with trainees. The students would either be fully occupied with 'pre-course' sessions on statistics or would not arrive until Week 2.

(ii) Week 1. The main meiofaunal field sampling will need to take place before the trainees arrive (5-6 sites are envisaged for meiofauna, hopefully with more for macrofauna, since these samples are being taken long before the workshop). However, since a subsidiary aim of the benthic component is to give training in meiofaunal sampling and identification, further field sampling could be done with students during the final week (perhaps at one interpolated site on the field transect).

(iii) Week 3. Four field sites are likely to be the maximum that can be coped within the final week for the scope for growth and MFO field-based training (though more sites might be used for research activities throughout the period). Collection of bivalves (native or transplanted) and fish will need to be done on at least two sampling days in Week 3.

(iv) Week 4. There would need to be a separate concluding session for the trainers/researchers after the trainees have departed, in order to write research reports and assess the success or otherwise of the training.

ANNEX V

WORKSHOP PLAN OF THE ICES-IOC WORKSHOP ON BIOLOGICAL EFFECTS OF CONTAMINANTS

Bremerhaven, Federal Republic of Germany
12-30 March 1990

INTRODUCTION

The suggestion that a seagoing workshop be held was made at the first meeting of the Working Group on the Biological Effects of Contaminants (WG BEC) held at ICES Copenhagen in May 1987 (CM 1987/E:23). The decision to proceed was made at the next meeting of the WG BEC in April 1988 (CM 1988/E:26), and a Planning Group was formed consisting of Drs Stebbing, Dethlefsen, Thurberg and Heip. A "Proposal for a seagoing workshop on biological effects monitoring techniques" (CM 1987/E:34) was submitted to the 76th Statutory Meeting of ICES in Bergen in October 1988. In accordance with a resolution of that meeting (C. Res. 1988/2:30a), members of the Working Group on the Biological Effects of Contaminants (WGBEC) are continuing to plan the Workshop on Biological Effects Measurements to be held in Bremerhaven 12-30 March 1990.

The major requirement for ICES is to identify relevant techniques that can be incorporated in monitoring programmes, while a major requirement for IOC is to widen the geographic scale of the workshop programme and to evaluate new kinds of indices of toxic stress. In this workshop IOC's priority is their interest in integrating the results of biochemical and cellular indices of contaminant induced stress in fish in relation to the gross pathology of disease. Several proposals to the workshop are directed to questions raised by IMO, specifically those involving the biological quality of sediments and the bioavailability of the contaminants they contain, as well as the effects of contaminants in the sea surface microlayer in relation to incineration of toxic wastes at sea, and pollution gradients related to oil platforms.

From the outset it was proposed that this should be a joint workshop with a group of IOC (Group of Experts on the Effects of Pollution - GEEP) with which we share the same objective of establishing the use of biological effects techniques in monitoring programmes. Dr McDowell Capuzzo was appointed by GEEP as their representative on the Planning Group.

Letters of invitation, together with the Workshop Proposal, were sent out from ICES in Copenhagen and from IOC in Paris. By 14 April 1989, 42 proposals had been received or promised from more than 50 scientists wishing to participate. The Planning Group met at the International Maritime Organisation (IMO) in London on 20-21 April 1989 to consider the plans and proposals in detail. Later the ICES WG on the Biological Effects of Contaminants met at DAFS Aberdeen from 9 to 12 May 1989, in particular to consolidate the chemical elements of the Workshop plan.

OBJECTIVES OF THE WORKSHOP

(i) To test and intercalibrate biological effects techniques designed to detect and measure the effects of pollution.

(ii) To test primarily those techniques that can be deployed at sea, to complement the emphasis given at the IOC Oslo Workshop to techniques suited to nearshore applications.

(iii) To test the techniques on known contamination gradients of the kind that would be likely to be covered by a monitoring programme.

(iv) To relate results from biological indices to chemical data for the contamination gradients in such a way that causal relationships can be identified.

(v) To make a comparison of the suitability of different kinds of techniques that consider the same organisms (eg fish) or habitat (eg benthos), by deploying them simultaneously on the same gradient.

PROPOSALS

Proposals have been received and grouped under the following topics with a coordinator for each (Appendix 1).

(i) Fish -gross pathology (A.D. Vethaak)
-biochemistry (R. Addison)
-cell pathology (M.N. Moore)

(ii) Bioasaays (L. Karbe)

(iii) Benthos -sediment bioassays (P. Chapman and R. Swartz)
-benthic studies (C. Heip)

(iv) Chemistry (W. Cofino)

(v) Statistics (M.Carr)

RATIONALE FOR DIFFERENT CONTAMINATION GRADIENTS

(i) Offshore gradients on a transect NW out of Bremerhaven: A cruise track has been proposed (Table 1 and Figure 1) that traverses contamination gradients that attempts to minimize the effects of natural and unrelated factors. This transect is proposed particularly for those involved in fish studies and, to a lesser extent, those who intend to conduct water quality bioassays. Numerous requirements were considered important when this track was proposed, which include uniform depth, known differences in contaminant concentrations in sediments, uniform sediment type, a variety of contaminants (OCs, metals, PAHs, petroleum hydrocarbons) and proximity to Bremerhaven.

The benthos group will use an inshore extension of this transect designed to detect the effect on the benthos of the River Elbe plume, perhaps involving five stations on an axial transect. Plans for this element will be consolidated after a preliminary investigation of the plume area by Dr Rahor from the Alfred Wegener Institute.

(ii) Oil platform gradient: various techniques can sometimes best be tested on a gradient where a single toxic contaminant is dominant. To this end an oil platform gradient will be used to deploy the benthic techniques where oil and drilling mud are the main factors contributing to a biological impact. This gradient will also provide fish samples of interest to the biochemists. Several oil platforms are under consideration, including a Shell platform off Aberdeen, a Phillips Petroleum platform off Norway and a Dutch oil platform.

(iii) Incineration area: it is known that many contaminants accumulate at the sea surface, by association with buoyant material or by deposition from the atmosphere, resulting in concentrations orders of magnitude higher than the immediate subsurface. We therefore propose to consider the question that such data pose by focusing effort on the surface microlayer, to see whether water quality in the microlayer is depressed and to identify the best techniques to monitor change.
The possibility of sampling with respect to time following an incineration event will be explored. If incineration has been suspended by March 1990, or if bad weather makes this element of the programme impractical, microlayer methods will be directed to a contaminated estuarine or harbour location.

RATIONALE FOR DIFFERENT TYPES OF BIOLOGICAL TECHNIQUES

(i) Fish studies: for some time those involved in fish disease studies in the North Sea have been concerned primarily with the occurrence of disease in terms of gross and cell pathology and its frequency. In recent times its possible relationship to the distributions and concentrations of toxic contaminants has created considerable interest in the role of contamination in disease induction. While some of these data provide correlations with disease frequencies, the question of whether or not a causal relationship exists with contamination remains unanswered, and the problem was identified in the last Quality Status Report for the North Sea as one of some urgency.

A number of powerful biochemical and cellular techniques have been proposed for use alongside the established approach to fish disease studies in the North Sea. With the range and number of submissions using fish, the workshop will provide a good opportunity to integrate the results of these techniques, as well as a rigorous test of the value of different approaches for monitoring at sea.

(ii) Bioassay studies: the value in using biological systems to provide a rapid overall index of water quality is well established, and the proposals to use oyster larvae on water column samples, microlayer samples and sediment samples suggests some agreement as to the most useful. The workshop will provide practical case histories for addition to the ICES manual on the oyster larval bioassay technique. Few bioassay techniques are sensitive enough to detect variations in water quality offshore, but within the workshop the utility of assessing the effects of contaminants in the surface microlayer in the vicinity of an incineration area will be studied.

(iii) Benthic studies: the basis of the benthic component of the workshop will be the analysis of macrofauna and meiofauna community structure using multivariate techniques and other methods of differentiating commnunities along pollution gradients. The Sediment Triad approach (chemistry, bioassay and community analysis) has not previously been tested in European waters. At the workshop there is a good opportunity to test this approach (under the guidance of Dr P Chapman), as a number of benthic community, sediment bioassay and sediment chemistry proposals have been submitted. The Triad approach combines these three methods for the detection of contamination of sediments as a unified study. Sediment bioassays will be tested as a means of measuring sediment toxicity and an intercomparison made with benthic community

data in the context of appropriate sediment chemistry. The coordination of these three elements will obviously require the use of the same box core samples for macrofauna and meiofauna community analysis, sediment and elutriate bioassays and sediment chemistry.

SAMPLING STRATEGY

(i) German Bight Transect: 5 stations on the transect for fish, water quality bioassays, sediment sampling and hydrography.

(ii) Elbe Plume (extension of German Bight transect): ca. 5 axial stations for benthic studies, including samples for macrofauna, meiofauna, sediment bioassay and sediment chemistry.

(iii) Oil Platform gradient: 2 stations for sampling fish and 5 stations for benthic studies as 2. above.

(iv) Incineration gradient: to include microlayer and subsurface samples for water chemistry and water quality bioassays.

CHEMISTRY

In any study of environmental contamination and its effects, it is self- evident that both biological and chemical data are not merely required but are interdependent. In this workshop the requirement for an appropriate chemical data base and the collaboration of chemists to interpret their significance are indispensable. Dr Cofino will provide overall coordination of the workshop chemistry, with help from Drs Boon and Föyn, who are all members of the ICES Working Groups for Marine Chemistry. The German Hydrographic Institute have offered to carry out much of the water and sediment chemistry, and the collection of hydrographic data.

The plan for the sampling strategy and chemical requirements for the workshop was drawn up at an ICES BEC WG with advice from members of the Marine Chemistry and Sediments WGs. The listing of chemical requirements and sampling strategy (Appendix 2) is the results of that meeting.

If for any reason the chemical analyses identified in Appendix 2 can not be carried out, it has been decided that the total number of station worked will be reduced, rather than limit the range of contaminants analysed or the replication of samples to be analysed. It is not intended to compromise the quality of the chemical data base considered necessary to interpret the biological data.

STATISTICS

Intercomparison of biological techniques to detect contamination gradients is only possible if there is standardisation of methods for data presentation and use of the same statistical procedures and criteria to determine the significance of different responses. M. Carr (Plymouth Marine Laboratory) will be collaborating primarily with the benthic group and their own group of statisticians, but will also be responsible for data archiving and providing guidance on the treatment and presentation of data.

ROLE OF COORDINATORS

For each study area coordinators have been identified and invited. We anticipate their role to be:

(i) to coordinate the work of the participants in their group so as to make an intercomparison of the different techniques possible.

(ii) to coordinate the identification and provision of samples and equipment (for use in the lab and at sea) during the workshop.

(iii) to report the results on behalf of their group at the conclusion of the workshop and to prepare summary reports.

(iv) to carry out preliminary editing of reports and papers before publication, and to assist in the identification of appropriate reviewers for the papers.

(We anticipate assigning a student to each of the coordinators for the duration of the workshop to assist them.)

RESEARCH VESSELS

	12.3.90	30.3 90	number of scientists
(i) Valdivia (Univ. of Hamburg)			12
(ii) Victor Hensen (AWI)			9
(iii) Friedrich Heinke (Biol Anst Helg)			5
(iv) Solea (Fed Res Bd Fish)		18.3	5
(v) Walter Herwig (Fed Res Bd Fish)		23.3	12
(vi) Hollandia (Rijkswaterstaat)			7
(vii) Aurelia (NIOZ)			7
(viii) Gauss (German Hydr Inst)			8

FOUL WEATHER CONTINGENCY PLAN

A bad weather contingency plan will consist primarily of collecting samples on the identified gradients and stations in advance, and preserving them in a form that can be used during the workshop. Participants will be asked to identify the types and number of samples required and the methods of preservations to be used.

The outline plans for each topic area are:

(i) Fish studies. Collection of fish samples (dab and other flatfish) at intervals along the German Bight gradient (NW from Bremerhaven) and preservation.

(ii) Water quality bioassays. Intercomparison on techniques under workshop conditions using a specific toxicant (eg copper, TBT). Assessment of toxicity of elutriates of large water samples passed through XAD ion exchange resin to concentrate organic contaminants (to be carried out under the direction of Dr L Karbe).

(iii) Benthic studies. Collection and preservation of macrofauna samples from one or more gradients, to include subsamples for meiofauna, for sediment bioassays and for chemical analysis. Preserved polluted harbour sediments could also be used for intercomparison of sediment bioassays. A paper exercise will be conducted with existing community, sediment bioassay and sediment chemistry data to examine the Triad approach using North Sea data (to be carried out under the direction of Dr P Chapman).

PREPARATORY WORK

In preparation for the Workshop a number of activities have already been initiated, or will be carried out prior to the Workshop, including:

(i) Preliminary investigations of indices of toxic effect on isolated flounder hepatocytes from the River Elbe and River Eider (Lowe, Moore and Kohler-Gunther).

(ii) In addition total pathology is being out on flounders from the same area for familiarisation with these populations (Simpson).

(iii) Sampling of macro and meiobenthos at regular intervals from the Workshop stations (Fig. 1, Table 1) (Rachor).

(iv) Monthly analyses of sediment contaminants from Workshop stations (Fig. 1, Table 1) (German Hydrographic Institute).

(v) Sampling of dabs for gross pathology and contingency plan (Dethlefsen).

TIMETABLE

December 1989	Planning Group Meeting
12-30 March 1990	Workshop
early May 1990	Combined meeting of WG BEC and Workshop co-ordinators
1 July 1990	Report on Workshop to ICES and IOC
June 1991	ICES-IOC Workshop Symposium

FINANCE

Estimates of the total cost of the workshop at this stage, exceeding those covered by the participants, can only be approximate, but we can identify the major areas of expenditure:

radiochemicals	$ 3K
consumables (analytical standards, chemicals etc)	$ 5K
transport of equipment	$ 5K
travel costs	$20K
subsistence costs	$15K
hire of students	$ 7K

	US $55K

PUBLICATIONS

(i) Report to IOC (July 1990)

(ii) Report to ICES (July 1990)

(iii) Publication as special number of a journal - Workshop Symposium Volume.

APPENDICES

1 - Proposed cruise track to study contamination across German Bight (V. Dethlefsen).

2 - List of proposals, subdivided into groups under Coordinators.

3 - Proposed analytical chemistry.

Table 1. Positions of German Bight transect stations plotted in Figure 1.

Station Number			
1	54°00'N	08°00'E	
1a	54°01'N	07°49'E	BEWG
1b	54°04'N	07°30'E	BEWG
2	54°6.5'N	07°24'E	GHI
3	54°25'N	06°15'E	GHI
4	54°50'N	05°35'E	
5	55°10'N	05°00'E	GHI
6(optional)	55°35'N	04°10'E	GHI

GHI - German Hydrographic Institute Station

BEWG - ICES Benthic Ecology Working Group Station.

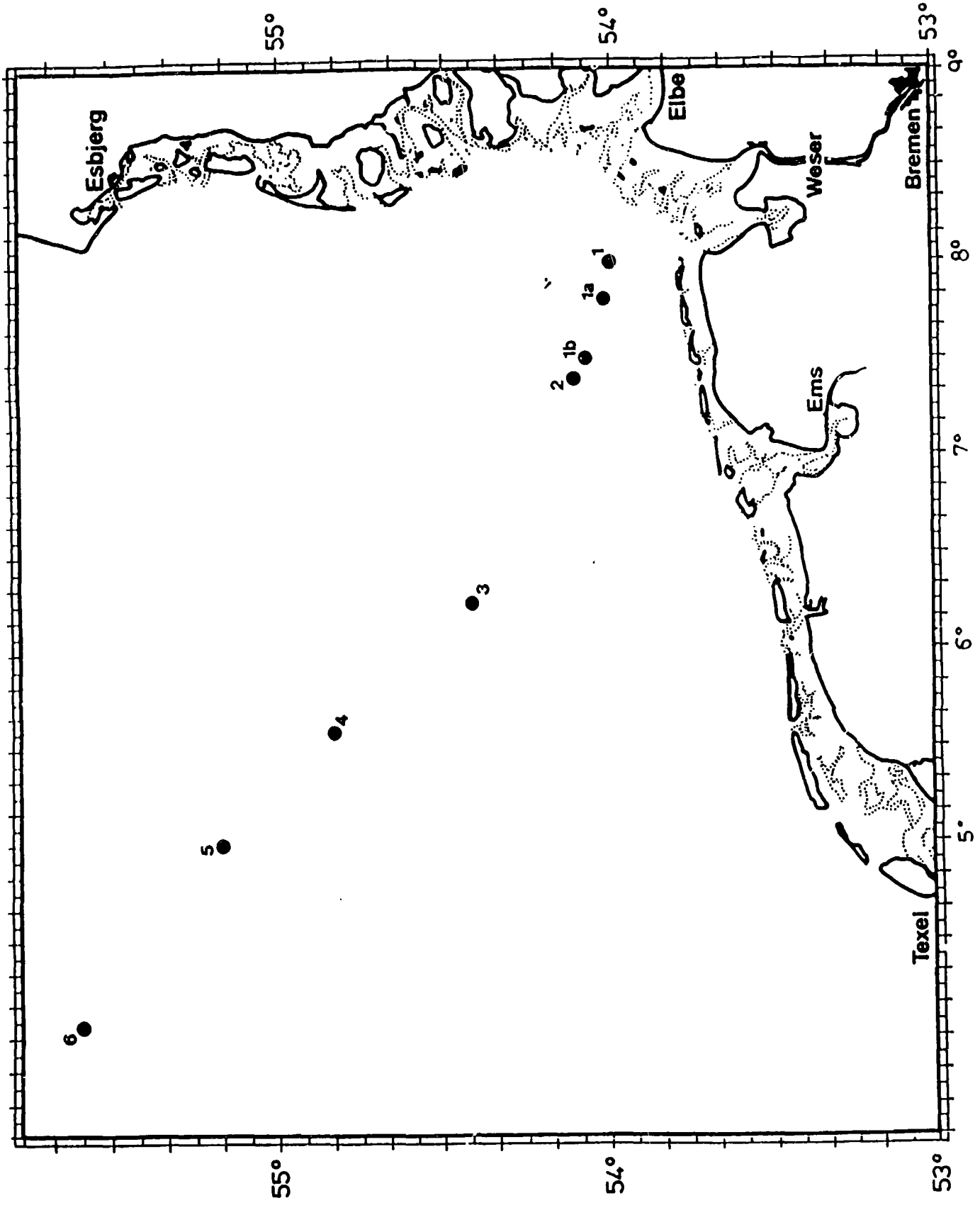

FIGURE 1: POSITIONS OF GERMAN BIGHT TRANSECT STATIONS

APPENDIX 1

PROPOSED TRACK FOR STUDIES DURING THE BREMERHAVEN WORKSHOP ON BIOLOGICAL EFFECTS MONITORING - MARCH 1990 PRESENTED AT ICES WORKING GROUP ON BIOLOGICAL EFFECTS OF CONTAMINANTS ABERDEEN, 9-12 APRIL 1989

Volkert Dethlefsen
Bundesforschungsanstalt fur Fisherei
Institut fur Justen- und Binnenfischerei
Aussenstelle Cuxhaven
Niedersachsenstrasse, 2190 Cuxhaven, F.R. Germany

The proposed track on which all studies of the workshop could be performed is situated between 54°N/07°50'E and 56°N/03°24'E, its total length roughly 200 nm. It is entirely located on the German part of the continental shelf of the North Sea. This will have the advantage that the chemical support offered by the German Hydrographic Institution would be available for all possible stations on this proposed track. On the first 120 nm depths only vary between 32 and 45 m The sediment structure is quite uniform, the fraction smaller than 63 µm is variable between 5 and 20%. The track beyond the 120 nm to the end of the German part of the continental shelf covers the northeastern tip of the Dogger Bank which is known for its high fish disease rates and contamination. Enclosed information on contamination of various compartments should be used to discuss the final placement of the stations for the workshop.

Information is available on

- salinity gradients, suspended solids, areas of low dissolved oxygen
- cadmium and lead in seawater;
- cadmium, lead and vanadium in particulate matter;
- contents of fines in the sediments of the North Sea;
- concentrations of lead, arsenic, mercury and cadmium in the fine fraction of sediments < 20 µm;
- cadmium, copper, lead and mercury in Pagurus bernhardus;
  cadmium, lead and mercury in livers of dab (Limanda limanda) of the German Bight;
- cadmium, lead and mercury in livers of dab (Limanda limanda) of the North Sea;
- for organochlorine material information is included on trichlorethene in seawater of the German Bight;
- on gamma-HCH and HCB in seawater;
  PCBs, HCB, ΣDDT in sediments;
  PCBs, HCB, DDE in zooplankton;
  PCBs, DDE and HCB in Pagurus bernhardus;
  PCBs, ΣDDT in livers of dab;
  petroleum hydrocarbons in the German Bight.

The last three figures contain information on disease of dab and malformation rates of fish embryos.

From material included it can be taken that no uniform gradients for the substances of the various pollutant groups exist. Also there is no uniform trend with decreasing contamination and with increasing distance from the coast. For some of the substances some of the compartments gradients can be found the other way round.

For the group of contaminants to be analyzed in the course the workshop, i.e. heavy metals, organochlorines, and petroleum hydrocarbons, it can be stated that based on the material enclosed significant differences in concentrations do exist on the proposed track. The members of the planning committee and the members of the ICES Working Group on Biological Effects Monitoring might wish to consider the suitability of the sampling area.

APPENDIX 2

LIST OF PARTICIPANTS, PROPOSALS AND INVITED CO-ORDINATORS

I. FISH

A. GROSS PATHOLOGY - Vethaak (Coordinator)

* 1. Gross pathology of livers of dab - Kranz

2. Characterise pathological changes in flatfish - Bucke

3. Gross disease and histopathology of flatfish - Vethaak

4. Gross pathology of fish -ap Rheinallt

B. CELLULAR PATHOLOGY - M N Moore (Coordinator)

1. In vivo cell injury and oxyradical damage in fish livers - Moore

2. Erythrocyte micronuclear formation in fish - Roddie

3. Effects of contaminants on the functional integrity of fish hepatocytes - Lowe

4. Contaminant induced cellular responses of the fish liver - Kohler-Gunther

5. Unscheduled DNA synthesis as a measure of genetic damage in fish and P32 post-labelling method of genotoxin-DNA adducts - Chipman and Livingstone

6. Histopathological analysis of bivalve molluscs from selected gradients of anthropogenic contamination - Auffret

C. BIOCHEMISTRY - Addison (Coordinator)

1. Estimation of lysozyme activity in the blood of marine fish - Mock

2. Catalytic enzyme activity in crustaceans - McHenery

3. Catalytic activity and number of enzyme sites of Na/K ATPase in flatfish - Stagg

4. Sublethal effects of pollutants on fish - Forlin and Balk

5. Immunochemical analysis of cytochrome P-450 monooxygenase induction in larval and adult fish tissue - Goksoyr

6. Effects of xenobiotics on the MFOs of fish - Hansen, Addison and Renton

7. Tissue levels of metallothionein and heavy metals - Hogstrand and Haux

8. Biochemical composition of fish in response to stress - Leavitt and Capuzzo

9. Morphological and chromosomal aberrations during embryonic development in pelagic fish embryos - Cameron and von Westerhagen

10. Detection of effects of organophoshates and organic contaminants in fish tissue using automated biochemical method - Galgani and Suteau

II. BIOASSAYS - Karbe

1. Application of liquid/solid extraction techniques for water quality bioassay studies - Karbe, Behning and Bloemeke

2. Oyster embryo bioassay - Thain

3. Copepod toxicity studies - Roddie

4. Water quality bioassays of surface microlayer in relation to contaminant concentrations - Stebbing and Cleary

5. Pollution induced community tolerance - Blanck, Tiselius and Molander

6. Sea surface microlayer bioassay with oyster larvae - van den Hurk

7. Availability of heavy metals along a pollution gradient and its effects upon the growth of marine phytoplankton - Rijstenbil

8. Sea-surface microlayer: contamination, ecotoxicolgy and monitoring - Hardy

9. Effects of a gradient of pollutants in water and sediment on the ecophysiology of benthic organisms - Absil and Hummel

10. Water quality bioassay using a copepod - Williams

III. BENTHOS

A. SEDIMENT BIOASSAYS - Chapman (Coordinator)

1. Sediment bioassays with amphipods, a polychaete and oyster larvae- Chapman and Swartz

2. Sediment quality triad - Chapman

3. Sediment bioassay with a clam and oyster larval bioassay - Phelps

4. Sea surface microlayer and sediment quality bioassay with oyster larvae and an amphipod - van den Hurk

5. Sediment toxicity and contaminant bioavailability - Roddie and Butler

B. BENTHIC STUDIES - Heip (Coordinator)

1. Meiofauna benthic community effects - Warwick, Platt, Vincx and Heip

* 2. Macrofauna benthic community effects - Rachor and Kroncke

* 3. Epifauna benthic community effects - Duineveld and Rumohr

4. Imaging the upper sediment layers using REMOTS Sediment Profiling camera and the sediment surface with TV and Stills photograhy - Rumohr

*5. Mesocosm experiment - boxcosm - de Wilde, Duineveld, Berghuis and Smaal

6. Size structure of benthic communities - Schwinghamer

IV. CHEMISTRY - Cofino (Coordinator)

1. Analysis of organic microcontaminants in sediments - Abarnou and Bodennec

2. Selected metal analyses in fish organs related to disease - Protasowicki

3. OCs (HCB, HCHs, DDT family, cyclodienes and PCB congeners in tissues of fish, benthic macroinvertebrates and sediments - Boon

4. Selected metals (Cu, Zn, Cd, Pb, Cr, Fe, Ba) in tissues of fish benthic macroinvertebrates and sediments - Cofino and Marquenie

5. PAHs by GC-MS in tissues of fish, benthic macroinvertebrates and sediments - Foyn and Klungsoyr

* 6. Brockmann, University of Hamburg

* 7. Huhnerfuss, University of Hamburg

8. Oil, metals and OCs in water and sediment samples - German Hydrographic Institute

V. STATISTICS - Carr (Coordinator)

VI. VESSEL OPERATIONS - Dethlefsen (Coordinator)

(* - proposal not yet received)

APPENDIX 3

PROPOSED ANALYTICAL CHEMISTRY

A. GERMAN BIGHT TRANSECT - Bremerhaven to NW across German Bight

- 5 stations for fish studies and water quality bioassays

1. Fish samples
   - dab (Limanda limanda) one sex only, otoliths to be taken for ageing, size range 20.25 cm. 10-25 individual fish analyses per station
   - 3 pooled samples fo 25 fish each
   - liver: polar and apolar lipids, metals (Pb, Hg, Cd, Cr), DDT, OCs, PAHs, THC, As, IOC list of chlorobiphenyl congeners (see Wells, 1988).
     The distribution of the liver tissue between participants to be organised by Dethlefsen.
   - muscle: of secondary importance, chemical analyses to be a subset of those for liver.

2. Sediment samples
   - 5 samples per station
     subsamples of box core samples taken with small corer, top 2-3 cms extruded and sliced off, mixed and stored by appropriate methods for different contaminants.
     (As whole sediments will be used, normalisation procedures will be needed to accommodate differences in grain size).
   - Same suite of contaminants as for fish.
   - granulometry, organic carbon content, redox, sulphide, ammonia.
   - sediment bioassays.

3. Hermit crabs (Eupagurus bernhardus) 3*10 at each station.
   (analysis of abdomen only)
   - same suite of analyses as for fish.

   (possible collaborative link to be explored to assist with analytical load).

4. Benthos
   - pooled samples as each station of 5 representative species.
   - same suite of analyses as for fish.

5. Water samples
   - single large volume pumped water samples from surface and bottom at each station.
   - analysis of both soluble and particulate phases.
   - metals, OCs, PAHs, THC.
   - subsamples for water quality bioassays.

6.	Hydrographic data	-	salinity, temperature, dissolved oxygen, suspended particulate load, chlorophyll, nutrients (silicate, phosphate and nitrate). All except chlorophyll to be carried out by the German Hydrographic Institute.
B.	OIL PLATFORM GRADIENT		
		-	off Dutch coast 2 stations for fish 3-5 stations for benthos
1.	Fish samples	-	preferably dab, one sex, otoliths for ageing, size range 20-25 cm 20 individual fish analyses per station Liver: THC (IR & GC), PAHs, barium. (distribution of liver samples to be organized by Dethlefsen).
2.	Sediment samples	-	5 box core samples at 3-5 stations THC (IR & GC), PAHs, barium, carbonates, DOC. redox and granulometry
3.	Benthos	-	pooled representative samples of 5 species same suite of analyses as fish.
C.	INCINERATION AREA	-	samples for water quality bioassay from surface microlayer and 0.5m
		-	analyses to include OCs (octachlorostyrene and hexachlorobenzene), TBT and metals (Cd, Cr, Zn).
		-	sampling strategy to be worked out later, once it is established that incineration is still taking place in 1990.

ANNEX VI

THE MEASUREMENT OF VULNERABILITY IN THE DESIGNATION OF OCEAN AREAS

INTRODUCTION

The IMO has requested GEEP to consider "the scientific basis for the identification of vulnerable marine areas". This is a complex question and GEEP has indicated that it can most usefully comment on certain aspects only. In particular, assessments of 'vulnerability ' require quantitative statements on the sensitivity of biological processes to contaminants and to disturbance, and it is the development of this aspect that GEEP sees as its primary contribution.

The more general features of management and protection of sensitive aquatic environments have been considered by the International Union for Conservation of Nature and Natural Resources. In particular, a book summarising the results of a series of workshops deals comprehensively with the problem: "Marine and Coastal Protected Areas: A Guide for Planners and Managers", by R.V. Salm and J.R. Clark, IUCN 1984. To quote from the Preface: "...this book is arranged in three parts. The first introduces protected areas as one of many tools for managing coastal and marine resources and outlines a process for planning a regional or national system of protected areas. The second part considers the specific principles and techniques for planning and managing protected areas in different environments. The third part offers a number of tools and case studies to help protected area planners and managers carry out their tasks". We draw the attention of IMO to these efforts by IUCN and recommend that discussions be held with IUCN to help in drawing up criteria for 'vulnerable areas'.

The Marine Environment Protection Committee of IMO is itself engaged in gathering information from member states on criteria used under national jurisdiction which may be relevant for the designation of Special Areas and Particularly Sensitive Sea Areas, and in reviewing particular case studies. GEEP welcomes the opportunity to consider and discuss the results of these initiatives by IMO at the appropriate time.

In the meantime, GEEP will continue to explore the possibilities for using sensitive biological techniques to establish "dose-response" relationships between contamination/disturbance and biological response, as indicated in the report of their fourth session in Paris, December 1987. The rationale of this approach is to identify procedures which may be used to evaluate biological response to stress in order that degrees of environmental impact may be quantified in practical assessments of vulnerability.

COMPARATIVE RESPONSES AMONGST ECOSYSTEMS

The theory of the comparative response of different ecosystems to contaminant discharges and other perturbations is not well developed (Gundlach and Hayes, 1978; Owens and Robilliard, 1981). Rabelais and Boesch

(1987) concluded that four features of benthic communities could be used in a comparative evaluation of habitat sensitivity to the impacts of oil exploration and exploitation:

(i) The sedimentary regime, with depositional areas being the ultimate repository of particulate-bound contaminants;

(ii) Temperature, controlling both rates of biodegradation and of re-colonisation by benthic organisms (n.b. this criterion is controversial; many will not accept the primacy of temperature effects);

(iii) Depth, which also affects recovery rates after disturbance;

(iv) The extent of species interactions within the community, which affect stability and resilience.

Habitats that are vulnerable to exposure to oil may be ranked in terms of the likely persistence of the oil (as a function of the energy status of the environment, and the activity of oil-degrading biological processes; Jackson et al., 1989), the nature of the sediment, the biological characteristics of the dominant fauna and flora, etc. The GEEP ad hoc intersessional group took as its starting point the evidence that might allow dose-response relationships to be drawn for particular types of benthic community, and to ask with what degree of sensitivity could we reasonably expect to detect contaminant-induced change, using current procedures?

HYDROCARBONS AND BENTHIC COMMUNITIES

The environmental monitoring of conditions around most oil exploration and drilling platforms is required by legislation. A wealth of information is potentially available, therefore, on concentrations of hydrocarbons within the sediments, and on the benthic macrofauna (meiofauna are not included in most monitoring studies). However, in reviewing these data, a lack of adequate quality control in some studies acts to limit the general utility of the results. Based on those data where quality control is considered adequate, one index of overall dose-response that has been used relates total sediment hydrocarbon content to species diversity measured as the Shannon-Wiener statistic.

Figure 1 shows data from Davies et al. (1984). From this and other studies on the Norwegian sector of the North Sea, species diversity is seen to reduce when total hydrocarbon levels (THC) exceed 100 ppm. This effect is due predominantly to the use of oil-based drilling muds. In 1985 the Paris Commission Working Group on Oil Pollution considered the impact of these drilling muds on the North Sea and compiled a list of "agreed facts" to describe the scale of biological impact. In brief, they concluded that major deleterious biological effects were confined within 500 m of the drilling platform and associated primarily with burial under the drilling cuttings. Surrounding this area of major impact is a transition zone up to 1000 m (the full extent depending on hydrographical conditions and the scale of drilling operations) within which lesser biological effects (e.g. a decline in species diversity) are detectable. Beyond this area, reductions in species diversity are not detected, but elevated hydrocarbon concentrations attributed to oil- based drilling muds were measurable.

A significant reduction in diversity is, however, a relatively insensitive indicator of change and deterioration in benthic communities (Gray et al., 1988). More sensitive techniques are now available which are based on analysing the matrix of numbers of individuals of each species at each station by multivariate statistical procedures. When such procedures are applied to data from a 1987 survey at the Ekofisk field in the North Sea (in this case Principal Coordinates Analysis and Classification Analysis), results illustrated in Figure 2 are obtained. These results discriminate between a severely impacted area within 1000 m of the platform and an area out to 3000 m characterised by significant changes in species abundance compared with a group of stations further from the platform.

Around the drilling platforms in the Norwegian sector of the North Sea, the barium content of the sediment correlates closely with total hydrocarbon content (Figure 3) and may be used as an index of contamination from oil-based drilling muds. Figure 4 plots the barium content of the sediment for each of five groupings of benthic community structure discriminated by multivariate techniques as shown in Fig. 2. These results, taken together, indicate that significant changes in the benthic communities may now be detected at total hydrocarbon concentrations in the sediments as low as 10 ppm.

Apart from demonstrating the fact that statistical procedures are now available that allow the detection of significant change in benthic community structure at higher levels of sensitivity than are achieved with simple measures of species diversity, these results focus the problem of where the line might be drawn that distinguishes an acceptable from an unacceptable amount of damage to the biological resource. It is reasonable to postulate that a change in the relative abundance of different species within a community may be a precursor of likely reduction in overall species diversity, as sensitive species succumb to continuing contamination. Such a postulate needs to be examined through future trend monitoring. The important conclusion, however, is that measurements of biological response at the community level are now achieving a sensitivity that allows objective evaluation of likely future changes within these communities.

PHYSIOLOGICAL RESPONSES TO HYDROCARBONS

GEEP has adopted as one of its chief aims to relate together various measures of biological response to contaminants, including physiological and community levels of effect (Bayne et al., 1988). Our rationale is to challenge the hypothesis that physiological (and biochemical) indices of response may provide greater sensitivity and specificity than measures of community change, and may therefore serve as early-warning indicators of biological impact. Recent studies allow a preliminary analysis of this problem (Moore et al., 1989; Widdows and Donkin, 1989).

Figure 5 is a dose-response relationship between the tissue concentration of aromatic hydrocarbons within the mussel **Mytilus edulis** and physiological determination of the scope for growth (SFG; see Widdows and Johnson, 1988). Superimposed upon this graph are hypothetical values for tissue hydrocarbon concentrations in mussels positioned around oil rigs in the North Sea, based on measured hydrocarbon concentrations in the water, and experimental determination of the bioaccumulation of hydrocarbons by mussels (J Widdows, Plymouth Marine Laboratory, pers. comm.). To quote from Moore et al. (1987), the conclusions to be drawn from these comparisons are that "...there is likely to be a very slight and probably measurable effect

on the performance of mussels....living in the water column in the vicinity of the North Sea oil platforms, but that this degree of biological effect is not considered to result in a marked impact on the overall performance and survival of the mussel".

These results pertain to a likely biological response to water-borne hydrocarbons, and are not directly relevant to conditions within the sediment communities on the benthos. Nevertheless, they indicate that physiological measurements, made on mussels deployed in the field, could serve as simple and cost-effective monitors of environmental quality, responsive to contaminant concentrations that may, over longer periods of time, affect the abundance of species within the local benthic communities. Where community diversity is the target for protection by legislation, and the response variable in assessment of 'vulnerability' to contamination, physiological (and biochemical; see Addison et al., 1988) measurements may serve as useful early warning indices.

In studies that have documented the long-term persistence of petroleum, significant sublethal effects, which are likely to affect population and community properties, have been recorded. Krebs and Burns (1977) studied populations of fiddler crabs (Uca pugnax) for seven years after a spill of No. 2 fuel oil in Falmouth, USA. They observed long-term reductions in recruitment, population density, sex ratios amongst adult crabs, behavioural changes and overwintering mortality. Following the Galeta oil spill in Panama Jackson et al. (1989) observed changes in the behaviour of stomatopods and injury to corals. The discrepancies observed with respect to dose-response, between laboratory studies of acute toxicity and field measurements in the aftermath of oil spills, may be due at least in part to sublethal responses that differentially affect the growth and reproductive potential of component species.

FUTURE DEVELOPMENTS

There is convincing evidence, therefore, to support the contention that coupled physiological and ecological observations can, with adequate sensitivity, detect the biological effects of low-level contamination by hydrocarbons, and contribute to predictions of longer-term deterioration in community structure and function. In order to carry this subject forward, two topics now need to be addressed *viz*. comparative studies with contaminants other than hydrocarbons, and a comparison of dose-response relationships between different environments.

A welcome opportunity to consider the first topic will occur during the ICES/IOC North Sea workshop in 1990. This workshop will include studies of benthic community ecology. The opportunity exists to sample along a transect of contamination that comprises trace metals and/or pesticides, rather than hydrocarbons, and to apply multivariate techniques such as those evaluated during the GEEP workshop in Oslo (Gray et al., 1988). We recommend to the ICES/IOC steering group for the North Sea workshop that a non-hydrocarbon contamination gradient be identified for such a comparative study.

Our second topic is the comparison of biological response between environmental regimes e.g. temperate, sub-tropical and tropical, and between habitats e.g. soft-sediment, hard-sediment, mangrove and coral reef. Some of the features known to affect the sensitivity of communities to hydrocarbons vary along such a geographical axis, such as gradients in the degree of biogenic interaction within communities, and the significance of seasonal

factors in production, energy flow and nutrient cycling. It is essential that dose-response relationships being established amongst north temperate habitats are compared with a wider range of habitat type, in order to establish a scale of 'vulnerability' of general (global) application.

GEEP has made a start on this with its second workshop, held in Bermuda in 1988; the results will be published during 1989. In 1990, GEEP will be convening a training/research workshop in Xiamen, China, providing another opportunity to consider, using standard techniques, the responses of benthic communities and individual sentinel species to contamination. These activities will provide more useful data for the ad hoc group to assess inter-habitat vulnerability. GEEP recommends to IMO that they contribute to the financial support of these activities which are designed to yield objective criteria with which to measure the vulnerability of marine habitats to disturbance and contamination.

(B. Bayne, J. Gray, J. Capuzzo: 6 February 1989.)

REFERENCES

Bayne, B.L. et al. 1988. Mar. Ecol. Prog. Ser. 46: 1-5.

Davies, J.M. et al. 1984. Mar. Poll. Bull. 15: 363-370.

Gray, J.S. et al. 1988. Mar. Ecol. Prog. Ser. 46: 151-165.

Grundlach, E.R. and M.O. Hayes. 1978. Mar. Tech. Soc. J. 12: 18-27.

Jackson, J.B.C. et al. 1989. Science 243: 37-44.

Krebs, C.T. and K.A. Burns. 1977. Science 197: 484-487.

Moore, M.N., D.R. Livingstone, J. Widdows, D.M. Lowe and R.K. Pipe. 1987. Phil. Trans. Roy. Soc. Lond. B 316: 603-623.

Moore, M.N., D.R. Livingstone and J. Widdows. 1989. In press.

Owens, E.H. and G.A. Robilliard. 1981. Mar. Pollut. Bull. 12: 75-78.

Rablais, N.N. and D.F. Boesch. 1987. In: D.F. Boesch and N.N. Rabalais (eds.) Long-Term Environmental Effects of Offshore Oil and Gas Development. Elsevier Applied Science, London, pp. 71-147.

Widdows, J. and P. Donkin. 1989. In press.

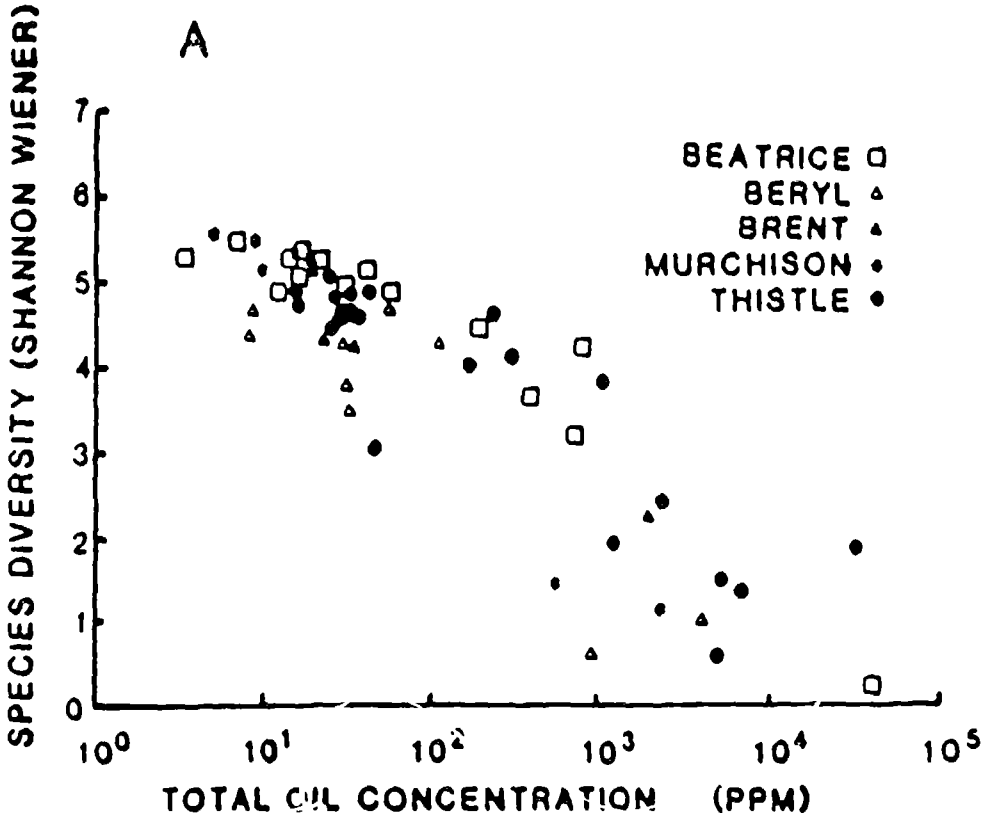

Figure 1. Relationship between species diversity and total oil concentration in the sediments of five North Sea oilfields. (From Davies et al., 1984).

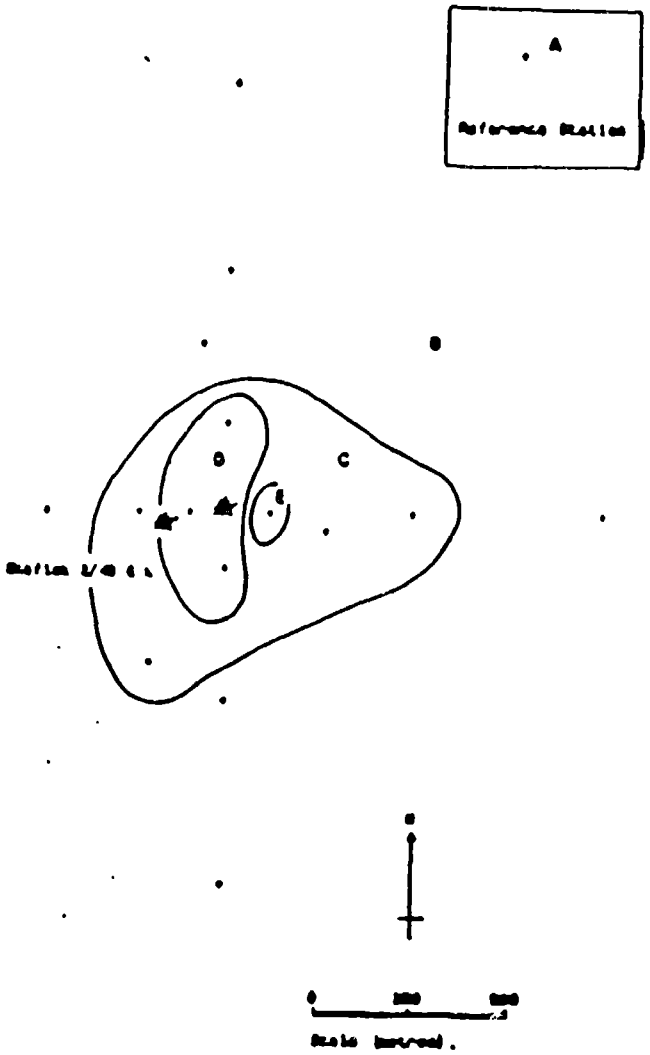

Figure 2. Geographical distribution of station groupings derived from ordination and cluster analyses for stations around the 2/4B&K platforms, Ekofisk oilfield environmental survey, July 1987.

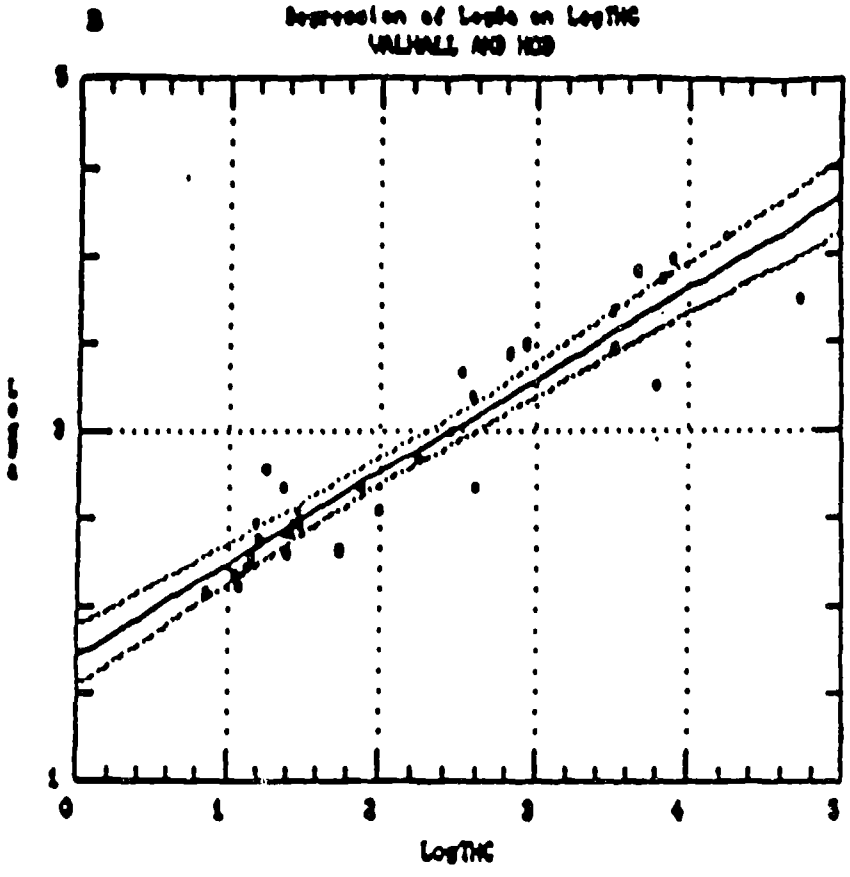

Figure 3. Relationship between barium content in sediment and total hydrocarbon content.

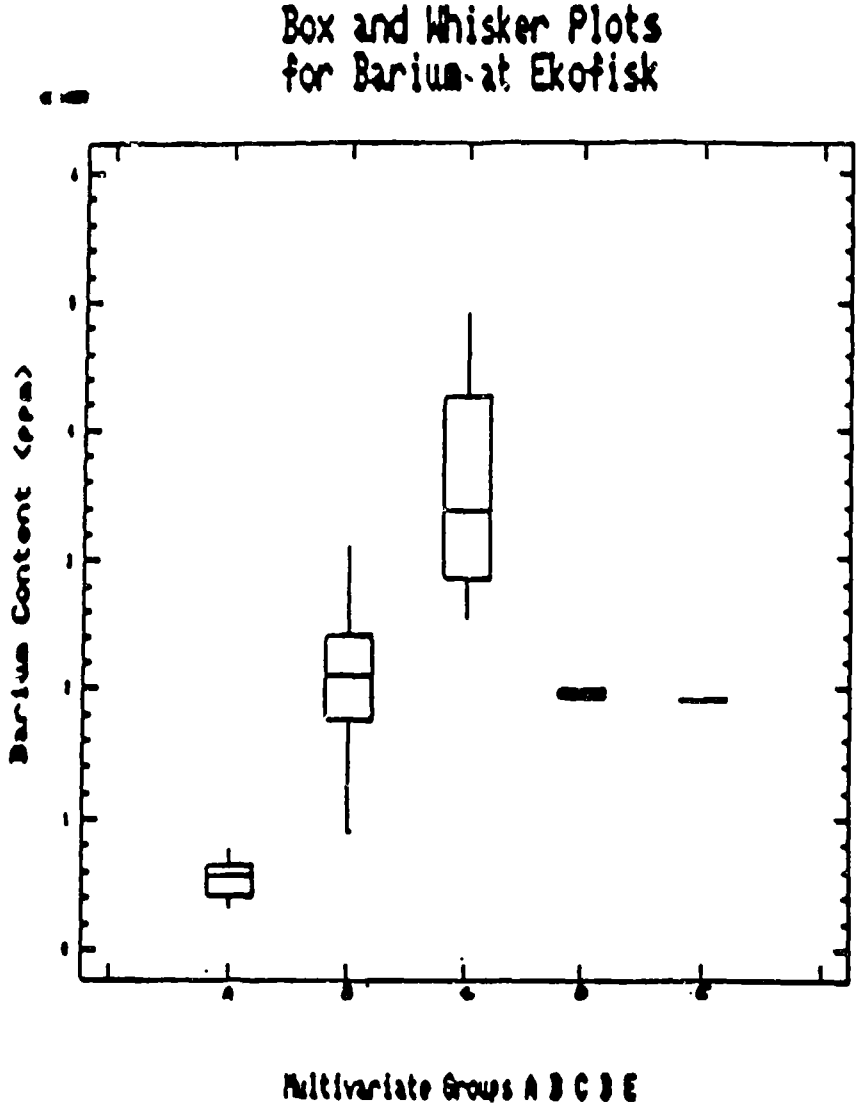

Figure 4. Barium content of sediment in station groupings from multivariate analysis in Fig. 2 (Ekofisk field, N. Sea, 1987).

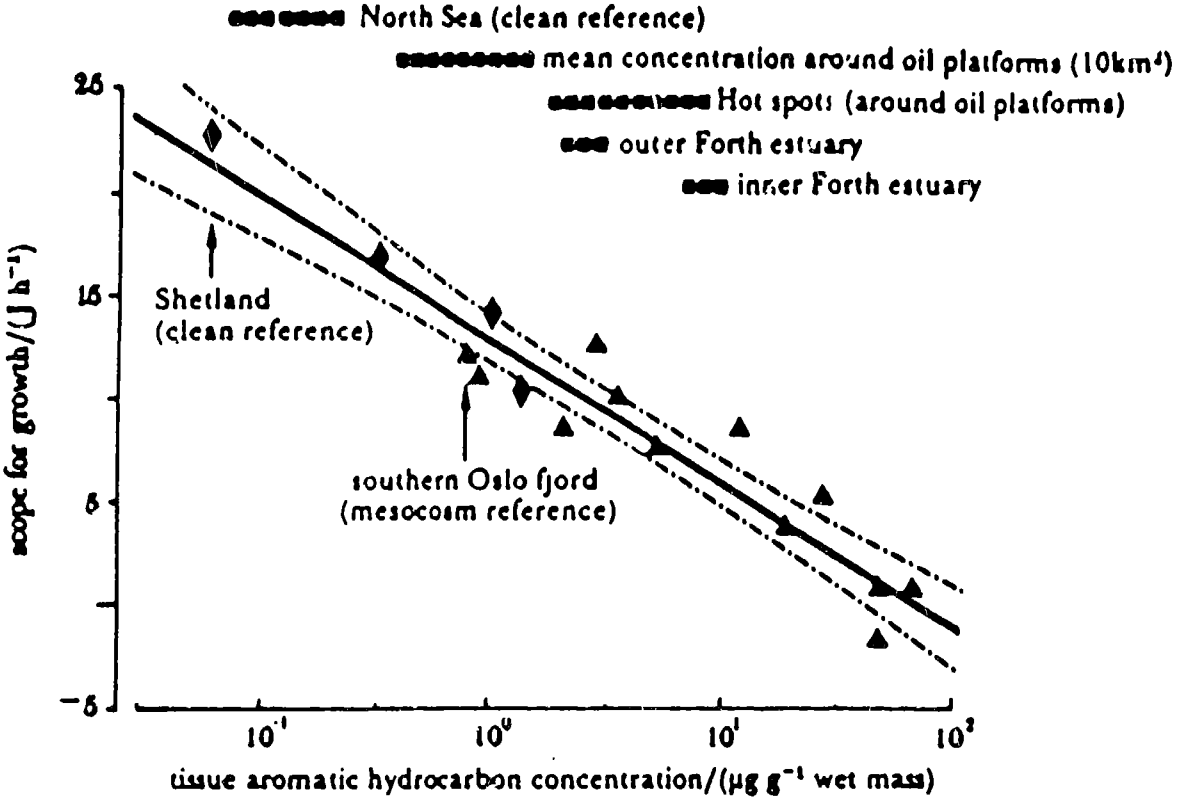

Figure 5. Relation between scope for growth (J h^{-1}; based upon a standard animal of 0.5 g dry mass, particulate organic matter of 0.5 mg l^{-1}, season of May-July) and the concentration of two- and three-ringed aromatic hydrocarbons (μg g^{-1} wet mass) in the body tissues of Mytilus edulis (▲ Data from oil exposure and recovery experiments at Solbergstrand, Oslofjord, Norway (Widdows et al. 1985). (◆) Data from Sullom Voe, Shetland, U.K. (Widdows 1984). Horizontal bars represent an estimate of the tissue concentration based upon the observed concentration of hydrocarbons in the water at various sites in the North Sea (Massie et al. 1985). (From Moore et al., 1987).

ANNEX VII

FRONTISPIECE OF

Marine and Coastal Protected Areas: A Guide For Planners and Managers

Rodney V. Salm
assisted by
John R. Clark

based on

The Workshops on Managing Coastal and Marine Protected Areas
World Congress on National Parks, Bali, Indonesia, October 1982
Organized by the IUCN Commission on National Parks
and Protected Areas

sponsored by

International Union for Conservation of Nature and Natural Resources
National Park Service, U.S. Department of the Interior
Sanctuary Programs Division, U.S. National Oceanic and Atmospheric Administration
United Nations Environment Programme
World Wildlife Fund

International Union for Conservation of Nature and Natural Resources
Gland, Switzerland