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International Council for the
Exploration of the Sea

C.M.1987/E:23

*REPORT OF THE WORKING GROUP ON
THE BIOLOGICAL EFFECTS OF CONTAMINANTS*

Copenhagen, 25 - 27 May 1987

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WORKING GROUP ON THE BIOLOGICAL EFFECTS OF CONTAMINANTS

(Copenhagen, 25 - 27 May 1987)

1 OPENING OF THE MEETING

The meeting opened at 09.30 hrs on 25 May 1987 and the participants were welcomed by the Working Group Chairman, Dr F. Thurberg (USA).

After the introduction of each Working Group member (Annex 1), the Chairman briefly explained the lineage of the Working Group from the Working Group on Marine Pollution Baseline and Monitoring Studies in the North Atlantic and its immediate predecessor, the Study Group on Biological Effects Techniques, which met in Hirtshals, Denmark in April 1985.

2 ADOPTION OF AGENDA

The Agenda was adopted without revision and appears as Annex 2. Dr Stebbing, Mr Lloyd and Dr Marquenie agreed to divide the responsibility of recording the minutes of the meeting.

3 COUNCIL RESOLUTION ESTABLISHING THE WORKING GROUP

The Working Group was established by the Council in C.Res.1986/2:24 and its title and duties defined as follows:

- "(1) The present Study Group on Biological Effects Techniques will be transformed into the "Working Group on Biological Effects of Contaminants", with the following general terms of reference:
 - a) to develop approaches and procedures to discriminate between biological effects induced by anthropogenic activities and the natural background incidence of abnormalities in fish and shellfish, and thus promote the development of reliable approaches and techniques for the detection and evaluation of the effects of contaminants in marine organisms;
 - b) to maintain close contact with the IOC Group of Experts on Effects of Pollutants (GEEP) and other relevant bodies, to ensure that, where appropriate, ICES activities are coordinated with those of GEEP. To this end, an observer from the IOC should be invited to attend meetings of this Working Group.
- (2) The Working Group will meet for four days in spring 1987, at a venue to be decided to undertake the following tasks:
 - i) review the results of the GEEP Workshop on the assessment of biological effects techniques;

- ii) review the results of the ICES Workshop on the Use of Pathology in Studies of the Effects of Contaminants;
- iii) select techniques and prepare protocols which could be adopted for use in a cooperative programme of monitoring of biological effects in the ICES area;
- iv) prepare a review of the potential applicability of bioassays, utilizing fish eggs for use in biological effects monitoring programmes."

4 REPORT OF THE STUDY GROUP ON BIOLOGICAL EFFECTS TECHNIQUES

Prof. Dundas (Study Group Chairman) said he felt that there were no specific matters from the Study Group remaining to be dealt with. The report of the Study Group, therefore, becomes a basis for the present deliberations of this Working Group.

Dr Stebbing said that the Working Group should be aware that he is co-author of a chapter of a book to be edited by W. Salomons and B.L. Bayne on the North Sea entitled "The role of biological monitoring in the North Sea" that depended in part upon material presented and discussed by the Study Group meeting in Hirtshals. The chapter was reviewed for the editors by Prof. Dundas.

The Chairman briefly reviewed some of the reasons given at Hirtshals as to why it had taken so long to make progress in the use of biological effects techniques. These included the natural reluctance of biologists to move from research to monitoring and the requirement for a suite of techniques. Furthermore, monitoring is expensive and the expectations of those who fund such ventures are often too great. There is also the interdisciplinary problem of dealing with chemical causes and biological effects and the greater variability of biological techniques. He observed that it had taken a decade from the ICES/EPA Workshop in Beaufort to the IOC/GEEP Workshop in Oslo to evaluate many of the deliberations of Beaufort in the practical workshop in Oslo.

Mr. Lloyd, as a member of a regulatory organization, felt in considering such techniques that one needed to know whether their application helped in making regulatory decisions. He felt that these techniques tended to be too fragile and speculative. He explained that tests were needed that were:

- 1) indicators of biological water quality reflected in some activity of the test species - true bioassays;
- 2) indicators of stress as a measure of the biological effects on natural communities.

He said that 10-15 years ago various biologists began to fund their work with pollution money by insulting their animals with toxic agents rather than developing the techniques that were actually required.

Prof. Dundas made clear that while Beaufort and more recently the GEEP Workshop dealt with specific techniques, the ICES Study Group approach was one of building up a strategy for biological

effects monitoring from first principles. However, this holistic view can only get one so far before one is confronted with the reality of needing to select a suite of specific techniques. He, therefore, admired the entrepreneurial spirit of GEEP whose more pragmatic style had actually started to employ and evaluate some potentially useful techniques.

Dr Dethlefsen noted that biological tests were non-specific and failed to enable discrimination between anthropogenic and natural stressors. He explained that he had been using biological systems for monitoring the effects of pollution for some years using the frequency of disease in fish and malformation in living fish embryos. These simple quantifiable effects were readily communicable to pollution managers, and he felt that it is unnecessary to use sophisticated cellular ultrastructural changes or physiological indices.

While the Working Group expressed some support for the use of fish disease (see later) and the need to communicate such effects to politicians and managers, it felt that it is also important not to subjugate the scientific and practical problems to considerations of problems in communicating the results to such people.

5 RELATIONS WITH IOC

5.1 IOC/GEEP Oslo Workshop

In the absence of the final report, the Working Group reviewed the GEEP III information about the Workshop.

Background - The Group of Experts on the Effects of Pollutants (GEEP) was formed by IOC and, at its first meeting in December 1984, identified the requirement for a workshop to evaluate various techniques proposed to measure the effects of chemical contaminants on marine organisms. While there has been a long-standing requirement for techniques to measure "biological effects" to be able to differentiate between contamination and pollution, there has remained the need for a practical evaluation of the techniques proposed.

Furthermore, GEEP found that a workshop for this purpose should test techniques covering the full spectrum of biological organization, from the molecular to the community level. Although the transfer of this expertise to others was recognised at the outset as a priority, it was considered appropriate that at this first workshop those involved should be research scientists currently actively developing these techniques. It was also considered essential to utilize a known pollution gradient for which the types of contaminants could be reproduced and extended over a greater range of concentrations in experimental systems. A vital aspect of such an evaluation identified at the outset was the need for rigorous statistical design and the requirement for scientists to handle all samples "blind". Furthermore, as much work as possible should be completed during the workshop itself. Techniques that fall within the following areas were considered initially to be suitable for evaluation in this way:

- 1) Biochemical responses including those that show specificity for particular contaminants such as the system responsible for the mixed-function oxygenation of organic compounds and the metal-binding proteins.
- 2) Cytochemical responses including the activity of cellular organelles involved in the sequestration and metabolism of toxicants.
- 3) Histopathology to assess quantitatively the extent of pathological change in cells and tissues due to toxicants.
- 4) Physiological responses of isolated tissues and whole organisms, including respiration, feeding and excretion rates and growth energetics.
- 5) Community attributes intended to detect changes in structure due to pollution.

It was recognized by GEEP that significant omissions from this list, such as genetic toxicity tests and fish pathology, would have to be considered at a later stage.

Four criteria were used in selecting a site for the Workshop:

- 1) There should be a well-defined gradient of contamination due to multiple contaminant inputs.
- 2) There should be a good physico-chemical data base.
- 3) The species required must be available.
- 4) There should be adequate laboratory and support facilities.

Various sites were considered and the offer by the University of Oslo to host the Workshop was accepted.

The Workshop was conducted from 11-29 August 1986 and attended by 31 scientists from 12 countries, who applied their various techniques to material collected from the contamination gradient in the Frierfjord and from a mesocosm facility at Solbergstrand dosed with 4 concentrations of diesel oil and copper. ICES sponsored one participant, Dr M. Auffret, who studied pathological conditions in molluscs collected at different sites along the gradient. From the outset it was recognised that a crucial component was the chemical analysis of water, sediments and tissues for the various contaminants. Metals were analysed by the Department of Marine Chemistry, Oslo and organic contaminants by the Institute of Marine Research at Bergen.

The Working Group noted that the results of the Workshop are presently being prepared as a book and a complete report will be made to IOC at the end of 1987. A selection of 70+ concentration-response curves for the mesocosm experiment and concentration-gradient curves for the Frierfjord show the kinds of response and their precision. However, in the absence of any chemical data, it is impossible at this stage to make any evaluation. Nevertheless, certain responses stand out in the sense that there were large

changes in response in relation to exposure concentration, or point on the gradient, and their variability.

While many data remain to be analysed, particularly the correlations between biological and chemical data, GEEP asserts that it is already clear that the Workshop will provide a unique data set for comparing and evaluating techniques for biological effects monitoring.

In the discussion of the information available from the Workshop, several Working Group members suggested that some of the techniques (e.g., mixed function oxidases) are rather subtle for use in monitoring programmes at some times of the year as the system could not be stimulated (McHenry), and that it was difficult to see what significance they have for fish or how they might be interpreted (Dethlefsen). It was suggested that sophisticated techniques are too expensive and, therefore, unsuited for monitoring (Føyn). In answer to these criticisms about the GEEP Workshop, it was asked where else had such a range of techniques been evaluated in this way with the same statistical criteria on the same gradient at the same time, and that the Workshop represented a step in the right direction. Furthermore, it was only by the use of sensitive, sublethal techniques that one can anticipate trends and hope to prevent irreversible effects on the biota. It is obviously important not to determine the capacity of the biota in the environment to deal with stress by exceeding it (Stebbing). However, Mr Lloyd suggested that the key question is "What techniques constitute good bioassays, in that they provide good discrimination and precision?" At a first glance, none of those deployed are particularly sensitive, some are too variable and some seasonally inconvenient. What is required is to say whether biological water quality is good or poor. Scope for growth may be a good index, but where there is sewage pollution, the increased potential for growth may outweigh a reduced scope for growth.

In response it was noted that scope for growth, when used to determine the effect of hydrocarbons, tends now to be interpreted in conjunction with body burdens, particularly since the relationship is good enough to be able to predict scope for growth directly from body burdens.

5.2 Future GEEP Activities

Proposals for future GEEP activities for the next 18-24 months were outlined by Dr Stebbing as follows:

- 1) August 1988. Training Workshop at Bermuda Biological Station.
- 2) Appointment of four Biological Effects Fellows who could act as Technical Assistants at the Bermuda Workshop.
- 3) Possibility of a workshop in the WESTPAC region (Philippines) in 1989.
- 4) Possibility of a workshop in the CARIPOL region.

- 5) Possibility of cosponsoring a workshop with NOAA in the Gulf of Mexico to evaluate bioassay techniques.

The Chairman then supplemented this summary with more up-to-date information, indicating that a workshop in Puerto Rico was a possibility and that a workshop in the Philippines seemed less likely for the near future. The Bermuda Training Workshop will involve a selection of the techniques used at the Oslo Workshop. Since the Workshop in the Gulf of Mexico will likely include techniques beyond those covered in Oslo, for example, bioassays, the Chairman suggested that the Working Group consider cooperating in some way on this activity. The Working Group could also cooperate with GEEP by suggesting the inclusion of methods of special interest to ICES in workshops outside the ICES area and by influencing GEEP to cooperate in planning a workshop in the ICES area.

Mr Lloyd expressed surprise that GEEP should extend its activities globally so soon and also that several well-known tests such as those involving echinoderm larvae and fish eggs have not yet been tested by GEEP.

The Chairman explained that a single workshop could not possibly evaluate all tests, and the evaluation of tests involving eggs and larvae, or pathology, might be included in a future workshop. He also explained that future financial support for GEEP activities depends on taking workshops to different areas. There is also a need to apply and evaluate the techniques in other environments, including tropical and sub-tropical areas.

5.3 Future Cooperation between IOC/GEEP and the Working Group on the Biological Effects of Contaminants

Dr Dethlefsen proposed that the Working Group explore the possibilities for an International Workshop for around 30 scientists during summer 1989 or beyond. The Working Group agreed that this would be a useful project. Accordingly, Drs Dethlefsen, Stebbing and Thurberg will explore a possible shipboard biological effects techniques workshop as a cooperative effort with IOC/GEEP on an informal basis and will prepare the necessary paperwork for ICES consideration and approval. Members of the Working Group are encouraged to begin a search for appropriate techniques and researchers. Dr Stebbing will serve as the initial point of contact for this effort.

Such a shipboard workshop will be considered an initial test of a suite of biological effects measurements that might be included in an international monitoring programme.

Dr Stebbing noted that while there is pressure on IOC/GEEP to move away from the North Sea, ICES requires activities in the North Sea or North Atlantic. In considering Dr Dethlefsen's shipboard workshop proposal, one possibility might be to evaluate the kind of bioassays not covered by the Oslo Workshop (larval tests, fish eggs and genotoxicity techniques) and to invite IOC/GEEP to deploy such techniques as it deems most applicable in this shipboard workshop.

The Working Group then considered possible ways of cooperating with IOC/GEEP on land-based activities (workshops).

The Bermuda Workshop was thought to be too far advanced in the planning to permit an ICES input at this stage. Mr Lloyd supported the idea of including methods of interest to ICES in the Gulf of Mexico initiative, and IOC funding could attract outside support. However, a North Sea-based workshop was more likely to be supported by ICES member countries.

Apart from the possibility of ICES support for an official observer to a Gulf of Mexico or Caribbean workshop, there is little likelihood of ICES support for other participants. Interest in cooperation with GEEP in this exercise was expressed, however, since ICES has considered biological effects monitoring to be important for over a decade.

Prof. Dundas noted that the interests of the two groups are complementary and not competitive and the importance of a fruitful relationship should not be overlooked. He encouraged participation by both Chairmen (IOC/GEEP and Working Group BEC) in each others' meetings.

Dr Stebbing suggested that this "statement of intent" to cooperate in the shared aims should be included in the minutes of the meeting, so that the Working Group is clearly on record as recognizing the important potential of such a cooperative effort. It must be noted, however, that such collaboration in a full and practical sense is not always possible as the two groups are compelled to respond to different concerns and governing bodies.

Dr Pawlak explained that the Working Group report and its expression of cooperation would be communicated through the Advisory Committee on Marine Pollution (ACMP) to IOC.

Dr Pawlak suggested that an overlap in timing of GEEP and ICES Working Group meetings could help in establishing some practical form of collaboration; the Chairman will investigate the possibility of such a joint meeting.

In response to requests for advance copies of the Oslo Workshop report, the Chairman said he felt there would be no problem with respect to obtaining the final chapter, which would cover the main conclusions and recommendations. The Working Group would also like to see the report of the ICES representative to the Workshop (Dr Auffret) when it is available and Dr Pawlak will attempt to provide it to the members.

In conclusion to this discussion, the Chairman assured the Working Group that he would carry forward to GEEP a spirit of collaboration and cooperation.

6 REPORT OF THE WORKSHOP ON THE USE OF PATHOLOGY IN STUDIES OF THE EFFECTS OF CONTAMINANTS

Dr Dethlefsen presented a report on the ICES Workshop on the "Use of Pathology in Studies of the Effects of Contaminants". He explained that this subject area covers areas of responsibility of

two Working Groups with the result that the link between disease and pollution had been somewhat neglected. He said that the report dealt with fish disease in the ICES area and that while some of the most thorough studies linked pollution and disease causally - a view endorsed by the Workshop - others did not. Dr Dethlefsen said he felt the Workshop achieved a change of opinion and that new studies provided better evidence relating pollution stress to disease, although it was acknowledged that epidemiological relationships alone cannot establish causality. WGBEC will watch with interest the potential development of methods in pathology that could be included in our list of biological effects measurements that require prompt and special attention. The need for experimental evidence to determine whether stressed organisms are more susceptible to disease pathogens was accepted and Dr McHenry reported experiments in preparation designed to answer this question, as did Mr Lloyd and Dr Marquenie.

Mr Lloyd said he could not support some of the conclusions of the Report which were at variance with the UK views expressed at the Workshop. In his experience, studies in freshwater on salmon, perch, and various diseases have never indicated conclusively that any outbreak of disease was related to pollution. He also added that disease in the sea is most common in flatfish whose intimate contact with contaminated sediments might be more likely to induce disease and that there are few fish in fresh water that are exposed in this way. Disease appears to be less prevalent in marine pelagic fish species. Although there was no case for fish disease work and cruises to come to a halt, further conclusions on causality should be derived from laboratory experiments. In response, Dr Dethlefsen claimed that any stress on fish increases their susceptibility to bacteria, viruses and parasites, and that there are many instances in the literature that accept the relationship between pollution and disease.

Dr Dethlefsen also encouraged laboratory experiments in order to determine possible causes of fish diseases that are observed in the field. He stressed the importance of such work at this stage. Mr Lloyd remarked that such experiments can only be successful if both ecotoxicologists and fish-histopathologists collaborate closely.

Dr Dethlefsen further explained that broad-scale epidemiological studies should be continued and that contaminant and residue concentrations in organisms should be assessed in order to establish linkages between cause and effects. Mr Lloyd asked whether or not sufficient chemical data are already available from programmes such as the JMP (Joint Monitoring Programme of the Oslo and Paris Commissions). Dr Dethlefsen remarked that JMP uses other species than those closely studied for disease. Dr Marquenie clarified this point by noting that JMP serves other purposes than fish diseases, namely long-term changes in contaminant body burden. Therefore, hot spots, such as dumping grounds, are not emphasized.

At this point Prof. Dundas reminded the Working Group that fish pathology was historically linked to fish stock assessments rather than to contaminant studies. If there is a sound basis for relating fish pathology to contaminants, why did the Working Group on Pathology and Diseases of Marine Organisms fail to make

that recommendation? Dr Dethlefsen explained that pathologists, in general, lack knowledge on contaminants and tend to focus on pathology in a descriptive way. The Chairman, therefore, noted that one of the tasks of the Working Group on Biological Effects of Contaminants was to help bridge the gap between studies of pathology and pollution.

Mr Lloyd remarked that experiments now underway may answer some of the cause and effect questions, although the answers may be several years away.

Dr Dethlefsen reported that an increased prevalence of fish diseases (especially in flatfish) has been observed in areas remote from contaminant sources. These results, as yet unpublished, are likely to lead to interesting findings in the future, especially with regard to contaminant transport. Dr Dethlefsen explained that, in his opinion, the higher concentrations of certain metals in remote areas originated from anthropogenic input and that flatfish are a target species because of their intimate contact with the sediments.

Dr Dethlefsen also reported information from the Puget Sound (USA) Project, in which liver cancer was induced in flounder through sediment exposure. Although field and laboratory experiments were conducted, a direct statement on cause and effect was carefully avoided in the report.

A discussion led by Mr Lloyd considered the problem of the limited analytical chemistry capacity; this "bottleneck" slows down interpretation of biological effects data. When Prof. Dundas noted that we here face both a resource (chemical analysis support) and coordination problem, Dr Pawlak described the role of the new Working Group on Environmental and Monitoring Strategies and said that group might be very helpful in solving such problems.

A brief discussion followed on invertebrate pathology especially on the imposex condition in gastropods exposed to tributyl-tin (TBT). This might be a useful screening tool, using analytical chemistry only sparingly, to confirm by chemical analysis the identification of areas suspected on the basis of biological methods to be contaminated with TBT.

7 FISH AND LARVAE IN BIOLOGICAL EFFECTS MONITORING

7.1 1986 Statutory Meeting Special Session

Dr Dethlefsen reviewed the papers on fish eggs and larvae presented by his laboratory at the Theme session on "Effects of Contaminants on the Reproductive Success and Recruitment of Marine Fish and Shellfish" at the 1986 Statutory Meeting.

To bring his presentation into perspective, he first explained that observations have been made related to four major long-term changes:

- hypertrophication (algal composition, O₂ deficiencies);
- reproductive failure (fish, seals, birds);
- diseases of fish;
- changes in populations of fish, seals and phytoplankton.

He is particularly concerned about major ecological changes. For example, he explained that in the Helgoland area, a number of invertebrate species have decreased in number or disappeared. The species were not replaced by new species, rather shifts in population composition occurred.

Dr Dethlefsen then described studies on the egg hatching success of whiting, collected from different areas, artificially fertilized and then cultured.

High PCB contamination of ovaries was observed (although lower than of livers) and the low survival of embryos was directly correlated to PCB and DDE concentrations in the parent ovaries. At all levels above 150 ng/g PCB (dry weight) in the gonad tissue, egg hatching was strongly reduced. At lower levels, however, both poor and good hatching occurred, indicating that factors other than PCBs may be of importance.

Dr Marquenie explained the vital importance of obtaining the PCB data on a congener basis so that the effects of metabolized and stable PCBs could be evaluated.

The malformation of embryos of spring-spawning fish was described for several different species. The embryos were collected at sea and analysis of the samples revealed that the highest malformations (up to 50%) were found in:

- The dumping area for wastes from the titanium dioxide industry;
- Mouth of the river Rhine;
- German Bight;
- Shipping channel along the Dutch-German coast.

This was followed by a discussion on the transport of PCBs via the atmosphere. Dr Pawlak reported that a study of the atmospheric deposition of contaminants is underway.

7.2 Other Fish Egg and Larvae Studies

The Chairman reported on the use of flounder eggs in biological effects studies conducted at Milford, CT (USA).

Fish were collected during the spawning season from sites with different levels of contaminants in the sediments. The fish were spawned in the laboratory, the eggs fertilized, and the embryos and larvae cultured. Differences in viable hatch, larval development, and genetic abnormalities were apparent when data from fish

collected from clean sites were compared to those from more contaminated areas.

The Chairman further reported that comparable egg and larval work with flounders on the west coast of the USA is underway.

Mr Lloyd reported from a lecture by Dr H Rosenthal that it is often difficult to obtain good hatching success even with uncontaminated fish. This may lead to serious problems in data interpretation.

Dr Dethlefsen replied that the methods used were highly standardized with internal controls and the reported differences should be regarded as significant.

According to Dr Føyn, oxygen consumption of fertilized eggs appears to be a promising indicator of fish egg health in oil pollution studies, and should also be considered as an effects measurement in this area. Prof. Dundas commented that bacterial infections may hamper oxygen transport to the egg and that this possibility has to be taken into account.

At the 1986 Statutory Meeting a suggestion was made that a small group chaired by Dr Rosenthal and Dr Murawski should prepare a review on fish eggs methodology. The Chairman will inquire as to the status of that report. If the report is non-existent, the Working Group will consider taking up the task.

8 FRAMEWORK FOR SELECTING TECHNIQUES FOR A COOPERATIVE MONITORING PROGRAMME

The Chairman reminded the Working Group that three important and valuable resources are available in the selection of a suite of effects measurements: the results of the IOC Oslo Workshop, the extensive work on fish eggs and larvae reviewed here and at the Theme Session, and the results of a GEEP questionnaire on the addition of biological effects measurements to the mussel watch programme. The Chairman will contact the GEEP representative responsible and will attempt to provide the results of that questionnaire to the Working Group members in the very near future.

Prof. Dundas proposed a framework that might be used in the determination of a few key biological effects tests that the Working Group could recommend for initial widespread use and evaluation in a Cooperative Monitoring Programme. A wide gap exists between the recognition that contamination of the environment is occurring (by chemical analysis or otherwise) and the eventual evaluation of its biological effects. This gap is too wide to be bridged by any single method. Methods that measure: 1) water quality, 2) population community health, size and composition, 3) general effects of contaminants on key species, or 4) specific physiological effects on a target animal, organ or tissue, either of a specific contaminant or a complex of contaminants, may help bridge part of the gap.

Each case requires individual interpretation and may require techniques appropriate to that part of the gap. In some cases the whole gap need not be bridged and attention can then be focused

on a specific area, for example, water quality or the action of a specific pollutant on selected species.

Dr Pawlak described a new ICES handbook series for the publication of methods descriptions: Techniques in Marine Environmental Sciences. A discussion then followed on the opportunity available to this Working Group to move forward on biological effects methods through the publication of descriptions of several key techniques.

With the suggested framework for bridging the gap between contaminants and their ultimate effects on stocks of living marine resources in mind, the Working Group prepared a small, carefully selected list of biological effects techniques for use (1) in a future at-sea biological effects workshop, (2) in the preparation of an initial small group of ICES Techniques handbooks and (3) as techniques with promise in broad-scale monitoring programmes.

These were:

- 1) Techniques in the general area of fish eggs and larval development;
- 2) Scope-for-growth with bivalve molluscs;
- 3) Water quality bioassays with mollusc larvae;
- 4) Measurement of scope for primary production;
- 5) Several techniques to be selected from the most successful of the Oslo (IOC) Workshop results;
- 6) Two tests that require development but show considerable promise: particle size distribution in a community and immunosuppressive responses.

The Working Group recognized that excellent cases can be made for many other techniques. Those selected for this initial group cover some of the stated goals of the Working Group at this time and cover a broad range of disciplines. The list includes well-established techniques as well as newly developing ones. It draws upon the experience of a unique workshop (IOC) that evaluated over 30 types of measurements, and the list included tests useful in bridging the gap described by Prof. Dundas.

The Working Group recognized the need to push forward with biological effects testing, evaluation, and implementation in a broad-scale monitoring programme.

9 FUTURE WORK

The Working Group prepared an action list for interessional activities that will include: further contact with GEEP on cooperative action, planning for a ship-based biological effects Workshop, evaluation of techniques tested at the Oslo GEEP Workshop, identification of key investigators so that several biological effects handbooks can be initiated and further work on a framework for a cooperative biological monitoring programme.

10 OTHER BUSINESS

Two additional reports were given on related research that presented a more overall ecosystem approach to problems of evaluating contaminant effects on marine species.

The first, by Dr Marquenie, described surveys at 60 sites in the Netherlands area using fresh water mussels as a "mussel watch" for cadmium. A very interesting aspect of the study was the extensive use of tufted ducks as a monitoring technique, and Dr Marquenie explained the role of PCBs in duck reproductive failure.

The second presentation, by Dr Granmo, described a 5-year study in Sweden employing a series of biological measurements (using algae, onion root growth, crustaceans, fish, ducks, and the Ames test) to test industrial effluents. The combination of this extensive set of biological measurements identified the most serious effluents in terms of potential damage to plant and animal life in the discharge area. This study emphasized the value of a carefully selected suite of measurements rather than dependence on a single or only a few tests.

With the ecosystem approach in mind, Dr Marquenie proposed that the Working Group compose an overview of recorded or suspected large-scale ecological changes, if possible including cause/effect relationships. Such a document may give guidance to the following:

- other interested groups of biologists or chemists;
- the selection of critical community levels of contaminants;
- the more reasoned selection of methods and techniques to assess effects.

In addition, Dr Dethlefsen stated the importance from a future historical point of view, indicating that a broad knowledge of changes is essential to discriminate between natural events and anthropogenic impacts.

It was concluded that Dr Marquenie will prepare a letter in conjunction with Dr Dethlefsen which requests members in ICES countries to provide information on changes (decrease and increase) in major marine populations that might be driven by contaminants. This material will be developed into a background document.

The Working Group reviewed Dr Stebbing's draft paper on action towards an international biological effects monitoring programme and agreed with points 1, 3 and 6. The remainder of this action paper largely follows and reinforces the proposed course of action subsequently agreed by the Working Group.

11 APPROVAL OF ACTION LIST AND RECOMMENDATIONS

- 1) All members should review the GEEP/Oslo Workshop Proceedings.
- 2) All members should evaluate results from the GEEP mussel watch questionnaire.
- 3) Dr Thurberg should investigate the status of the Rosenthal et al. fish egg/larvae review, as recommended by ICES Theme Session S at the 1986 Statutory Meeting.
- 4) Drs Stebbing and Dethlefsen should carry out action items arising from the proposal for a ship-based workshop.
- 5) Action arising from Dr Marquenie and Dr Dethlefsen's request for data on major changes in community structure occurring in recent decades. The first step is to construct guidelines for the supply of information.
- 6) Members should develop Handbook descriptions of protocols for specific biological effects techniques.

The Working Group recommended that it should meet for four days in the spring of 1988 at ICES headquarters. If possible, the meeting should be coordinated with that of GEEP to permit a one- to two-day overlap. The last week of May should be avoided. The Working Group agreed to the following tasks for the next meeting:

- 1) Review of GEEP Oslo Workshop results, and review of future GEEP plans.
- 2) Continue the preparation of plans for a ship-based workshop.
- 3) Review the paper on fish egg viability, if available.
- 4) Review progress in the preparation of descriptions of methods for the Handbook.
- 5) Review of the results of the ICES Workshop on Primary Production Measurements in the context of the biological effects techniques listed in our selected list.

This is Recommendation 2 in Annex 4.

12 CLOSURE OF THE MEETING

As all business was completed, the Chairman thanked the participants for their contributions and closed the meeting at 17.30 hrs on 27 May.

ANNEX 1

LIST OF PARTICIPANTS

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ANNEX 2

Working Group on Biological Effects of Contaminants

Copenhagen, 25 - 27 May 1987

AGENDA

1. Opening of the Meeting.
2. Adoption of Agenda.
3. Council Resolution Establishing the Working Group.
4. Report of the Study Group on Biological Effects Techniques.
5. Relations with IOC:
 - 5.1 Reports on the GEEP Oslo Workshop.
 - 5.2 Future GEEP Activities.
 - 5.3 Future Cooperation between IOC and the Working Group on Biological Effects of Contaminants.
6. Report on ICES Workshop on the Use of Pathology in Studies of the Effects of Contaminants.
7. Review of the Use of Fish Eggs in Biological Effects Monitoring Programmes.
 - 7.1 Report on Statutory Meeting Theme Session on this Topic.
 - 7.2 Reports on Ongoing Activities in this Area.
8. Development of a Framework for Selecting Appropriate Techniques for a Cooperative Monitoring Programme.
9. Future Work.
10. Other Business.
11. Approval of an Action List and Recommendations.
12. Closure of the Meeting.

ANNEX 3

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ANNEX 4

RECOMMENDATIONS

Recommendation 1

The Working Group on Biological Effects of Contaminants recommends that a shipboard workshop be held for two weeks preferably in summer 1989 to test the use of a number of techniques, particularly bioassays, to measure the biological effects of marine pollution; ICES member countries are encouraged to provide research vessel(s) for this workshop and IOC should be invited to cooperate in this activity.

Recommendation 2

The Working Group on Biological Effects of Contaminants recommends that it meet for four days in spring 1988 at ICES Headquarters to carry out the following tasks:

- 1) Review the results of the GEEP Oslo Workshop and future GEEP work;
- 2) Review progress in the plans for the sea-going workshop on biological effects techniques;
- 3) Review the paper on methods using fish eggs and larvae;
- 4) Discuss the preparation of draft descriptions of techniques for monitoring biological effects;
- 5) Review results of the Workshop on Primary Production Methods with a view to their applicability to biological effects.

