Intergovernmental Oceanographic Commission
Reports of Meetings of Experts and Equivalent Bodies

IOC Group of Experts on Effects of Pollutants

Second Session

Paris, 2-5 December 1985

Unesco

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In this Series

Reports of Meetings of Experts and Equivalent Bodies, which was initiated in 1984, the reports of the following meetings have already been issued:

- Third Meeting of the Central Editorial Board for the Geological/ Geophysical Atlases of the Atlantic and Pacific Oceans
- Fourth Meeting of the Central Editorial Board for the Geological/ Geophysical Atlases of the Atlantic and Pacific Oceans
- Fourth Session of the Joint IOC-WMO-CPPS Working Group on the Investigations of «El Niño»
- First Session of the IOC-FAO Guiding Group of Experts on the Programme of Ocean Science in relation to Living Resources
- First Session of the IOC-UN(OETB) Guiding Group of Experts on the Programme of Ocean Science in relation to Non-Living Resources
- First Session of the Editorial Board for the International Bathymetric Chart of the Mediterranean and Overlay Sheets
- First Session of the Joint CCOP (SOPAC)-IOC Working Group on South Pacific Tectonics and Resources
- First Session of the IODE Group of Experts on Marine Information Management
- Tenth Session of the Joint CCOP-IOC Working Group on Post-IDOE Studies in East Asian Testonics and Resources
- Sixth Session of the IOC-UNEP Group of Experts on Methods, Standards and Intercalibration
- First Session of the IOC Consultative Group on Ocean Mapping
- Joint IOC-WMO Meeting for Implementation of IGOSS XBT Ships-of-Opportunity Programmes
- Second Session of the Joint CCOP/SOPAC-IOC Working Group on South Pacific Tectonics and Resources
- Third Session of the Group of Experts on Format Development of the Working Committee on International Oceanographic Data Exchange
- Eleventh Session of the Joint CCOP-IOC Working Group on Post-IDOE Studies of South-East Asian Tectonics and Resources
- Second Session of the IOC Editorial Board for the International Bathymetric Chart of the Mediterranean and Overlay Sheets
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1. OPENING OF THE SESSION

The Session was opened at 09.30 on 2 December 1985 by the Chairman, Dr. B. Bayne, who welcomed all the participants.

The Secretary of IOC, Dr. M. Ruivo, welcomed the participants to IOC and stressed the importance attached to this relatively new area of work in the IOC. He referred to the early development of the GIPME programme, which focussed on the chemical monitoring and the development of scientifically based methodologies for chemical analyses. This has now taken a great step forward, and the third stage of the Comprehensive Plan has now been activated. The task of GEEP lies within this phase, and is particularly important in relation to the evaluation of the state of the health of the oceans. As in the case with chemical analyses, methodological developments and intercomparisons are required. Dr. Ruivo said that an appropriate way of developing the programme further may be through pilot projects carried out on a regional basis for definition of sensitive or vulnerable areas, terms used in the UN Convention on the Law of the Sea. The IOC also attaches significance to cooperation with other agencies in this respect, for example, with IMO and FAO. The UN Environment Programme is also a potential partner in this work.

The Technical Secretary for the Session, Dr. G. Kullenberg, welcomed participants and referred to certain activities which had occurred since the First Session of GEEP, further elaborated under Item 3. The composition of expertise at this Session of GEEP (Annex III) had been considered at the Third Meeting of the officers of the GIPME Programme, in view of the major agenda items. The Technical Secretary explained that the expertise for a Group of Experts session is selected from a roster of experts composed of scientists nominated in their personal capacity by the Member State. The number of experts participating in any one session is limited by resolution of the Governing Bodies. For the present time, this number is a maximum of five in the case of GEEP.

The Chairman declared the session opened.

2. ADMINISTRATIVE MATTERS

2.1 ADOPTION OF THE AGENDA

The Provisional Agenda was adopted. The Chairman emphasized the three major items as being the Workshop on Biological Effects Measurements (Item 4), Vulnerable Areas (Item 6) and Strategies for Monitoring Biological Effects (Item 10). The Agenda as adopted is given in Annex I.

The List of documents was checked, and the most recent inter-sessional products were added to the list (Documents IOC/GGE(EP)-II/15 and IOC/GGE(EP)-II/16. The Chairman also drew attention to the FAO (1981) publication (Document IOC/GGE(EP)-II/17).

2.2 DESIGNATION OF RAPPORTEUR

It was decided that participants would contribute to different items for the report and that the Technical Secretary would act as rapporteur.

2.3 CONDUCT OF THE SESSION

The Session would be conducted in plenary. The Chairman suggested a timetable so as to facilitate the writing of the report, with the aim of going through the draft report on Thursday afternoon.

3. INFORMATION ON INTERSESSIONAL ACTIVITIES AND DEVELOPMENTS

The Technical Secretary referred to the Thirteenth Session of the Assembly (12-28 March 1985), where the Chairman of WC/GIPME put similar emphasis on the studies of the effect of pollutants, as embodied in the terms of reference of GEEP, since they are fundamental to the GIPME plan and constitute an important first step towards establishing a solid scientific basis for the definition and identification of vulnerable areas.

It was also noted that the UK was generally satisfied with the progress made by GEEP in the implementation of Stage 3 and had supported the recommendation that a practical workshop on techniques for biological effects measurements be held, and that high priority should be assigned to the development of guidelines for the identification of vulnerable areas.

Reference was made to the statement of the delegate from Venezuela on the use of an on-going research project on the National Park at Morrocoy as a basis for a pilot study to develop and apply guidelines for identification of vulnerable areas in a complex coastal environment, and the offer to hold a subsequent session of GEEP in Caracas.

A suggestion from France was that GEEP should provide guidance on research needs in ecotoxicology. France also stated that it would make training available, as well as facilities in support of the programme, especially in areas of data management and marine chemical analysis required to support the programme.

Bulgaria drew attention to the importance of studying coastal marine ecosystems with a view to modelling their development under the effects of eutrophication, and expressed the belief that it would be desirable to organize an international symposium on this problem, under the auspices of IOC, in the future.

The Assembly had adopted Resolution XIII.5, instructing the Secretary to organize, with the eventual participation of other interested organizations, notably IMO and UNEP, and under the guidance of GEEP, a practical Workshop on biological effects measurements with a view, inter alia, to establishing the scientific basis for the definition of vulnerability of marine areas to marine pollutants.

The Technical Secretary also referred to the Fifth Session of the IOC Working Committee for GIPME, Bangkok (30 July - 3 August 1984), in which several tasks for GEEP were identified and the terms of reference for GEEP were formulated. The specific points made will be referred to in the relevant Agenda items.

Reference was also made to the Third Meeting of the officers of WC/GIPME (Chairman and Vice-Chairman of the Working Committee, Chairmen of the Group of Experts) together with the Secretarial staff, 15-17 July 1985, Paris. At this meeting the activities of GEEP were reviewed and endorsed and clear priorities were set. These dealt with sensivity, vulnerability, biological effects techniques, and also concerned interaction and cooperation with other organizations. In view of the great importance attached to the many subject areas covered by GEEP and the need for an appropriate scientific input at the sessions of the Expert Group, the Officers meeting also recommended that the number of participating experts be increased to a maximum of 10, if possible, from 1988. This was supported by the Group (Recommendation GEEP-II.I).

Reference was made to the intersessional activities of the Group, which had covered subjects on: (i) The development of a proposal and a plan for the Workshop on Biological Effects Measurements; (ii) Biological Effects in Musselwatch Programmes and (iii) Vulnerable Areas. Reports on all these activities were presented, and were discussed under the respective Agenda items (Items 4, 5 and 6).

4. IOC WORKSHOP ON BIOLOGICAL EFFECTS MEASUREMENTS

The Chairman introduced the item by reviewing activities since GEEP-I. The proposal prepared in June 1985 had been sent to various potential funding agencies. The Chairman had visited Oslo in September 1985 and, with Professor Gray, had developed a working strategy for the Workshop. A description of this basic strategy, together with the aims of the Workshop, was then sent to potential participants on September 18. Since then, the statisticians, with help from scientists at IMER and on the basis of data made available from Norway, had reviewed the strategy for the Workshop and made certain recommendations to be discussed.

The meeting was then asked to consider: (i) The Budget; (ii) The List of Participants; (iii) The publication of the results; (iv) Planning and Logistics; (v) The need for chemical analyses, and (vi) Further plans for the Workshop.

4.1 THE WORKSHOP BUDGET

The Chairman reported that the Budget (Annex IV) was based on 30 participants, for whom Apex travel and a basic per diem would be paid, amounting to a total of 550 man-days in Oslo. The per diem was calculated to cover bed/breakfast charges of NK.270 and a remaining figure of NK.200. The Budget must also cover certain consultancy charges, secretarial assistance, recurrent expenditure, etc. It totals US$100,000.

Funding is anticipated from IOC and from sources in Norway, UK and USA (Annex IV). As presently conceived, the Budget balances provided all potential funding sources are realised.

It was stressed in discussion that Oslo University would be subsidising the Workshop to a considerable degree, through provision of laboratories, student assistance, ship time, etc. GEEP also acknowledged with thanks the Norwegian Institute for Water Research for making available the mesocosm facility at Solhergstrand on Oslofjord.

The Group then considered how the funds should be administered. It was proposed that Professor Gray would take care of travel assistance through a contract from IOC. Dr. Capuzzo would administer funds for the purchase of chemicals. Subsistence costs would be met from US, UK and Norwegian sources. Professor Gray would administer consultancy contracts for faunal and chemical analysis.

4.2 THE WORKSHOP PARTICIPANTS

The Group considered the list of participants already circulated (Annex 5). This list represents the key expertise required to apply and to evaluate the suite of techniques, which are to be compared at the Workshop in a scientifically convincing way. To this list had been added invited participating observers representing FAO/UNEP (Professor E. Nevo, University of Haifa, Israel) and ICES (a nominee to represent expertise in invertebrate pathology).

The Group also recognised the advantages of including participants from current regional programmes in order to facilitate GEEP's dialogue with these programmes and to initiate preparations for future Training Workshops which would be conducted in association with such regional programmes (see Section 8). It was agreed that three further participants be invited, to represent regional programmes in the Western Pacific, Caribbean and Mediterranean areas. A list of appropriate persons would be supplied to the Secretariat.

These additional participants could not be covered by the original budget (Annex IV), so extra funding would have to be found. It was understood that the participating observers from FAO/UNEP and ICES would be covered by these organizations. The participation of the regional experts would need to be supported by extra funding from IOC.

It was then agreed that formal invitations to attend the Workshop would now be issued by IOC to all those on the participants list.

4.3 PUBLICATION OF THE WORKSHOP PROCEEDINGS

It was agreed that publication would take two forms:

(a) A report to IOC which would give a summary statement of the methods used, a full account of the results and of the discussions and recommendations of the participants, to be published in the IOC Workshop Report Series.

(b) A book to be published by Inter-Research, Hamburg, which would be edited by Drs. Bayne and Gray and would include an introduction to the rationale and aims of the Workshop, a full account of all techniques (prepared by the appropriate participants) and a summary and statements of results and interpretations. Preliminary discussions with Inter-Research had been held.

4.4 WORKSHOP PLANNING AND LOGISTICS

The Group had available for discussion a document prepared by Drs. Clarke and Widdows (Annex VI) setting out in some detail the statistical and other constraints guiding the Workshop planning. In essence a transect will be established in Frierfjord/Langesundfjord south-west of Oslo to cover a gradient of contaminant levels in sediment and water; samples of the sediment community and of local, resident mussels, crabs and flounders will be taken along this contaminant transect. In addition a soft sediment mesocosm facility at Solbergstrand will be employed for four months prior to the Workshop. Four basins will be set up to cover three concentrations of an exposure «cocktail» and one clean, control condition. Samples of a clean soft-sediment community and of mussels, crabs and flounders will be exposed within these mesocosm basins from early-April to the period of the Workshop. The Workshop will thus supply material of known and controlled exposures (mesocosm) and similar material from an impacted field situation for analysis by participants.

In determining the details of the Workshop, the document in Annex VI was accepted as a preliminary statement. In addition, a questionnaire, prepared by Dr. Livingstone, was accepted by the Group as designed to elicit detailed information from participants in order to aid the final stages of planning. This would be expanded to include all the disciplines represented at the Workshop and sent to participants with a revised version of Annex VI.

4.5 CHEMICAL ANALYSES

The Group recognised the need for chemical analyses of sediments and mussel tissue to support the biological measurements to be made at the Workshop. A sum of money had been identified in the budget (Annex VI), but this represented a minimal cost. Accordingly, various alternatives were agreed for a «strategy» of chemical sampling (Annex VII), to cover various contingencies. Extra funds would be sought to cover the preferred option. If enough funding is not obtained, priority will be given to mesocosm samples, and NIVA will be approached regarding the field samples.

The Group requested the GEMSI representative (Professor K. Palmork) to consider undertaking the organic analyses «on contract». In this way, an input to the Workshop from GEMSI would be assured and the quality of analysis guaranteed. Dr. Palmork agreed to consider this and to communicate directly with Professor Gray as soon after the meeting as possible.

The Group recommends that IOC issue a formal invitation to Professor Palmork to undertake this task. Professor Abdullah (University of Oslo) would be approached by Professor Gray concerning the inorganic (metal) analyses required.

4.6 TIMETABLE

The following timetable was agreed:

(a) December 1985: Issue of formal IOC invitations to participants. Followed as soon as possible by the issue of Workshop details (Annex VI) and appropriate questionnaire.

(b) January 1986: Professor Gray to undertake preliminary survey of Frierfjord/Langesundfjord in order to establish a detailed sampling programme.

(c) February 1986: Questionnaires returned. Drs. Livingstone and Clarke analyse these and visit Oslo to finalize equipment requirements. Requirements for recurrent items passed to Dr. Capuzzo. Final details of requirements for chemical analysis agreed.

(d) March 1986: Sampling of field sites for sediment and community samples. Faunal material available to Dr. C. Help (meiofauna) and Professor Gray (macrofauna); sediment to Professor Palmork for chemical analyses. Mesocosm experiment set up. First samples made available for chemical analysis. Mussel transplants to Frierfjord (or later - by mid-May).

(e) April 1986: Budget finalised.

(f) May 1986: Second paper on statistical analyses and other information circulated, together with paper on biological/chemical interactions (for discussion at the Workshop).

(g) June 1986: Second mesocosm samples for chemical analysis. Participants submit summary statements of their procedures for circulation.

(h) July 1986: Final mesocosm samples for chemical analysis. Community samples made available to Dr. Warwick (meiofauna) and Professor Gray (macrofauna) for final analysis.

(i) August 1986: Workshop.

(j) September/October 1986: Report on Workshop to IOC.

(k) December 1986: Deadline for written contribution from participants.

(l) March 1987: Deadline for manuscript to publishers.

5. BIOLOGICAL EFFECTS IN MUSSELWATCH PROGRAMMES

It was recalled that an exercise had been initiated through GEMSI, but that it had been considered appropriate to include a biological section, specifically seeking information on biological effects studies carried out within the on-going musselwatch-type programmes. Accordingly, an ad hoc Group had been set up at the First Session of GEEP, with Dr. A. Bremner as Chairman, charged with suggesting a biological part of a questionnaire for circulation by GEMSI. A questionnaire had been developed intersessionally by Dr. A. Bremner and Dr. D. Phillips.

Since the Sixth Session of GEMSI, it had also been decided, through intersecretariat consultation between IOC and UNEP, that Dr. G. Topping be invited to take the lead in the joint GEMSI-GEEP exercise, since it was considered to be mainly a GEMSI-oriented task at the present stage. More pronounced biological expert involvement may be required later.

The Technical Secretary informed the Group of the discussions on the subject at GEMSI-VII (13-20 November 1985), where a first draft by Dr. Topping had been considered and revised, but not finalized. It was therefore not available to the Group. Dr. Topping will prepare it for circulation early in 1986. The Chairman concluded that the Group now needed to amend the proposed biological questionnaire so as to cover the needs for the first aim of the exercise, namely to obtain an inventory of on-going national and international musselwatch-type field programmes. The questionnaire should primarily seek information on which biological observations are included in the programmes, if any, and ask for reasons why such observations were not included if this was the case. Certain specific questions could also be included, but should be strictly limited.

After a brief discussion, it was decided that all participants would review the questionnaire developed intersessionally (Document IOC/GE(EP)-II/9), and pass their annotated versions to the Chairman, who would integrate the comments into a final version covering the GEEP part of this first stage of the exercise. This version is attached as Annex VIII.

The Group expressed its appreciation to Drs. Bremner and Phillips for their contribution. The ad hoc Group would be approached, as appropriate, to participate in the evaluation stage at a later date.

6. VULNERABLE AREAS

6.1 REPORT OF AD HOC GROUP

Professor Gray summarized his report of the GEEP ad hoc Group on Vulnerable Areas. The report (Annex IX) focusses on areas of the coastal zone and provides draft guidelines for the practical assessment of ecosystem characteristics and processes of vulnerable areas.

Previous efforts in this field are related almost exclusively to oil spills and to oil spill control. Yet an approach based on mapping of available information can be used to investigate other management problems directed at resource protection. The vulnerability of an ecosystem could then be judged, in part, on its presumed assimilative capacity for a specific input or series of inputs. Assessment of vulnerability can also be made through an understanding of community characteristics of a specific ecosystem (e.g. nutrient status, rates of primary production, trophic complexity), the interactions between ecosystems, and the physical and chemical features of the system that govern ecological processes. In developing an approach to study vulnerable areas, the Group considered that the mapping approach should be expanded to a more dynamic consideration through (i) incorporation of known seasonally and other components of regular variability in ecosystem characteristics; (ii) assessment of management demands on ecosystem characteristics interfaced with socio-economic considerations.

New techniques are available which facilitate this integration of ecological and socio-economic processes into simple computer simulation models. These models do not predict detailed and specific events, but are decision-making tools which can be of particular importance in arriving at research priorities.

The step is to identify variables and processes (biological, physical, and those concerned with human intervention), which can be incorporated into the model. If possible, the input sources and transfer processes should be encompassed but it is not necessary fully to quantify these processes. From the input data hypothetical scenarios are constructed and simulated in the model. For example, the sources of primary production may be identified and then the effect of hypothetical reductions in rates of production can be simulated. By running a sensitivity analysis, various scenarios can be explored and tested against each other.

One goal is to identify critical variables and processes which could give guidance to the setting of research priorities in order to arrive at measures of vulnerability. The models are not, therefore, traditional ecosystem models with quantified variables and transfer rates, but rather decision-making tools. The novel aspect is that it is now possible to encompass socio-econcomic aspects with ecological processes. These types of models are a useful and perhaps essential first step in management of protected areas, such as National Parks or areas thought to be vulnerable to human intervention.

6.2 SUGGESTED ACTION

Following a discussion of these topics, the Group then considered how it might best contribute new insights to the problem of assessing «vulnerability» in coastal ecosystems. The suggestion of the ad hoc Group that a site-specific study, based on the Morrocoy National Park, Venezuela was accepted. The following steps were recognised:

(a) Area maps evaluated, historical information gathered.

(b) Decision making model integrates ecological processes with socio-economic considerations.

(c) Detailed study is undertaken (3 years).

(d) Training workshop is conducted to consider the results of the study and to interface evaluation of vulnerable areas with biological effects studies.

One outcome of this study would be the development of various mapping techniques from which more dynamic features of the area could be inferred e.g. seasonal shifts in the likely impacts of tourism on key ecosystem processes within the Park. The decision-making model for the case study would be a central element in furthering an understanding of evaluation procedure for vulnerable areas.

Accordingly, it was agreed that the ad hoc Group on Vulnerable Areas should meet with Dr. Jorge Rabinovich (Venezuela) during the next 10 months to facilitate the development of a decision making model, interfacing management requirements with existing scientific data for the Morrocoy National Park as an example. The ad hoc group will consider the general applicability of the model to the study of vulnerable areas. In addition, the group will gather information on on-going activities (e.g. IUCN/UNEP) and make recommendations to a subsequent GEEP meeting on a comparative approach to the study of vulnerable areas.

6.3 INFORMATION FROM MEMBER STATES

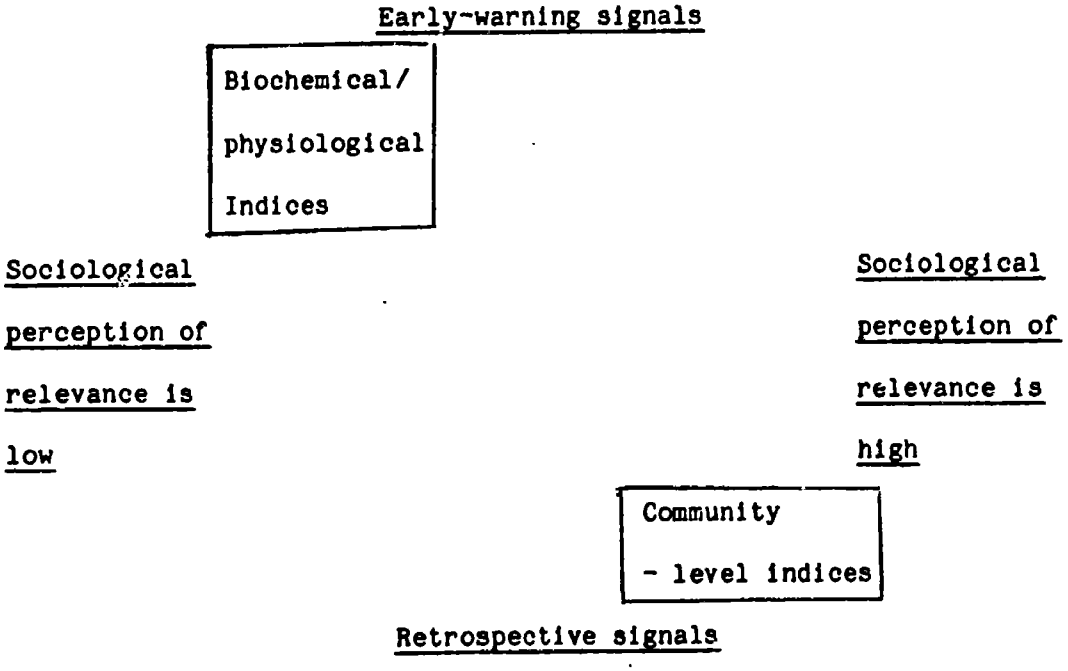
Only very limited response from IOC Member States to requests for information on national projects or considerations regarding vulnerable or protected areas had been received, suggesting that this kind of work may only now be initiated. Considerations within GEEP may help stimulate this.

6.4 VULNERABILITY IN SECOND EFFECTS WORKSHOP

The Group recognised that assessments of the biological effects of pollution and evaluation of vulnerable areas had elements in common although, in the present state of knowledge, fully effective integration between the two, could not be recommended. The results of the first Biological Effects Workshop would be evaluated, in part, in the context of the needs for understanding ecosystem vulnerability. It would therefore be appropriate that a Training Workshop be held at some time in the future at which recommendations for biological effects monitoring could be treated along with lessons learnt regarding vulnerable areas. It would seem appropriate also that such a Training Workshop be held in Venezuela in association with the project on the Morrocoy National Park.

7. EFFECTS OF POLLUTION ON POPULATIONS

Most of the discussion centered on the relationship between the responses of individual organisms and those of populations, and the demand to interpret effects on the individual in terms of their consequences for populations. While it is evident that factors such as reproductive effort, fecundity, egg viability or scope for growth must have a bearing on population dynamics, the nature of the links amongst all levels in the biological hierarchy are difficult to determine. Such difficulties are most acute when considering the relevance of bio-chemical indices, as early-warning signals, to resource impacts and the sociological perception of such impacts. This difficulty can be expressed diagrammatically:



Biochemical/Physiological indices provide early-warning but there is a need to increase sociological perception of their relevance. Community-level indices provide retrospective information of high «perception relevance»; the need here is to derive indices with better early-warning characteristics.

In relating the results of scientific research to management needs, there has been a tendency to assume that indices of biochemical and physiological response need not give rise to concern until they can be related to demonstrable population change. The problem therefore is to understand how to link biochemical indices to changes in communities and, furthermore, how to improve the sensitivity of community analysis to a point where effects can be detected early enough for control action to prevent irreversible damage.

The feeling of the group was that the discussion of population effects arrived at much the same conclusions as GEEP-I, but that the design and objectives of the Biological Effects Workshop were such that links may be expected to emerge between the various indices and population effects, as well as improvements in the sensitivity of indices at the population level.

One hope for improving insight into links between individual effects and population change lies in population genetics. Changes in levels of contaminants may lead to the appearance of tolerant individuals in the population through selection. Examples were cited of metal tolerance in nereids from estuaries contaminated by metals, changes in the frequency of certain alleles in metal tolerant molluscs, greater heterozygosity in longer-lasting cod in a survival experiment, and selection for metal-tolerance in bacteria in contaminated areas.

It was noted that population genetic effects of these types might be beneficial or deleterious; on the one hand, extreme selection pressures might reduce the genetic diversity of the population with long-term effects on the ability of that population to withstand further or different environmental changes; on the other hand, genetic adaptability may help to reduce the impact of a stressor on a population. Knowledge of genetic effects is thus important in trying to assess the longer-term consequences of impacts at the population level. The Group recognised that there was a great deal of current research relevant to these fundamental problems, and GEEP would continue to review this work in the light of its terms of reference.

8. TRAINING ON EFFECTS MEASUREMENTS

Approaches to training in biological effects measurement techniques were discussed. Detailed arrangements for training are best left until the outcome of the 1986 Workshop on Biological Effects Measurements is known, since only then would the most useful and generally applicable techniques be identified. While various procedures for training were envisaged by the Group, including visiting fellowships for trainees in expert host laboratories, or courses offered in trainees' laboratories by visiting experts, most discussion centered on the workshop approach to training.

Criteria for selecting a suitable site for a Training Workshop included (i) The availability of reliable analytical chemical data describing contaminant distribution; (ii) Preferably, the existence (or development) of a comprehensive chemical monitoring programme; (iii) The availability of both contaminated and «control» environments and (iv) Access to laboratory space and facilities. There were also good reasons for linking a Training Workshop to one of the regional programmes, possibly WESTPAC or IOCARIBE/CARIPOL; the latter was particularly attractive as there would be GEEP involvement in the Venezuelan project.

It was eventually decided that Dr. Capuzzo would, as an intersessional activity, consider programmes, potential facilities and venues in the WESTPAC Region before the Workshop in Oslo; in the light of this evaluation, a Training Workshop could be held in 1988 in the WESTPAC Region and in 1989 in the Caribbean. Both Workshops would involve some, but not necessarily all, approaches evaluated at Oslo. The suggested timing here is designed, in part, to facilitate linking training in biological effects measurements with the evaluation of vulnerable areas; this link is seen as being most practical in 1989.

9. REVIEW OF SPECIAL EFFECTS PROBLEMS

9.1 GENERAL

At the Third meeting of the officers of WC/GIPME (IOC, Paris, 13-15 July 1985) various topics relevant to GEEP's terms of reference were identified, with a request that GEEP initiate appropriate discussions. Two topics in

particular, euthrophication and marine mammals, were emphasised, the former because it represents a potential environmental problem of major global proportions, the latter because of general interest and as a result of a specific request that GIPME consider both the chemical and biological aspects to the problem of pollution effects in marine mammals.

9.2 EUTROPHICATION

Euthrophication of coastal waters has become a problem of global concern. Observations of increased incidence of exceptional algal blooms, hypoxic events and increased phytoplankton and/or benthic biomass have been documented in many coastal areas, although causal factors have not been clearly established. Impacts on fish and shellfish resources as a result of toxic algal blooms or hypoxic events have also been demonstrated. Problems of eutrophication in coastal waters primarily result from nutrient inputs from sewage and agricultural run-off.

In the marine environment nitrogen is most probably the key limiting factor. Therefore, investigations of the fluxes of nitrogen in marine systems, including studies of nutrient regeneration at the sediment-water interface, are important; it is essential that these studies be linked with studies of the hydrodynamics of specific locations in order that predictive models can be derived.

GEEP supports the concerns of ICES and the Bulgarian delegation to IOC regarding eutrophication/hypertrophication in coastal waters. The Group recognises that this topic is of fundamental interest also to other inter-governmental, national and international organizations. It was considered that a joint review was called for. The Technical Secretary was therefore requested to consider what action from GEEP would be most helpful in prompting urgent discussions in the widest possible framework and, in liaison with the Chairman of GEEP, to initiate a proposal to the agreed body (e.g. GESAMP) to take on a review of this important question and to offer the fullest collaboration of GEEP.

9.3 MARINE MAMMALS

The Technical Secretary informed the Group of previous discussions with ICES which had taken place in connection with two meetings on the protection of marine living resources arranged by UNEP, in March and October 1985. To the second of these meetings a joint ICES/IOC proposal had been made suggesting the organizations prepare jointly a review on levels and effects of pollutants in marine mammals. The Group was asked to take this into account in the deliberations.

The best documented effect of pollution on marine mammals is the impact of organchlorine compounds on reproductive processes. There are now three examples of such impacts: The first to be reported was in Californian

sea lions during the mid-1970s; the second was in Baltic ringed seals during the mid-1970s; and the last in Waddensee harbour seals in the late 1970s. In all these cases, blubber concentrations of several hundred ppm of PCBs, or PCBs and DDT group residues combined, were correlated with an unusual incidence of abortions, stillbirths or morphological changes in the female reproductive system. This correlation has been interpretated as a causal relationship, especially as experimental feeding of PCBs to laboratory mammals had also caused reproductive interferences. More recently, high organochlorine concentrations in the blubber of Gulf of St. Lawrence (Canada) beluga whales have been invoked to explain unusual strandings and pathology in these animals; however, reproductive effects have not yet been reported in this population.

The interpretation of these data is complicated by the fact that organochlorine residue concentrations are usually measured in blubber, and such concentrations are significantly affected by biological factors, such as the animal's age, its sex and its condition. Thus, if the condition is poor, and the blubber is thin, residue concentrations (as blubber net weight) are high, and vice versa. The question is then whether high blubber residue concentrations cause poor condition, or are an effect of it. This consideration is particularly important in evaluating the significance of residue determinations in stranded (and therefore possibly starved) or emaciated animals.

What trends are likely in the occurence of this effect? In geographic terms, the impact of organochlorines on marine mammal reproduction seems to be limited to those areas where there are extremely high levels of organochlorine pollution. The Group does not expect, for example, that such effects would be observed in Eastern Canadian seals, where organochlorine residue burdens are two orders of magnitude below those in Western Europe. (In this context, the Gulf of St. Lawrence beluga effect is distinctly anomalous.) In terms of temporal trends, organochlorine residue concentrations in seals seem to be declining. PCB concentrations, for example, appear to be falling by about half over a decade, although certain PCB congeners may not be declining to the same extent. (In this context, GEEP considered that marine mammals may be suitable monitoring organisms in which to detect changes over large scales of space and time). If the dose response relationship between organochlorine burdens and reproductive interference can be determined by direct experiment, these data, combined with temporal trend data, could lead to a prediction of when reproductive effects would probably cease.

In the light of these considerations, GEEP encourages the national programmes already under way e.g. in Scandinavia, The Netherlands and Canada, which focus on this problem. GEEP also emphasises the importance of considering biological factors (such as age, sex and condition) when monitoring chemical trends using biological «accumulators». Finally, the Group agreed with the proposition that a review be prepared summarizing available knowledge on the influence of organochlorines on marine mammals, and especially with regard to the hormonal and immune defence systems and the need to understand the patho-biological implications. Such a review as proposed should be carried out jointly with ICES. The Technical Secretary was requested, to inform ICES about the positive response of GEEP to the proposition of a joint activity in this field. Dr. Addison would be the IOC/GEEP representative in the joint Group preparing the review. A draft of the review may be presented to the next session of GEEP, and the review would be expected to be finalised early 1987.

10. STRATEGIES FOR MONITORING BIOLOGICAL EFFECTS

The evolution of a strategy for biological effects monitoring, discussed by GESAMP and more recently by ICES, was reviewed. The results of these discussions were accepted by the Group as a basis for further developments and as providing means for incorporating biological effects techniques in wider monitoring programmes. It was accepted that the suite of techniques to be evaluated at the first Biological Effects Workshop had been carefully selected on the basis of which procedures might best be incorporated into such monitoring programmes.

One activity considered to have potential for the further development of the monitoring strategy was its incorporation into an expert system software shell; this could make the strategy, and the selection of appropriate techniques for specific problems or phases in a programme, accessible to the non-expert. Current research towards this end was known to members of the Group.

Field bioassay applications had not been included among the techniques for consideration at the first GEEP Workshop. The Group reviewed briefly the advantages and problems in their use and their location within a monitoring strategy, in order to define needs for further work in this area. Bioassays were considered as useful reconnaissance tools in the first phase of monitoring, especially for identifying environmental heterogeneities on spatial and temporal scales not readily ameanable to other approaches. A distinction was made between the use of bioassays in waste disposal evaluation and in field monitoring; a wide range of approaches in the former category was available and had been subjected to a measure of intercalibration. Relatively few methods in the latter category were in regular use, primarily in point source monitoring. Such methods were of use where short spatial and temporal scales were involved and where acute effects were of concern. Attention was also drawn to the use of chemical manipulation experiments using bioassays, to identify causal agents in observed field effects.

In order to better assess the place and role of bioassays in the strategy, GEEP agreed that the available techniques should be reviewed by Drs. Stebbing and Capuzzo who should contact Dr. Harold Rosenthal, both to call on his experience in the use of bioassays and to provide information concerning compatible activities within ICES and possibly other organizations. The review should encompass consideration of the reasons for application of each bioassay method and the needs for assessing the comparability of results. In relation to manipulation experiments, the advice of GEMSI on the practicalities of such approaches would be necessary.

In further discussions on this topic, it was acknowledged that many of the problems pertinent to agreement on monitoring strategies required, by their very nature, multi-disciplinary approaches, including knowledge of an area's physical, chemical and biological characteristics. GEEP's terms of reference are specifically biological in emphasis, but the Group is well aware that measurements must be set in a more comprehensive environmental context if they are to be fully meaningful. At the appropriate time, following discussion of these matters at the Biological Effects Workshop and at GEEP-II, it was the Group's intention that GIPME be approached to give due consideration to these interdisciplinary requirements in the further development of its programme.

11. INTERACTIONS WITH OTHER GROUPS AND ORGANIZATIONS

The Chairman opened the discussion stating that, besides GEMSI, co-operation and interaction with FAO, UNEP, ICES and IMO should be considered at this stage of the development of GEEP.

The Chairman had participated as an IOC observer in the recent FAO/UNEP Meeting on the Biological Effects of Pollution (Blanes, Spain, 7-11 October 1985). The possibility had been discussed that FAO participate in the IOC Workshop on Biological Effects Measurements through sponsorship of one or two participants from the Mediterranean Region, to be arranged by the FAO Staff Member at the UNEP Co-ordinating Unit for the Mediterranean Action Plan. This was fully endorsed by the Group and it was decided that appropriate action be taken by the Secretariat in consultation with the Chairman.

In relation to the UNEP Regional Seas Programme, it was noted that interaction and co-operation could potentially be developed within several sectors in relation to biological effects of pollutants. It was considered most appropriate to develop this in due course, e.g. in connection with the vulnerable areas studies.

The observer from ICES, Dr. M. Parker, stated that the relevant ICES Groups will maintain close liaison with GEEP. The ICES study group on Biological Effects Techniques will continue its work, taking into account as far as possible the results obtained from the GEEP work plan, in particular the Workshop on Biological Effects Measurements. Within the ICES governing bodies and scientific community there is a considerable interest in this work. An important follow-up to this Workshop would be to transfer the experiences gained in the most appropriate way to the laboratories involved in regulatory activities within national and international programmes. The group welcomed this and agreed that as close links as possible should be maintained with the ICES groups and community.

During the ICES Statutory Meeting, 7-13 October 1985, the possible ICES involvement in the Workshop had been discussed, in consultation with the Chairman of GEEP and the Technical Secretary. It had been suggested that ICES could contribute by sponsoring the participation of one or two pathologists, perhaps in particular invertebrate pathologists. The Group noted that the advanced stage of the planning, the timing, the geographical siting, the scale and the overall logistics render it not feasible to include fish pathology in this Workshop. It is not possible, in the selected geographical siting of the Workshop, to mount a scientifically and statistically convincing fish pathology component.

However, GEEP would welcome the participation of one invertebrate pathologist and would be grateful for nomination of an appropriate expert from ICES; in view of the planning, a nomination should be made in the very near future.

The Group acknowledges that ICES has a long-standing involvement in fish-pathology studies, and accordingly, GEEP has not included this in its present work programme. The Group is very keen to be kept informed about developments in fish pathology work within the purview of ICES. The Group would also be interested to obtain information on results of a biological nature from the ICES 1985/1986 joint monitoring programme, if at all possible before the Oslo Workshop, so that the Workshop may benefit from this information.

The Group expressed the strong wish that ICES be represented also at GEEP-III. The Chairman considered that the most appropriate way of presenting the results of the Workshop formally to the ICES community would be at the Statutory Meeting in 1986. The Group agreed that Dr. Bayne would be most suitable to give such a presentation and it was agreed that the Secretariat would contact ICES to explore this possibility.

In considering interaction with GEMSI, the Group in particular expressed the hope that Dr. Palmork (the GEMSI representative) would undertake to do the organic chemical analyses required for the Workshop (as specified in Item 4).

The Group also discussed the wider aspects of interaction with GEMSI and endorsed conclusions reached during GEEP-I and recorded in the report of the meeting (IOC/GGE(EP)-I/3, March 1985). An associated area of specific interest related to the question of chemical/biological interactions and the constraints that these might impose on both chemical and biological measurements in marine pollution studies. This topic was considered important, and the Group invited Dr. Capuzzo to prepare a discussion paper which would be used at the Oslo Workshop to initiate an exchange of views amongst participants. As a result of these discussions, and any further assessment offered at GEEP-III, a more focussed set of questions would subsequently be put to GEMSI in order to prompt an agreed GIPME stance on the subject.

In relation to IMO, the Technical Secretary informed the Group that good contacts were established with the Marine Environment Division of IMO Secretariat, that discussions were currently aimed at identifying specific points of interaction with IOC. These points included subjects of concern to GEEP, such as vulnerable areas, monitoring in relation to dumping, development of bioassay techniques for field work, and the inter-relationships between laboratory and field studies of biological effects and assays. The Group expressed strong interest in transfer of results of its work to all other organizations, and willingness to give advice in relation to discussions with IMO and in taking up relevant tasks. This question would be considered again at GEEP-III.

12. FUTURE INTERSESSIONAL WORK

On the basis of the developments made so far by the ad hoc groups established at the First Session and the discussions during this Session, the requirements for future intersessional work were reviewed, and the following basic structure agreed upon.

The ad hoc Group on the IOC Workshop on Biological Effects Measurements organized under the auspices of GEEP, continues its work with the following revised membership and terms of reference:

Membership: B.L. Bayne (Chairman), T. Bakke (representing NIVA), J. Capuzzo, J. Gray, D.R. Livingstone.

Terms of reference:

(i) To prepare the IOC Workshop on Biological Effects Measurements to be held in Oslo, Norway, in August 1986, following the work-plan and time-schedule outlined in Agenda Item 4.

(ii) To report to GEEP-III on the results, and

(iii) To prepare a report on the results of the Workshop for publication in the IOC Workshop Report Series.

The ad hoc Group on Vulnerable Areas continues its work with the following revised membership and terms of reference:

Membership: J.S. Gray (Chairman), J. Capuzzo, G. de Mahieu, R. Warwick.

Terms of reference:

(i) To prepare draft guidelines for the practical assessment of ecosystem characteristics/processes of vulnerable areas. In this context an area with mangrove, coral reef, coral sediment, and seagrass areas in Venezuela, earmarked as a national park, is to be considered as a case study area.

(ii) To submit a summary of the findings and proposals for further work to GEEP-III.

The ad hoc Group on the Review of Biological Effects in National and and International Musselwatch programmes will be retained intersessionally with Dr. A. Bremner as Chairman, in order to facilitate the evaluation stage of the musselwatch programmes review. This, however, was not expected to be initiated until late in 1986, or early 1987, after the answers to the questionnaire had been received and suitably compiled. Details of the evaluation work and terms of reference for it could accordingly only be defined at a later stage. The most appropriate membership of this ad hoc Group could then also be decided.

The ad hoc Group on Effects of Pollution on Populations will not continue since this work will be further developed through a different strategy.

Other tasks to be completed intersessionally by the Group included:

(i) The review of programmes, potential facilities and venues in the WESTPAC Region, in view of the need to find a suitable site for a training workshop on biological effects measurements (Item 8);

(ii) The preparation of an outline of physical, chemical and biological processes related to eutrophication in marine waters, together with a definition of the problem and suggestions of terms of reference and required expertise for an ad hoc Group or other group to evaluate the understanding of the problem of eutrophication (Item 9);

(iii) The preparation of a review, jointly with ICES, of available knowledge on the influence of organochlorines on marine mammals, especially with regard to the hormonal and immune defence systems and the need to understand the pathobiology and detailed pathology of natural populations in contaminated and uncontaminated areas. (Item 9);

(iv) The preparation of a review of available techniques of field bioassays in order to assess the role of these techniques in strategies for monitoring biological effects (Item 10).

13. ELECTION OF OFFICERS

In accordance with the IOC Manual, an election of the Chairman for the intersessional period and the next session of GEEP was held. Dr. B. Bayne, being eligible for another period of office, was nominated. This was seconded and Dr. Bayne was duly elected.

14. OTHER MATTERS

The Technical Secretary proposed that the Third Session of GEEP be held in conjunction with the Workshop on Biological Effects Measurements in Norway. It was decided to hold the Session for three days during the first week of September 1986. Participants would be selected according to the major agenda items, by the Secretariat, in consultation with the Chairman.

15. ADOPTION OF SUMMARY REPORT AND CLOSURE

The Summary Report was adopted and the meeting declared closed by the Chairman at 16h30 on 5 December 1985.

ANNEX I

AGENDA

1. OPENING OF THE SESSION

2 ADMINISTRATIVE ARRANGEMENTS

2.1 Adoption of the agenda
2.2 Designation of rapporteur
2.3 Conduct of session

3. INFORMATION ON INTERSESSIONAL ACTIVITIES AND DEVELOPMENTS

4. IOC/GEEP WORKSHOP ON BIOLOGICAL EFFECTS MEASUREMENTS

4.1 Budget
4.2 Participants
4.3 Publication
4.4 Planning and logistics
4.5 Chemical Analyses
4.6 Timetable

5. BIOLOGICAL EFFECTS IN MUSSEL WATCH PROGRAMMES

6. VULNERABLE AREAS

6.1 Report of ad hoc group
6.2 Suggested action
6.3 Information from member states
6.4 Vulnerability in Second Effects Workshop

7. EFFECTS OF POLLUTION ON POPULATIONS

8. TRAINING ON EFFECTS MEASUREMENTS

9. REVIEW OF SPECIAL EFFECTS PROBLEMS

9.1 General considerations
9.2 Eutrophication
9.3 Marine mammals

10. STRATEGIES FOR MONITORING BIOLOGICAL EFFECTS

11. INTERACTIONS WITH OTHER GROUPS AND ORGANIZATIONS

12 FUTURE INTERSESSIONAL ACTIVITIES

13. ELECTION OF OFFICERS

14. OTHER MATTERS

15. ADOPTION OF SUMMARY REPORT

16. CLOSURE

ANNEX II

RECOMMENTATIONS

The GIPME Group of Experts on Effects of Pollutants,

Recommendation GEEP-II.1

NUMBER OF PARTICIPATING EXPERTS

Mindful of the suggestion of the Third Meeting of the officers for the Working Committee of GIPME that the number of nominated experts participating in any one session of GEEP be increased to a maximum of 10, and

Noting that the range of scientific interests now adopted by GEEP and viewed as necessary to fulfill the Group's objectives, has increased to cover a very diverse range of biological topics, including biological responses to pollution from the biochemical to the community level, concepts of vulnerable areas, eutrophication, organisms from marine plankton to mammals, and all set in the context of most effective strategies for training and for biological monitoring,

Recommends that the number of participating experts at any one session be increased to a maximum of ten.

Recommendation GEEP-II.2

WORKSHOP ON BIOLOGICAL EFFECTS MEASUREMENTS

Mindful of the instruction by the Fifth session of the Working Committee for GIPME to the Secretary of the IOC to arrange a workshop on the Effects of Pollutants, and

Mindful of Recommendation XIII-5 of the Thirteenth Assembly, instructing the Secretary to «(ii) organize, with the eventual participation of other interested organizations, notably IMO and UNEP, and under the guidance of the Group of Experts of Pollution, a practical workshop on biological effects measurements with a view, inter alia, to establishing the scientific basis for the definition of vulnerability of marine areas to marine pollutants», and

Noting that the scientific basis for biological effects measurements must be developed in a stepwise manner so as to ensure intercomparability of results on a regional and eventually global basis, starting with a rigorous scientific evaluation of available techniques effected in a region of known pollution gradients and available chemical and biological data base,

Recommends that a practical Workshop on Biological Effects Measurements be carried out with participation of carefully selected experts specifically invited to represent the best available expertise in the relevant scientific fields;

Further recommends that this Workshop be held at the University of Oslo during 10-30 August 1986.

Recommendation GEEP-III.3

CHEMICAL ANALYSIS FOR THE WORKSHOP ON BIOLOGICAL EFFECTS MEASUREMENTS

Mindful of the need for expert chemical analysis to accompany the biological components of the Workshop on Biological Effects Measurements, to be held at the University of Oslo in August 1986, and

Noting the requirement that such analysis meet the highest standards set by the GIMPE Group of Experts on Measurements, Standards and Intercalibration (GEMSI),

Recommends that GEMSI and, in particular, the Institute of Marine Research, Bergen, Norway, be invited to undertake the necessary analyses, under the leadership of Professor K. Palmork, with funding from the Workshop budget to meet the necessary costs.

Recommendation GEEP-IV.4

CONVENING THE THIRD SESSION OF GEEP

Mindful of the need to make best use of limited economical resources, and

Noting that several expert nominated as GEEP members will be present at the Workshop on Biological Effects Measurements in Oslo, August 1986,

Recommends that the Third Session of GEEP be arranged directly after the Workshop at a suitable site in Norway.

ANNEX III

LIST OF PARTICIPANTS

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ANNEX IV

TENTATIVE BUDGET FOR THE WORKSHOP ON BIOLOGICAL EFFECTS MEASUREMENTS

30 PARTICIPANTS:

- Expenditure:

Travel	US$30,000
Subsistence	US$31,000
Recurrent costs	US$10,000
Consultancy (chemical)	US$10,000
Consultancy (fauna)	US$ 7,000
Pre-workshop arrangements and travel	US$ 3,000
10% contingency	US$ 9,000
Total output	US$100,000

- Income:

From IOC sources	US$30,000
From Norway	US$20,000
From U.K.	US$14,000
From USA	US$30,000 - 50,000
Total income	US$94,000 - 114,000

ANNEX V

TENTATIVE LIST OF PARTICIPANTS FOR THE WORKSHOP ON BIOLOGICAL EFFECTS MEASUREMENTS, OLSO, AUGUST 1988

B L Bayne	(UK)
J S Gray	(Norway)
R Addison	(Canada)
J M Capuzzo	(USA)
R Clarke	(UK)
D Dixon	(UK)
R Green	(Canada)
C Heip	(Belgium)
D Johnson	(UK)
J Kuiper	(Netherlands)
B Kurelec	(Yugoslavia)
R Lee	(USA)
D Livingstone	(UK)
D Lowe	(UK)
B McCain	(USA)
G. de Mahieu	(Venezuela)
G. Gomez	(Philippines)
A. Bremner	(Australia)
	(China)
	(ICES Representative; France)
	(Malaysia)

ANNEX VI

IOC WORKSHOP ON BIOLOGICAL EFFECTS MEASUREMENTS
Oslo, August 1986

Participants should already have received a formal invitation to attend the workshop, as well as the preliminary letters outlining its general objectives, timing and location. This discussion paper presents preliminary, but detailed, information on the following.

1) Background data for the Frierfjord/Langesundfjord area, where it is proposed to carry out field work, and for the Solbergstrand mesocosms, where comparisons of the various approaches can be more critically scrutinised in a controlled environment.

2) The proposed sampling strategy, covering such details as collection sites in Frierfjord, experimental regimes in the mesocosms, material expected to be available, collection times, analyses proposed, and various logistical considerations.

3) Some tentative suggestions for what related chemical analyses it would be desirable to perform, as outlined by the GEEP II Paris meeting in December.

4) A summary timetable.

Also attached is a questionnaire, requesting detailed information from every participant about all aspects of the analyses you intend to perform, and giving you the opportunity to comment on the proposed sampling strategy, before any irrevocable steps are taken. Prompt reply is essential.

The twin objectives of
a) synthesising the wide spectrum of information that different cellular, organism and community approaches can generate in field surveys, and
b) comparing the relative sensitivities of these indicator techniques when faced with precisely the same impact gradient,
cannot readily be attained in field surveys alone. This is particularly true of comparisons between benthic community methods and, say, sublethal stress indices measured on bivalves, since many factors will preclude any meaningful definition of "equivalence" of pollution impact on the two groups. (For example, the hydrography of the fjords implies that littoral animals are exposed to quite different water masses than the deep-bottom soft-sediment communities.)

The workshop plans therefore centre both on survey sampling of native individuals and communities in Frierfjord/Langesundfjord (supplemented by a limited mussel transplant programme, intended to extend the range of experienced impact levels), and on coincidental exposure of soft-sediment fauna and indicator organisms to a controlled pollution gradient, in the mesocosm facilities at Solbergstrand. The latter will involve a fixed "cocktail" of some important local pollutants at three dilution levels (plus control), and as far as possible is designed to mesh in with the field programme, whilst facilitating comparisons by extending the range of impact to higher levels.

1. BACKGROUND DATA

Frierfjord/Langesundfjord

Map 1 shows the general region of Oslofjord, with Oslo, Frierfjord/Langesundfjord, and the Solbergstrand mesocosms indicated. Frierfjord is located in southern Norway and is connected to the Skagerak via Langesundfjord (Map 2). It is a typical stratified fjord system with a permanent thermocline and halocline at approximately 4-8 m depth dividing two distinct water masses. The surface water has a salinity range of 1 to 5‰ and a seasonal temperature range of 1° to 17°C, whereas the bottom water is maintained at 6° - 7°C and > 25 to 33.5‰ salinity throughout the year. In addition, the Skiens river and Frierfjord experience hypoxic and occasionally anoxic conditions below - 15 m and 50 m respectively (see depth profile below Map 2).

Metals and organic contaminants entering the system via the industrialized Skiens river are known to accumulate in the sediments but their concentration declines rapidly within 2 km of the source (Skei, 1981). However, a significant proportion of the contaminants, i.e. those in the dissolved phase, remain in the surface brackish water of Frierfjord and then mix with full salinity seawater of Langesundfjord beyond the sill at Brevik.

Therefore the hydrography of the system a) prevents a "simple" pollution gradient being established, b) limits the distribution of littoral brackish and marine species to the sill (Brevik) and beyond, and c) causes periods of hypoxia/anoxia in the deeper waters of Frierfjord due to restricted water exchange.

The available chemical data (NIVA) for mussels, crabs and fish are summarized in Table 1. There is considerable seasonal variation in the concentration of organic contaminants in the tissues of mussels. Maximum values occur in March/April, presumably reflecting an increased input into Langesundfjord at this time and the slightly higher bioaccumulation by mussels in the spring.

Clearly, the concentrations of metals and organic contaminants in the bottom waters of Frierfjord or the surface waters of Langesundfjord are not sufficiently high for there to be a marked gradient away from a heavily polluted and impacted area. Consequently, biological effects due to pollution cannot be guaranteed and are likely to be subtle.

Solbergstrand mesocosms

It is hoped that four basins will be available at the Marine Research Station, Solbergstrand (run by the Norwegian Institute for Water Research - NIVA). These are indoor concrete basins, of approximate size 3m by 10m (by 1.5m deep), with flow-through seawater at about 5°C and 34-35‰ salinity, and light intensity controlled to appropriate levels for typical soft-bottom communities. Field sediment and fauna are normally successfully transferred from box cores to plastic boxes, which are placed on the basin floor.

Table 1. Concentration of contaminants in the body tissues of marine animals sampled from Frierfjord and Langesundfjord (Season: July/August; for site designations see Map 2).

Organics (mg kg^{-1} d.w.)	Frierfjord (site A15)	Langesundfjord (sites A3 - A9)
Mytilus edulis		
Polycyclic aromatic hydrocarbons (PAH)	2 - 6	1 - 20
Hexachlorobenzene (HCB)		0.2 - 1
Pentachlorobenzene		0.05 - 1.5
Carcinus maenas	Frierfjord	"Uncontaminated site"
HCB	0.41	0.07
Octachlorostyrene (OCS)	0.20	0.03
Decachlorobiphenyl (DCB)	0.45	0.06
Cod (Liver tissue)		
HCB	2 - 8	
OCS	10 - 20	

Metals (mg kg^{-1} d.w.)	Frierfjord	Langesundfjord (sites A6 - B4)*
Mytilus edulis		
Hg		<0.4 - 1.0
Cd		<1.5 - 3.5
Cu		<6 - 21
Pb		<2 - 13
Zn		<100 - 180
Ni		<2 - 3

* No data for "uncontaminated reference site"

Carcinus maenas	Frierfjord	"Uncontaminated site"
Hg	0.92	0.35
Cd	4.05	3.67
Cu	1.77	0.86
Pb	161	129
Zn	211	185
Cod (muscle)		
Hg	0.5	-

2. SAMPLING STRATEGY AND EXPERIMENTAL DESIGN

The information given below is very much a preliminary attempt at formulating sampling strategy, and is almost certain to need substantial amendment in the light of logistical constraints and participants' requirements. However, it is presented in such detail in order to provoke detailed responses; it is important to identify any likely problems at an early stage.

Frierfjord/Langesundfjord

The precise sampling sites have yet to be selected; this is dependent on the outcome of a "quick-look" benthic survey by Professor Gray in early January. One possibility is described below; any changes to this are unlikely to invalidate the discussion that follows.

There will be 6 sampling sites, 4 in Langesundfjord and 2 in Frierfjord. The sites in Langesundfjord should be selected on the grounds of populous, and reasonably accessible, mussel beds (preferably with good littorinid populations also present), where collection of benthic box cores in the same general region is possible. Another important constraint is that the general sediment structure be as nearly equivalent across all benthic sampling areas as is realistically possible. It should also be possible to trawl and bait for fish and crabs in these areas. Though such approximate geographical conjunction of benthic and individual organism sampling sites is worth attempting, there is no illusion that this guarantees any meaningful "equivalence" of pollution regime (and there is also a large temporal disjunction); this consideration partly motivates the mesocosm studies.

Some background data are already available, from NIVA, at certain locations in the fjord (see Map 2 and earlier discussion) so there may be some advantage in selecting sites from these. A possible gradient might then be A3, A6 (or B4 - referred to as A6/B4 from now on), A9 and C1. Insufficient data exists from C1 to assess the likely environmental impact relative to A9, but it seems right to concentrate two stations in this general region, since the mixed water immediately below the Brevik sill offers one of the best hopes for a significantly impacted area. Dectection of significant impact will be aided by stretching the range of the pollution gradient at both ends; at the "clean" end it may therefore be worth trying to identify a more open coastal site further round the headland from A3, though it is not at all clear that this would be possible within the same constraints on similar sediment type, large mussel population etc. (Note also that the site chosen as "cleanest" would also, ideally, need to supply the benthic community and mussel populations for the mesocosm experiments and transplants - see later discussion.)

In order to further extend the range of impact at the top end, two sites are being considered in Frierfjord. Though the stratification confuses the picture, there should exist significantly impacted benthic communities very close to the source of the industrial pollution, in the Skien River mouth. There will be no native mussel populations here, so a transplant experiment is being considered, in which mussels are taken from A3 (in March/April), caged and buoyed at depth (say 10 metres from bottom), close to the benthic sample site. The "control" for this experimental site would be a further caged transplant from A3 to A15,

also at depth. Existing benthic data for a site near A15 indicate a diverse and relatively unimpacted community there, and mussel tissue concentration data confirms that exposure levels are lower than in the mixed waters below the Brevik sill. It will not be possible to transplant caged Littorina in the same way to these two sites, though it may be possible to bait (or dredge?) for native crabs and should be possible to trawl for fish.

After Professor Gray's "mini-cruise" of January, a decision will be taken on whether it is worthwhile including these two Frierfjord sites. If not, then two additional sites will be selected in Langesundfjord, giving say C1, A9, B4, A6, A3 and a "cleaner", more open, coastal site. [Logistical considerations will also enter - availability of buoys or other "permanent" fixtures for attachment of caged mussels, risk of disturbance? In addition to "quick-look" macrofauna, crab and fish surveys in Langesundfjord and Frierfjord, the January "mini-cruise" will also need to establish the precise location and size of the 4-6 mussel populations to be sampled in Langesundfjord and whether sufficient individuals of ≥4cm shell length are present; also the availability of Littorina at those sites.]

Sampling and analysis of benthic communities: In late March/early April, after the melt, benthic samples will be collected from the 6 sites in Frierfjord/Langesundfjord. The suggestion is that 6 replicate box cores (of area 0.25 mm^2) be extracted from each sampling site (analysis of at least 5 of the 6 replicates must be ensured, the extra core allowing some safeguard against loss or other analysis problems). The spacing of replicate box cores requires some consideration, in order that the replicates reflect the true between-core variability for that site. Without detailed knowledge of the area it is difficult to make specific recommendations but, as always, the right guiding principle is repeatibility; if the sampling were to be repeated on the following day by a different team of scientists, following a publishable sampling protocol (go to map location xyz etc.), then the two sets of samples should never exhibit significantly different mean values, for any of the variables measured, however many replicates were taken. This implies that the replicate cores be sited randomly over the area they are designed to represent (it being perfectly permissible to exclude certain sub-areas which fail to satisfy objective criteria); this is the nearest equivalent in field sampling to the laboratory experiment principle of randomising over the full set of "experimental units available for a treatment".

From each replicate box core a number of smaller cores will be removed. Firstly, ten meiofauna cores (each of area 2 cm^2) will be taken, spaced over the surface of the box core; these are then pooled before preparation. Secondly, a further core (or cores) will be removed for physical and chemical sediment analyses. The possibilities for chemical analysis are discussed in a separate section towards the end of the paper. It is not yet clear what variables (particle size distribution, organic content, metals, selection of PAHs, HCBs etc.) it is going to be possible to measure within the available budget, but the same principle of taking multiple sub-cores and pooling them seems appropriate, and one or two of the variables (particle size?) should be measured on all replicate cores from each site. Thirdly, it may be possible to remove further sub-cores if any participant needs these for other forms of analysis (e.g. bacteria?). Detailed instructions must be sent now on how

such samples are to be treated and dispatched (or stored until the workshop); clearly, the resulting analysis is the responsibility of the participant concerned.

The 30 (+ 6 spare) meiofaunal cores will be sent (in March/April) to Carlo Heip's team for analysis; it is anticipated that 20 cm^2 sediment-core pools will be enough to obtain reasonable numbers of copepods, though it is likely to need subsampling again for the anticipated higher frequencies of nematodes. The remaining box core sediment will be analysed for macrofauna at the University of Oslo. Again, the possibility of subsampling this sediment should be considered, dependent on the likely concentration of organisms. The resulting data, and the faunal samples themselves will be available at the start of the Workshop (though the possibility of sending out the data a couple of weeks before the workshop should also be considered).

Sampling and analysis of individual organisms: Unlike the benthic community studies, all sampling and analysis for the "sublethal index" work is expected to take place during the period of the Workshop. Logistical constraints therefore dominate and there are certain to be demands from, say, the physiologists and the biochemists that conflict with each other, and with the statistical necessities. The line taken below is that comparability of the various indices, based on a single species, absolutely dictates that participants work on exactly the same pool of animals, collected communally for a particular site, at only one point in time, and distributed at random amongst the participants. The absolute necessity for the physiologists to have a staggered supply of live animals from the various sites over several days has to be met, as does the need to spread demand on facilities and to be realistic about the speed with which sites can be sampled, whilst not engendering grossly inefficient use of participants' time and retaining some flexibility. The following is a possible compromise, whose logistic feasibility will have to be examined by the Oslo team.

The lowest risk strategy is to spend week 1 (August 11 to 17) sampling and analysing material from Frierfjord/Langesundfjord, and most of week 2 working on Solbergstrand mesocosm samples. There is then still time to salvage the more complex field work in the second week, in the event of logistical problems in the first week, it being relatively easy to slot the much simpler mesocosm sampling into revamped plans. [However, there are also arguments for reversing this order, most notably the desirability of minimising the time period between collection of benthic and individual organism samples in the mesocosm, and the advantages of a longer settling-in period for participants before the more complex field sampling takes place.] A minimum of one full day seems essential for participants to familiarise themselves with equipment etc., suggesting the following timetable.

Day 2 (Tues, Aug 12): Sampling of sites A3 and C1 in Langesundfjord. Similar remarks apply as for the benthic sampling, about sampling representatively from a well-delimited area, the total collection of mussels and Littorina from one site then being randomised when the partition for the various purposes is made. It is suggested that animals should be collected, or later selected from, only within an agreed size range, as a means of reducing between-animal variability. It is clearly of considerable importance that samples destined for tissue concentration analysis of

hydrocarbons, metals etc. are drawn at random from the total pool collected at each site. [See the later section for the possibilities under consideration for tissue chemistry.]

Logistics: A small number of scientists embark on the dayboat near A3, sample for mussels and Littorina at A3, travel (by dayboat) to C1, sample there and disembark somewhere near Brevik. Waiting there, with some sort of mobile laboratory van, will be the scientists needing to dissect and prepare material relatively soon after collection. Those who feel that their mussels etc. will not deteriorate when untreated (air-exposed?) for the further 2/3(?) hour delay, while the party returns to the University of Oslo laboratories, need not make the field trip of course. The party will need to split up, with the physiologists travelling immediately to the laboratories at Solbergstrand, where it is expected that their work would best be done, and the biochemists/cell biologists would return to the University, to start work on their treated material. The afternoon, evening and whole of the following day will be needed by the physiologists to complete their live-animal work, which cannot of course be deferred, so further field sampling will not take place until Day 4 (Thurs) and again on Day 6 (Sat). This should have the added advantage of allowing one or two of the quicker methods to produce some preliminary results, giving some flexibility for a change of design in emergency (e.g. further sampling at the extreme sites to increase sensitivity by increased replication.)

In parallel with this mussel/Littorina sampling from a dayboat, the Research Vessel would be needed for crab and fish sampling, with facilities on board for scientists to process material accordingly. The requirement here will be better understood after replies from participants have been received, but it seems reasonable to schedule this work coincident with the start of the mussel sampling (Day 2). Clearly, the lack of any strong spatial connection between the fish/crabs and the mussels makes it unnecessary to design for a strong temporal connection; there is therefore nothing to stop the RV sampling being completed at all Langesundfjord sites at a convenient pace (all on Day 2, or Days 2 and 3, say. Sufficient berths should be available.)

Day 4 (Thurs, Aug 14). Sampling of sites A9 and B4/A6 in Langesundfjord. The sampling protocol and logistics for these two sites would be much the same as on Day 2 (though the dayboat would now start and end at Brevik). It is expected that many of the participants who need to treat material shortly after sampling would not wish to make all three field trips, and will arrange amongst themselves to share out the work. The physiologists will again require the remainder of Day 4 and the whole of Day 5 to process their material.

Day 6 (Sat, Aug 16). Collection of transplanted mussel cages at A15 and at the Skien River mouth. This would probably need to be done from the RV (?), so after collection of cages and prompt transfer to land (where?), to repeat the division and preparation as on previous days, it might be sensible to plan the fish/crab sampling for these two sites on that day. There are also advantages of flexibility in programming two excursions (Days 2 and 6) for the

RV, rather than just one. Laboratory work will continue on Day 7 where necessary (e.g. physiology).

Day 8 (Mon, Aug 18). A "catching up" day before sampling begins at the Solbergstrand basins on Day 9. [This could be dispensed with and the ensuing programme brought forward by one day, if this would be more advantageous.]

Generally, no recommendations have been given on the number of replicate animals (or pools of animals) that participants working with individual organisms should aim to take. Participants will no doubt already have evolved an acceptable strategy for their particular technique (including such matters as whether they need to reduce inherent variability by sexing animals etc.); the constraint of available man-hours will also be paramount. Possibly some statistical suggestions will emerge when the attached questionnaires are returned; the only general point to make is that the replicates that participants aim to take must, of course, reflect variability at the relevant level. For individual animal readings this is just animal-to-animal replication; where pooling is desirable it is pool-to-pool replication, each pool consisting of different animals (rather than replicate readings from a single pool, of course).

Solbergstrand mesocosms

Preparation: In late March/early April, during a 3/4 week window of equivalent air and sea temperatures, sediment will be transferred from field box cores into 16 plastic containers (each roughly of 0.25m² area?) which are then transported to the mesocosm basins, attempting to minimise the stress to the faunal communities; the 16 batches of sediment would be properly randomised when allocating four batches to each of the four basins. Ideally, this sediment would all be taken from the "cleanest" of the Langesundfjord sites; this may prove logistically impossible, in which case local sediment would be used, preferably of the same general characteristics as in Langesundfjord. In the latter case an additional 4 field box cores should be taken to provide "time 0" samples for meiofauna, macrofauna and chemistry.

At the same time, Mytilus edulis, roughly within an agreed weight/size-band (1g?), would be transferred into the basins, again preferably taken from the same "clean" Langesundfjord site. It would again be important to randomise the allocation of batches of these between basins. They would be enclosed in steel mesh (1mm) cages of approximate dimension 30cm by 60cm (by 10cm deep), with a central partition and designed to exclude predators. The cages would sit on the floor of the basins, intermixed with sediment boxes. Until replies have been received from participants on numbers of animals likely to be required, it is difficult to estimate the number of cages to be used, but as many as 10 cages may be needed in each basin, each holding about 100 mussels.

If required, Littorina littorea, preferably from the same source site, would be separately caged, probably in perforated perspex boxes. Adequate flow-through would be ensured at the necessary 1/2 (?) feedings (of Ulva) per week. If required, crab and flounder (sp.) could also be

included, but are slightly more problematic. They would probably need to be free-ranging over a limited area of the basin, separated from other fauna, and fed at regular intervals (what with?).

The three experimental basins would be continually dosed, from April until the end of the Workshop, with a simple "cocktail" of important industrial pollutants. Ideally, the composition would reflect the industrial discharges in a region like Frierfjord; however this is logistically unrealistic and further constraints are also imposed by the flow-through nature of the experimental facility (the effluents are discharged into Oslofjord, ruling out environmentally persistent contaminants like PCBs). The proposal is therefore for a simple mixture of diesel oil and Cu; in the highest-dosed basin a combination of the water accommodated fraction (WAF) of diesel oil (at 100 µg/l) and Cu (at 20 µg/l) is suggested. Simple dilutions of this mixture will then be dosed to the other two basins, (25 µg/l WAF, 5 µg/l Cu) at medium-dose and (4 µg/l WAF, 0.8 µg/l Cu) at the lowest dose. Previous experience suggests that, by the time of the Workshop, the lowest dose will result in concentrations of PAHs in mussel tissue of 1 - 2 µg/g w.m., a value expected to be straddled by the Langesundfjord material.

Increasing the complexity of the "cocktail" by addition of chlorinated hydrocarbons is also being considered; hexachlorobenzenes are environmentally relevant to Frierfjord, where they are discharged from a magnesium plant. Possible concentrations of HCBs might be 0.01, 0.08 and 0.4 µg/l at the low, medium and high doses respectively. However, studies suggest that HCBs are not particularly toxic, with no mortalities in fish exposed to high concentrations; it is therefore doubtful whether it would merit the additional complications of attempting to control its water concentration in the basins. The fourth ("control") basin would not be dosed, but the flow-through local fjord water will naturally be impacted to some extent; it would not be expected to to differ greatly from the field conditions at the "clean" Langesundfjord site.

Thus, in addition to providing a more controlled environment, appropriate to coincident analysis of community and individual responses, the mesocosm studies will extend the top end of the pollution gradient examined in the field surveys. (Comments are particularly invited here on the doses chosen for the "cocktail", particularly the high dose levels. The intention is to impact strongly both individual organisms and the benthic communities, whilst avoiding mass mortality of the former.)

Sampling and analysis: At the very end of July, after approximately 4 months of continuous dosing, benthic samples would be taken from the 4 basins. The sampling protocol would be broadly similar to that for the field surveys, outlined above. From each of the 4 sediment batches in each of the 4 basins, ten 2 cm² cores will be extracted and pooled for meiofaunal analysis, and all the remaining sediment analysed for macrofauna. (The logistics of this have yet to be finalised, but it is probable that counting for these meiofauna cores will be at IMER, and the macrofauna at Oslo.) The intention would be for species counts to be available by the beginning of Week 2 (the latest date at which "benthic" participants would be expected to arrive). Values for physical sediment parameters (e.g. grain size) would also be needed, especially if the sediment is not from the same site (A3) as sampled in

March/April. Few replicates would be needed here though, in contrast with what is suggested for the field programme, because of the common sediment source. Possibilities for chemical analysis are discussed towards the end of the paper. It would certainly seem important to forge a link, through the chemistry, between mesocosm and field "effective impact" levels (arguably tissue concentrations for the individual organism studies and sediment concentrations in the case of community response).

Important considerations in the mesocosm studies are to allow as long an exposure to the dosing as possible (hence the need to set up the mesocosm experiment as soon as possible in the spring), and to minimise timing discrepancies between the benthic sampling and the individual organism work (hence the need to cut down on benthic analysis time by reducing replication to the viable minimum). Four replicate cores from each basin seem acceptable, bearing in mind the expected reduction in variability from the controlled environment, and common sediment structure. Some consideration needs to be given to the minimisation of disturbance to the other faunal groups in the mesocosm basins at the time of the benthic sampling.

If the proposed strategy for field sampling is adopted, sampling of the individual organisms in the mesocosms would begin on Day 9 of the Workshop. It is again essential to co-ordinate the collection, so that all participants are known to be working on exactly equivalent material (in the case of a single species at least). Constraints imposed by those working on live animals must again be catered for, suggesting the following plan.

Day 9 (Tues, 19 Aug): Sampling of Control and High dose basins.
The mussels, Littorina, crabs and fish from both basins are sampled during the day (species needed for live work first), in sufficient numbers to meet all replicate needs for all participants. (It would be advisable to plan for some excess animals to be left in the basins, in case of emergencies). The total pool of mussels collected would be taken from all cages in each basin and randomised before allocation to each participant; similar randomisation is needed for the other species. Physiological work would then proceed at Solbergstrand on the remainder of Day 9 and Day 10. The cellular and biochemical participants could again elect either to make the trip (this time shorter) to Solbergstrand from Oslo on Day 9, to prepare their material in the laboratories there, or wait for untreated material to be taken to Oslo.

Day 11 (Thurs, 21 Aug): Sampling of Low and Medium dose basins.
Protocols as for Day 9. Again, it is expected that some participants may want to share the preparation phase, thereby avoiding two trips to Solbergstrand.

Day 11 is the last of the formal "core" sampling days though, of course, specific questions or difficulties may arise that demand further field or mesocosm sampling. Benchwork will continue as long as is necessary, into the beginning of Week 3, though it must be drawn to a close by about Day 16 (Tues 26th), to allow sufficient time for evaluation and assessment before the Workshop closes on Day 20 (Sat 30th).

3. PROPOSED CHEMICAL ANALYSES

At the second meeting of GEEP (Paris 2nd-5th December), the following framework for chemical analyses was proposed. Its feasibility is being actively investigated, but it is already clear that budget constraints will be paramount, so two possibilities are outlined: a preferred and a second choice, the latter being a minimum viable option.

Sampling times and frequencies

The dominating principle is that chemistry must be performed on a random subset of the pool of material collected from each site/condition for biological analyses. Thus, sediment chemistry is performed on subcores extracted from (a random subset of) the box cores used for macrofaunal counts, and tissue chemistry on random (pools of) animals selected from the communal pools of material to be divided between the "sub-lethal effects" participants. To do otherwise, particulary in field sampling, is very likely to introduce a marked degree of additional variability arising from spatial and temporal fluctuations.

Preferred option

Field sediment: At end-March/early-April the 5 replicate box cores for faunal analysis are collected from the 6 field sites. Exactly as for meiofauna, from each replicate box core a fixed number of subcores, distributed over the surface, are removed and pooled to form one replicate "chemistry core" (which will later need subdivision for different types of chemical analysis and particle grain size measurement). For each site, only 3 of these 5 replicate chemistry cores can be analysed (separately, of course). They should be chosen at random from the 5, but the cores from which they came recorded; statistical analysis may later need to match the chemistry to specific replicates. Though it is not proposed to analyse the remaining 2 chemistry cores at each site, they should still be taken, if only to make sure that the quantity of remaining sediment (destined for macrofaunal analysis) is the same for each box core. In fact, it would be very desirable to preserve all 5 chemistry cores for each site, leaving open the possibility of future examination of unanalysed ones (in the event, say, of particularly anomalous faunal content, or to safeguard against loss of selected cores).

In the earlier discussion, it was suggested that a 6th box core be taken at each site, as a spare in case of loss or problems with one of the other 5 cores. If this is done, then it would also make sense to take a "chemistry core" from the extra box core, though it should not be one of the ones chosen for analysis initially.

It is assumed in the above that the amount of sediment required for chemical analyses does not constitute a majority portion of the box core. Whether this is so depends on the range of analyses undertaken, and these are yet to be finalised. Another consideration is that the cores should only be of a depth relevant to the majority of the biota.

Field tissues: Budget constraints preclude any tissue analysis other than for mussels. When the common pool of mussels is selected from the field sites (on August 12th, 14th and 16th) they are divided at random between participants and a further 3 random pools set aside for

(separate) chemical analysis at each site. There is clearly a race against time here to make some of these analyses available by the last 3 days of the workshop (27-29th August). Realistically, it ought to be possible to analyse at least one of the three replicates from each site, this being the minimum viable requirement, with the other two replicate values made available after the workshop. This strategy seems preferable to mounting special collection trips before the workshop, simply to obtain samples for chemical analysis, which will inevitably be from different "target populations" and with the possibility of intervening change in local exposure levels.

Mesocosm sediment: It was suggested earlier that the mesocosm experiment is set up at end-March/early April, with 16 sediment box cores to be randomly allocated to the 4 mesocosm basins and, if these are taken from the Solbergstrand region, a further 4 box cores taken for "time 0" faunal analysis. From these, 4 "chemical cores" are extracted as described above, and 2 are selected at random for "time 0" chemical analysis. If it proves possible to take the sediment samples from the Langesundfjord "clean" site, then no "time 0" faunal or chemical analyses are necessary, since values will be available from the field programme.

One uncertainty is the speed of uptake of the dosed "cocktail" by the sediment boxes in the mesocosm basins. The performance of some mid-term sediment chemistry should therefore be considered, say in mid-June. However, it may not be desirable to extract "chemistry cores" from the main sediment boxes during the course of the experiment because of disturbance to the communities. Additional cores would therefore need to be placed in each basin at the start, solely to provide this mid-term chemistry (2 replicates from each basin).

The most important sediment chemistry in the basins is for the final condition, of course. When the sediment boxes are removed for faunal analysis, in the 3rd-4th week of July, chemistry cores should be extracted from all replicates, in exactly the way described for field samples. Two of the four replicates cores in each basin are randomly selected for analysis; it is unlikely that the remaining two would be needed but it would still be wise to preserve them as a safeguard against loss of selected cores.

Mesocosm tissues: Again, only mussel tissue analysis can be contemplated within the tightly constrained budget. When the experiment is set up in March/April two pools of mussels should be randomly selected from the common pool of animals to be divided between the basins, for "time 0" tissue chemistry. More is known for mussels than sediments, about speed of take-up of dosed hydrocarbons in these basins, but it would still be useful to have some mid-term tissue chemistry if possible (2 replicate pools of mussels selected from each basin in mid-June).

There is again a timing problem for the final tissue analysis since mussels will not be collected for biological measurement until the 2nd week of the Workshop (Aug. 19 & 21). It is unavoidable therefore to take the animals for final chemical tissue analysis some time earlier, so that the results are available during the workshop. This is less worrying than if the same had to be done for field samples because, of course, the "target populations" in the mesocosms are fixed and the exposure levels carefully controlled in the intervening period. It is

suggested that, on about August 1st, two pools of mussels are randomly extracted from each basin, for final chemical tissue analyses.

A final point to note is that some simple water chemistry will be needed throughout the course of the mesocosm experiment, to monitor and control the dosing levels in the three experimental basins.

In summary: The "preferred option" involves a total of 72 (or 70) samples for chemical analysis, all but 12 of the last batch to be analysed by the last week of the workshop:

March/April: 18 field sediment (6 sites, 3 replicates at each)
2 mesocosm (time 0) mussel tissue
2 mesocosm (time 0) sediment (or none if sediment from Langesundfjord)

Mid-June: 8 mesocosm (mid-term) sediment (4 basins, 2 replicates)
8 mesocosm (mid-term) tissue

3rd-4th week in July: 8 mesocosm (final) sediment

August 1st: 8 mesocosm (final) tissue

August 12th, 14th, 16th: 18 field tissue (6 sites, 3 replicates at each, 1 replicate from each site to be analysed by August 26th, rest later)

Second choice option

Exactly as above, but reducing the number of field replicates for sediment and tissue chemistry from 3 to 2, also omitting the "mid-term" mesocosm sediment and tissue samples altogether. This leads to a total of 44 (or 42) samples (i.e. 18 reduced to 12 in the first and last entry in the above timetable, and the mid-June sampling omitted).

This second choice appears the only likely option with present funding; first priority for additional effort would be to increase field sediment replication from 2 to 3, followed perhaps by re-instatement of the 8 mid-term mesocosm sediment analyses.

Analytical requirements

The following types of analysis are currently under consideration, though the final choice is unlikely to be as wide-ranging as these lists suggest. The final choice analyses would be performed on both animal (mussel) tissue and sediments.

Mesocosms

1. Glass capillary GC of diesel residues, with GC.MS of PAHs, alkylated aromatics etc.

2. Copper.

Field

1. Polyaromatic hydrocarbons.

2. Electrolyte industry by-products (HCB, hexachlorobutadene, octachlorostyrene).

3. General organochlorines (PCB group, DDT group and cyclochenes).

4. Pulp and paper mill by-products (chlorinated phenols, cresoles and chlorinated anisoles).

5. Metals (Cu, Zn, Pb, Hg etc.)

For the tightly budget-constrained organic analyses, the philosophy will probably be to select an agreed set of "marker" compounds, representing several of the above categories, rather than attempt a comprehensive analysis. For example, it might be cost effective to plan for only a single GC.MS run for each sample (including members of 1,2 and 3 above, but not 4, perhaps?). From a statistical viewpoint it seems better to hold to, or improve upon, the recommended structure of sampling times and frequencies, at the cost of reducing complexity of chemical determination. It should be borne in mind that the experimental programme is designed to yield samples of very similar chemical composition, at a series of dilutions, and that will largely be true for field samples also, so it is not the intention (and will be quite impossible) to provide statistically-based discrimination of biological effects from specific chemical causes. Of course, many of the methods represented at the workshop are, by design, generalised stress indices.

4. SUMMARY OF PROPOSED TIMETABLE

Early-January 1986: Prof. Gray undertakes preliminary survey of Frierfjord/Langesundfjord, in order to choose sampling sites etc. for the March sampling programme.

Mid-February: Questionnaires returned. Equipment requirements finalised and consumables ordered. Changes made to benthic field sampling strategy and mesocosm design in response to comments from participants.

End-March: Box core samples taken at 6 field sites. Meiofauna subcores dispatched to Dr. Heip, chemical subcores and other subcores preserved and dispatched as necessary, physical subcores and residual to Prof. Gray (for macrofauna).

Further 16 box cores, and mussels, crabs, flounder collected and set up in mesocosm experiment, with dosing to begin shortly after. Two pools of mussels extracted from the collected batch for "time 0" tissue chemistry. If this collection is from Solbergstrand, and not the Langesundfjord "clean" site, additional 4 box cores collected for "time 0" meiofauna, macrofauna, and physical sediment analysis, with 2 of them being selected for sediment chemistry.

End-April/early-May: Latest date by which mussel transplants in Frierfjord effected (may be more conveniently combined with above).

Mid-May: Participants circulated with update on sampling strategy already executed and (further) plans for the workshop period. Also to include a second statistical discussion paper, on a framework for comparison of methods, and a discussion paper on biological/chemical interactions. Participants invited to comment and prepare a summary statement of their procedures.

Mid-June: Statements received and circulated to all other participants. If taken, intermediate chemistry subcores and tissue samples taken from mesocosm basins.

3rd-4th week in July: Final mesocosm benthic samples taken, for meiofaunal analysis (to Dr. R. Warwick), macrofaunal analysis (to Prof. Gray) and sediment chemistry.

1st week in August: Two pools of mussels randomly selected from each basin and dispatched for tissue chemistry.

August 11-30th: Workshop. Field sampling of mussels/crabs/flounder in week 1, mesocosm sampling in week 2. Subset of field mussels sent for tissue chemistry (one replicate from each site to be available before end of week 3). Field benthic data available at start of Workshop and mesocosm benthic data by start of week 2. Latter half of week 3 set aside for discussions and conclusions.

September/October: Presentation of results to IOC.

December: Deadline for written contribution from participants.

March: Deadline for manuscript to publishers.

Bob Clarke IMER
John Widdows IMER
Roger Green Univ. Western Ontario
20/12/85

ANNEX VII

REQUIREMENTS AND CONTINGENCIES FOR CHEMICAL ANALYSES

A: MESOCOSMS

1. Preferred option

Three sampling times: March (day 0), mid-June and August. All samples in duplicate for both animals (mussels) and sediments. Intermediate and final samples taken from all 4 mesocosms; day 0 samples from common pool of initial material (sediment analysis not required for day 0 if material is from Langesundfjord "clean" site, since available from field analyses below).

Sediment samples taken when cores removed for analysis. Tissue samples taken later, as close to workshop sampling of mussle as possible.

Total number of samples = 36 (or 34)

2. Second choice

As above, omitting intermediate sampling time.

Total number of samples = 20 (or 18)

B: FIELD SAMPLES

1. Preferred option

Triplicate samples from each of the six stations. For sediment, taken in March from the same box ores providing faunal analysis. For mussel tissue, taken during first week of the workshop in August, from the pool of mussels samples at each site. At least one replicate from each site to be analysed by the middle of the third week of the workshop, the other replicates later.

Total number of samples = 36

2. Second choice

As above, reducing triplicate to duplicate analysis.

Total number of samples = 24

C: ANALYTICAL REQUIREMENTS: MESOCOSMS

1. Glass capillary GC of diesel residues in both animals and sediments, with GC.MS of PAH's, alkylated aromatics etc.

2. Copper in sediments and animals.

D: ANALYTICAL REQUIREMENTS: FIELD

1. General organochlorines (PCB group, DDT group and cyclochenes).

2. Electrolyte industry by-products (HCB, hexachlorobutadene, octachlorostyrene).

3. Pulp and paper mill by-products (chlorinated phenols, cresoles and chlorinated anisoles).

4. Polyaromatic hydrocarbons.

5. Metals (Cn, Zn, Pb, Hg etc).

All these in sediments and animal tissues.

N.B. Discussion is still required, with NIVA and with Prof. Palmork, on the final selection of compounds for chemical analysis, of the field samples. Clearly, we will have to operate within the budget, it may therefore be necessary to select a small sub set of agreed "marked" compounds for analysis, rather than attempting the full list indicated above.

ANNEX VIII

QUESTIONNAIRE AND ACCOMPANYING LETTER RE:
BIOLOGICAL COMPONENTS OF MUSSELWATCH:
TO BE APPENDED TO CHEMICAL QUESTIONNAIRE CO-ORDINATED BY GEMSI

Dear

In this section of the questionnaire, we are seeking to determine what elements if any, appropriate to the assessment of the biological effects of pollution, are included in your "Musselwatch" programme. We are aware that biological effects measures are relatively rare in such programmes and we wish to determine the scale of such measurements world wide, what procedures have been found to be most useful, what the problems are in incorporating biological studies in monitoring programmes and, if no such measures are regularly employed, why this is so.

We are also aware that there is a good deal of laboratory research undertaken that is relevant to making "biological effects" assessments. We would welcome your views on what research you deem most appropriate. However, our chief aim is to document what biological studies are included in filed-based MusselWatch programmes. If you do not currently engage in such measurements, would you do so if standard biological procedures became available?

We are very grateful to you for taking time to answer our questions.

Yours faithfully

INTERGOVERNMENTAL OCEANOGRAPHIC COMMISSION

GIPME GROUP OF EXPERTS ON THE EFFECTS OF POLLUTION

QUESTIONNAIRE ON THE USE OF BIOLOGICAL EFFECTS MEASUREMENTS IN NATIONAL AND INTERNATIONAL 'MUSSELWATCH' PROGRAMMES

1. Name of organisation

2. Affiliation of organisation

3. Address of organisation

4. Country

5. Name of respondent

(Family Name) (Given Names)

6. Position held

7. What are the objectives for your 'Musselwatch' Programme

8. Is the work part of

8.1 International Regional Programme
8.2 National Programme
8.3 Sub National (State) Programme
8.4 Other
Please specify

9. In order to carry out the chemical components of Musselwatch, you will have to make certain observations of a "biological" nature eg. type of bivalve population (hard/soft sediment/mangrove, etc); size distribution in the population; age of individuals sampled; reproductive condition, etc. Please indicate which of these basic observations, and any others not mentioned, you make.

10. What chemical contaminants do you monitor regularly, and in what tissue?

11. What biological effects measures are you making in conjunction with your monitoring? Please specify, in detail, under the following headings:

    Biochemical:

    Cellular:

    Whole organism (Physiology and other):

    Population:

    Community:

12. What correlations do you seek to make between chemical measurements and biological effects? With what success?

13. What recommendations have you regarding monitoring strategies designed to equate biological effects with chemical measurements? How would your "optimal" monitoring programme (with particular reference to biological components) differ from your current practice?

14. Would you consider using Biological Effects Measures in future?

15. Is there a need for training in these?

16. Would you be interested in attending a training workshop on Biological Effects Measurements?

Please enclose reports or publications of studies involving biological effects measurements.

ANNEX IX

REPORT OF GEEP AD HOC GROUP ON VULNERABLE AREAS

Membership: J. Gray (Chairman)
R. Warwick
G. de Mahieu
A. Bremner

Terms of Reference:

a) To compile information from IOC Secretariat on reports or studies containing aspects related to classification of the coastal zone for protection purposes, with a view to identifying elements related to biological vulnerability and its quantification;

b) To prepare a draft guidelines for the practical assessment of ecosystem characteristics/processes of vulnerable areas. In this context, an area with mangrove, coral reef, coral sediment and seagrass areas in Venezuela, earmarked as a national part to be considered as a case study area.

c) To submit to GEEP-II a summary of its findings in relation to Item 1, and a draft guideline for ecological assessment and classification of vulnerable areas.

Based on material received from IOC and on a visit by J.s. Gray to Venezuela the ad hoc Committee wish to submit the following report. We have modified IOC/WC-GIPME v 17 to include some new data and review PNUMA-CPPS, and 3 papers on mapping techniques to give our overall evaluation.

DRAFT GUIDELINE ON THE SCIENTIFIC BASIS FOR THE IDENTIFICATION OF VULNERABLE AREAS

The concept of vulnerability with regard to marine areas has been used in a number of different contexts. Biologists have used the term to define areas containing sensitive biological life forms or ecosystem with high production rates or high diversity. In planning for the development of coastal areas the term has been used with varying meanings and has been used in legal contexts but without a common definition. Related terms such as "high risk areas" or "particularly sensitive areas" (IMO), have also been used for the definition of areas which may be particularly vulnerable to various forms of pollution. Hence, there is a need for a common scientific definition of "vulnerable areas" since this is of special interest in connection with contingency planning for the response to spills of chemicals and oil. In addition, knowledge of such areas may be of importance in connection with coastal zone development in general.

Furthermore, as stated by the Task Team on the Law of the Sea during the Second Session (IOC/TT-LOS I-II, 3) in Part VII: Protection and Preservation of the Marine Environment, Art. 199 (Contingency plans against pollution). "The IOC ..... could be more active in providing

the scientific basis for contingency plans against pollution accidents."

TERMINOLOGY

Vulnerable to what?

With accidents involving tankers carrying oil or chemicals, with offshore drilling for oil or gas, or a result of discharge of oil or contaminated water into the sea, coastal resources may receive acute and eventually long-term damage. Clean-up operations after spills may cause additional damage to the resources.

Coastal zone development projects may be caused of damage to coastal resources as a result of direct physical damage, or by the release of waste water (including sewage and nutrients), the disruption of normal current and turbulence patterns or the release of turbid water.

What is vulnerable?

All coastal resources, ecological or socioeconomic are, to a varying degree sensitive to the above-mentioned intrusions. The sensitivity may vary from a slight disruption to extensive damage or total destruction of the resource; from a short-term effect to a long-term, more or less temporary effect; from being geographically limited to a situation where extensive areas are affects.

Identification of vulnerable resources

Important, potentially vulnerable resources may be divided into different categories, for example:

- ecological or biological resources
- consumptive water use resources
- recreational resources
- industrial use resources

Ecological or biological resources

- defined as natural areas for wildlife conservation or preservation or areas of valuable food resources, including areas of fish and shell fish harvesting, areas where aquaculture is carried out, spawning and nursery grounds, wildlife refuge, breeding and nesting sites as well as habitats of endangered species.

Consumptive water use resources

- defined as areas from which water to be used on a consumptive basis is withdrawn. They contain structures such as water intake pipes, channels for water transport, dams etc. The water may be used for drinking waters, industrial processing or cooling water and irrigation.

Recreational resources

- defined as areas with recreational resources are e.g. beaches for swimming, diving, surfing etc., as well as areas where boating, canoeing

or sport fishing are carried out. To this category can be added marina and similar boat harbours.

Industrial use resources

Industrial use resources are usually for non-consumptive water uses and many are extremely large and cannot be classified as a single entity. Included are, for example, areas for transportation and communication, logging, waste disposal, power generation and flood control.

Factors affecting damage

The circumstances under which a resource is exposed to a spill of oil or chemicals may have a drastic influence on the type and extent of damage to the resource. Some of these factors related to the spill itself and other to the environment in which the spill occurs. Spill factors of significance are:

- type of discharge (acute or chronic)
- type of pollutant
- quantity of pollutant
- time of spill occurrence

Environment (site) factors include the actual conditions at the spill location. Important factors are:

- wind speed and direction
- water current speed and direction
- air and water temperatures
- tidal range
- season e.g. for breeding or spawning, fishing etc

Identification of vulnerable areas

The first step in defining vulnerable areas is often to prepare detailed coastal maps, which are useful in designing coastal contingency plans. Coastal zone development projects also need an input of data regarding vulnerable resources in the area in question. The information must be specific enough to provide meaningful guidance, for example including accessibility to them. The first step is to prepare a coastal sensitivity index based on geomorphological mapping of a coastline. Such an index is based on the physical longevity of a pollutant in each environment in the absence of clean-up efforts. However, both biological and socioeconomic features need to be included. The information can be presented in manuals and reproduced using maps of different scales. The most detailed should illustrate identified sensitive areas of the coastline such as areas where protective counter measures might be desirable. Areas not identified as sensitive might be covered in the manuals but by less detailed maps.

The manuals should contain information on the types of habitat in the area in question. Here geomorphological factors such as mud, sand, rock etc., should be given. In addition, the dominating ecosystems should be presented.

Table 1. Geomorphological and biological habitats to be included in coastal vulnerability maps.

Geomorphological habitat	Biological habitat
Mudflats	Coral reefs
Sandy beaches	Mangroves
pebbles or single beaches	Seagrass beds
Boulders	
Scattered rocks	
Tide pools	
Cliffs	
Estuaries, deltas	

The coastal areas can be scored on a scale reflecting the vulnerability to oil, the perhaps best studied pollutant which creates widespread public awareness of the problem. As a suggestion of such a scale, a modification is made to that of Gundlach & Hayes (1980).

The presence of man-made installations such as marinas, fishery harbours, amenity beaches, industrial ports and industrial coastal installations such as water intakes etc., should be presented.

Summary of possible vulnerability scale (in increasing order) to oil spill damage.

Vulnerability Index	Shoreline type	Comments
1	Exposed rocky headlands	Wave reflection keeps most of the oil off-shore. No clean-up is necessary
2	Eroding wave-cut platforms	Wave swept. Most oil removed by natural processes within weeks.
3	Fine-grained sand beaches	Oil doesn't penetrate into the sediment, facilitating mechanical removal if necessary. Otherwise, oil may persist several months.
4	Coarse-grained sand beaches	Oil may sink and/or be buried rapidly making clean-up difficult. Under moderate to high energy conditions, oil will be removed naturally within months from most of the beachface.
5	Exposed, compacted tidal flats	Most oil will not adhere to, nor penetrate into, the compacted tidal flat.

		Clean-up is usually unnecessary.
6	Mixed sand and gravel beaches	Oil may undergo rapid penetration and burial. Under moderate to low energy conditions, oil may persist for years.
7	Gravel beaches	Same as above. Clean-up should concentrate on the high-tide swash area. A solid asphalt pavement may form under heavy oil accumulations.
8	Sheltered rocky coasts	Areas of reduced wave action. Oil may persist for many years. Clean-up is not recommended unless oil concentration is very heavy.
9	Sheltered tidal flats and sea grass beds	Areas of great biologic activity and low wave energy. Oil may persist for years. Clean-up is not recommended unless soil accumulation is very heavy. These areas should receive priority protection by using booms or oil sorbent materials.
10	Coral reefs	High productivity and diversity with very slow recovery potential. Fringing reefs are less vulnerable than atolls since wave action is higher at former.
11	Salt marshes and mangroves	Highly productive of aquatic environments. Oil may persist for years. Cleaning of salt marshes by burning or cutting should be undertaken only if heavily oiled. Mangroves should not be altered. Protection of these environments by booms or sorbent material should receive first priority.

Fig. 1 From Gundlach and Hayes shows the application of such a map.

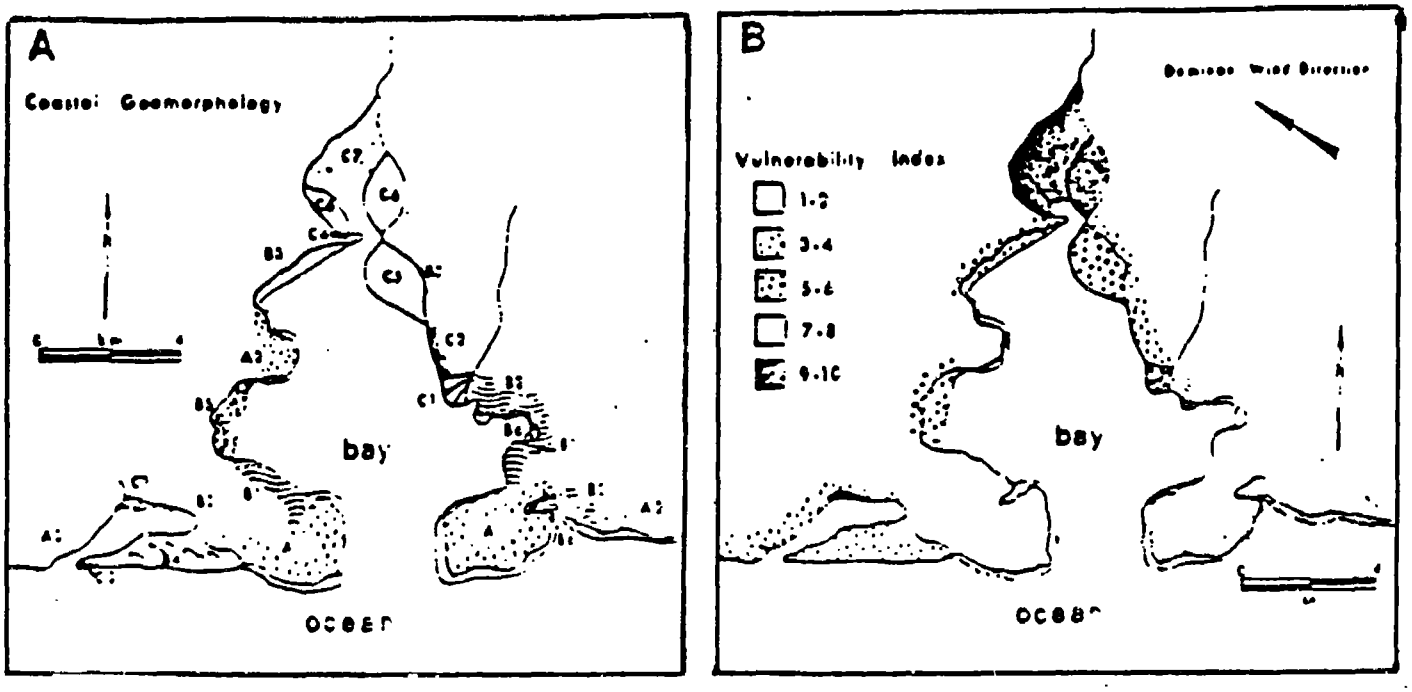

Fig. 1. A. Coastal geomorphology of a hypothetical shoreline. Shoreline types (A.-B6) are listed in Table 1.

B. Application of the Vulnerability Index to the shoreline types of Fig. 1A. In this model, 28% of the shoreline is classified as having a VI = 1-2, 31% has a VI = 3-4 (low risk areas), 7% has a VI = 5-6, 15% has a VI = 7-8, and 19% is classified as high potential oil spill damage with a VI = 9-10.

Oil exploration or related shore facilities would be best positioned in the lower part of the bay, away from the highly vulnerable estuarine system (C6-C7) at the head of the bay.

The map should also contain information on wildlife uses. Information should include a general brief listing of the significant wildlife in numbers and important specific information should be given to the factors shown in Table 2.

Table 2. Wildlife used to be included in the Coastal Vulnerability Maps.

General	Bird-nesting site, migration stop-over site, wildlife refuge, shellfish banks
Invertebrates	Crabs, lobster, shrimp, oyster, clam, mussels, shellfish or algae aquaculture
Fish	Commercial or sport fish (species), fish spawning or nursery sites, fish aquaculture

Birds	Wading birds, diving birds, gulls and terns, migration birds
Other wildlife	Turtles, turtle nesting, alligators or crocodiles, manates, dolphins
Endangered or threatened species	(species)

The map should provide information regarding seasonality, that is the months or season during which the area is particularly sensitive. As an example symbols commonly used are shown in Figs. 2-4 taken from Getter et al. 1981.

This can be further extended to be more specific and regional and to include recreational activities. Fig. shows symbols used in a plan for the protection of the coastal marine areas of the southeast Pacific (Colombia, Chile, Ecuador, Panama and Peru). Permanent Commission for the South Pacific PNUMA-CPPS July 1984). The final map of a hypothetical S.E. Pacific is shown in Fig. 6.

The S.E. Pacific map is highly detailed (not all symbols are described in our illustratory Fig. 5), but gives a rapid pictorial overview rapidly assessible by a layman. In preparing a contingency plan in the event of acute pollution incidents the plan should contain a Vulnerability Ranking Index.

This should be based upon the size and quality of the habitat, the number and diversity of wildlife species and/or their sensitivity to apollutant. It should also take into account the direct economic value of the resource.

The plan should also consider the likelihood of impact. This may primarily be relevant in the case of acute pollution incidents. It should reflect the prevailing wind and current patterns and other factors likely to influence the movement of a pollutant relative to the identified area. It should of course, take into account the transport routes for petroleum and chemicals, areas of drilling etc.

In addition, a plan should discuss the different types of countermeasures that could be taken in different situations, considering the threatened resources in question, the existing clean-up techniques, manpower and equipment. Also the response priority, based on sensitivity ranking of the different area should be taken into account.

Normally a contingency plan contains information on where existing equipment is stored, launch points for equipment, lists of personnel to be contacted. This information is of fundamental importance when using a coastal vulnerability plan.

General Considerations

The coastal vulnerability maps should be designed to be used by personnel whose background may not be in science. It should give the response personnel the environmental information needed to make rapid decisions at the outset of a spill.

By identifying "vulnerable area" or socioeconomic damage will quickly be identified and the responses decision makers can direct their attention to primary "action areas". These are sites where, if suggested protective counter-measures are successful, destruction of important habitats elsewhere might be prevented. The overall impact of a pollutant can be decreased greatly if those sites most vulnerable to the impacts of a spill can be protected. This is true even though less sensitive areas, or those for which clean-up technology is available and effective may become polluted. This approach directs available response resources to areas where they can accomplish the most, early in the response process.

Maps of vulnerable areas are valuable planning aids but have shortcomings. No dynamic aspects are incorporated into the maps so that changes in for example the populations of an important species in a vulnerable area may be influenced by factors remote from the area. A good example from Venezuela is that within the Morrocoy National Park (a coastal area) corals are being destroyed by turbid water from a river outside the Park boundary. The river turbidity has increased following deforestration of adjoining areas and increased soil erosion. Thus setting of National Park boundaries have not often in the past taken into account the factors influencing the whole ecological system within the Park. This it is GEEP's opinion that definitions of Vulnerable Areas must have a dynamic element and that mapping is only the first step in defining such areas. A broader concept of Vulnerable Areas is needed and we believe that to achieve object 2 of our terms of reference a case study is needed.

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The Morrocoy National Park Project, Venezuela

The aims of the Vulnerable Areas Committee are to prepare draft guidelines for the practical assessment of ecosystem characteristics/processes of vulnerable area. The inclusion of processes implies a dynamic aspect which cannot be achieved merely by mapping. We believe it is important to understand the dynamics of vulnerable area and the factors that affect such areas over time.

In Venezuela a comprehensive project covering microbiology, ecological systems (corals, seagrasses and mangroves), fisheries, pollutant influences, socio-economic effects of tourism and fisheries and management practices, is planned for the Morrocoy National Park. This area we suggested as being a suitable model by Dr de Mahieu and Dr Gray's visit has confirmed that the area is ideal to test and develop practical approaches to Vulnerable Areas, of relevance to developing countries.

The Park itself was created in 1974 and covers an area of 32,000 hectares (Fig. 1 shows the location and Fig. 2 the Park boundaries). The boundaries are arbitrary and do not include the Golfete de Cuare, an important flamingo breeding ground, but this has now been declared a protected area without having Park status. Before the Park was created private houses were built in the area but on creation of the Park these were demolished! The Park covers extensive Mangrove areas and offshore Cays with fringing coral reefs. Between the mangrove islands are extensive Thalassia beds. Frigate birds abound in the mangrove areas. Thus the Park is extremely rich in flora and fauna.

Tourist pressure has increased enormously in recent years causing damage to coral, sea-grass and mangrove areas. The Park Authorities have started periods of closure of 7 yr in affected areas but whether or not this is the appropriate time scale has not been studied.

Tourist boat use has increased significantly and effects of hydrocarbons on the ecological systems may be important, likewise boats anchoring in coral areas. Pollution input from south of the area may also be significant and there is already recorded damage to corals from increased sediment discharge from the Tocuyo river north of the Park where erosion has increased following deforestation to build sugar cane farms. Thus the threats to the Parks vulnerable areas are common ones to many developing countries in tropical regions.

The project aims

1 to assemble all the available data from a wide variety of reports and to prepare a data base (6 months work). Then a series of subprojects will begin.
2 Socio-economic study of fisheries in the National Park 1 yr
3 Origin, dynamics and effects of sediments on the coral communities in the Park 1 yr
4 Studies of the distribution, production and associated fauna of Thalassia testudinum in the National Park 1 yr
5 Plant ecology of the terrestrial mangrove zones 1 yr
6 Insect ecology of the National Park 2 yrs

7 Evaluation of hydrocarbon contamination in the National Park 2 yrs
8 Evaluation of persistent organochlorines in the National Park 1 yr
9 Evaluation of faecal bacterial contamination in the Park 2 yrs
10 Evaluation of the management plan for the Park 6 months
11 Effects of human intervention on the marine communities 1 yr
12 Effects of human intervention on the terrestrial communities 1 yr

The total budget for the Park Project is planned at Bs 4,663,000. Finance is not yet approved but expected in December 1985.

The expertise available is impressive. The project leaders Drs Losada and de Mahieu have wide experience of the benthic communities in the area and good publications records and research plans. Similarly the other colleagues involved are clearly highly competent most with advanced research degrees from the U.S. or Europe. Equipment and facilities view at Universidad Simon Bolivar are good and there is no doubt that the project will achieve a high level of international scientific competence.

What is lacking is sub-project on hydrography and water chemistry. This may be possible to resolve by Professor Mohammed Abdullah (Univ. of Oslo) who is at present on sabbatical leave in Mexico visiting Venezuela. Gray will see if this is possible.

Otherwise the potential of the project is great but I felt needed structuring better. To this end I suggest that at the end of the 6 month data base establishment phase a MODELLING WORKSHOP be held. Dr Jorge Rabinovich (ex Holling's group in Vancouver) is on the staff and is willing to lead such a Workshop. A model will be produced which integrates socio-economic and biological data and will produce critical areas or processes that need to be the focal points of the main project. Funds will be needed to bring 4-5 international modellers to Venezuela for 1 week and for computing time. Local experts will provide the data input to the model. It is suggested that 100 delegate countries be invited to send observers, preferably from Caribbean and relevant tropical countries to the workshop to see how an integrated biological and socio-economic model of National Park is developed. A preliminary proposal is enclosed.

It is also recommended that an International Scientific Advisory Panel of 3 persons with Dr Gray as co-ordinator be established. The group would meet once a year in Venezuela to discuss results and plans. The Advisory Panel will ensure good scientific standards are maintained and that international contacts are made for help with techniques, methods employed and otaining.

At the end of the 3 year project a TRAINING WORKSHOP should be held for IOC countries whereby the projects methods, results and recommendations are passed to other interested countries. It is presumed that topics such as damage to mangrove areas, tourist threats to coral reefs will be covered together with management strategies of a national park to limit vulnerability.

The project thus offers a unique opportunity for obtaining a better understanding of the dynamic aspects of vulnerable areas, such as rates

of recovery, potential for long-term damage, socio-economic aspects. It is likely that the important processes will be established and thus guidelines can be prepared of relevance to other developing countries in tropical areas.

J.S. Gray
Oslo, 11/11/85

PRELIMINARY IDEAS ON A MODELLING WORKSHOP FOR MANAGING THE MORROCOY NATIONAL PARK (VENEZUELA) AS A VULNERABLE AREA

There are new techniques and procedures in modelling that allow for a relatively rapid and simple development of computer simulation models of ecological processes. These models do not predict detailed and specific events but rather allow for an estimation of possible directions of change in intervened ecological systems; in other words, they are suitable for the evaluation of TRENDS following decision making and management of ecological systems.

Certain modelling workshops can achieve this with interdisciplinary teams, where specialists of the main disciplines involved are represented. These specialists, even though they do not need to know statistics, computers or mathematics, are the people that really develop the model.

In addition some procedures are available that warranty that unnecessary detail (which is a very common danger when well-known specialists participate) is avoided in the model.

In short periods (that go from one week of solid work, to periodical meetings that may last several months) a working simulation model is produced. This model is able to run under the so-called "hypothetical scenarios" and can be subjected to a "sensitivity analysis" that allows the identification of the most critical variables of the system.

A more ambitious model may even produce a field design of the research work that needs to be done in order to be able to apply the optimal decisions in managing vulnerable areas.

In cases such as the Morrocoy National Park, the most reasonable approach is to look beyond the artificial Park limits. If a DYNAMIC model of the ecological systems will be developed, it has to consider other ecological systems that are dynamically related to the Park itself; for example, if the silt discharge of the Tocuyo River increases with deforestation upstream, this aspect will have to be incorporated in the model.

Furthermore, to be really dynamic, even the most preliminary model will have to include at least two essential aspects of the Morrocoy National Park: (a) the rates at which some processes occur (e.g. primary and secondary productivity, mangrove accretion, human intervention, etc.) and (b) functional relationships between variables of the system.

A typical workshop for a model of a problem such as managing the Morrocoy National Park as a vulnerable area would be composed of the following KIND of participants: ecologists, physiologists, fishermen, industry administrators, Park administrators, tourism industry, tourists, economists, social scientists, and local villagers. The optimum size of a modelling workshop is usually between 15-20 people.

It is essential that these kind of workshops be carried out as early as possible in projects for the management of vulnerable areas, as in the

Morrocoy National Park. In this particular case, there is enough BASIC information from the area and its surroundings that a preliminary model could be attempted as early as necessary.

These workshops are relatively expensive. A one-week modelling effort (which implies about one month of previous preparation and one month of following analysis) may cost between 10 and 20 thousand dollars. However, if we look at it from the investment point of view, it may very well pay-off to warranty the success of a project that may cost 200,000 dollars.

Furthermore, if people from similar areas but of different countries (Africa and Asia, say) attend the workshop, it is highly probable that the dynamics modelled may be so general that, at least in part, it may be applicable to other situations with minor adjustments.

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