Intergovernmental Oceanographic Commission
Reports of Governing and Major Subsidiary Bodies

IOC-FAO Intergovernmental Panel on Harmful Algal Blooms

Second Session

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In this Series *Languages*

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IOC/FAO/IPHAB-II/3
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* For reasons of budgetary constraint, some of the Annexes have to remain untranslated and appear in English in the French and Spanish texts of the Report.

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Abstract

During its Second Session the IOC-FAO Intergovernmental Panel on Harmful Algal Blooms reviewed the actions completed during the past intersessional period. The major achievements reported on were: (i) establishment of a Harmful Algal Bloom Programme Office at the IOC Secretariat with two staff-members to take care of programme development and coordination; (ii) publishing and distribution of six issues of the IOC newsletter on toxic algae and algal blooms *Harmful Algal News* to 2000 subscribers; (iii) development of proposals for IOC Harmful Algal Bloom Science and Communication Centres in Denmark and Spain; (iv) implementation of the first IOC training course on the taxonomy of harmful marine phytoplankton for scientists from developing countries; (v) implementation of two workshops; an international workshop on training requirements in the fields of eutrophication and harmful algae, and an IOCARIBE workshop on algal blooms and mass mortality of marine organisms; and, (vi) establishment of an ICES-IOC Working Group on Dynamics of Harmful Algal Blooms and a SCOR-IOC Working Group on the Physiological Ecology of Harmful Blooms and planning of activities to be carried out in 1994-95.

During the this year's session, the Panel focussed its intersessional action plan around four tasks; (i) Algal Taxonomy; (ii) Aquatic Biotoxins; (iii) Design and Implementation of HAB Monitoring Programmes; and (iv) HAB Project Development, respectively. Furthermore, the Panel endorsed or agreed on action to be taken in relation to: (i) a HAB Training and Capacity Building Programme; (ii) availability of marine biotoxin standards and reference materials to developing countries; and (iii) computerized taxonomic databases. As a follow-up to UNCED, activities were recommended on: (i) long term trend monitoring of changes in phytoplankton species composition; and (ii) addressing the role of UV-radiation in the ecology of marine phytoplankton.

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1. OPENING

1 The Second Session of the IOC-FAO Intergovernmental Panel on Harmful Algal Blooms (IPHAB-II) was held in Paris, 14-16 October 1993. The Secretary IOC, Dr. G. Kullenberg, opened the Session and welcomed the participants who included Members representing 21 nations. The List of Participants is included as Annex III.

2 The Secretary IOC addressed the Panel by recalling that the ad hoc Intergovernmental Panel on Harmful Algal Blooms (IPHAB) was formed at the Sixteenth Session of the IOC Assembly, March 1991, in order to identify adequate resources for a broad programme to try and solve some of the problems caused by harmful algae. The Secretary IOC expressed his satisfaction to have FAO represented as a part of the Panel Secretariat.

3 The Harmful Algal Bloom Programme Plan and proposals (Document IOC-FAO/IPHAB-I/3) were adopted by the Seventeenth Session of the IOC Assembly in February-March 1993 and many Delegates pointed out the importance of and urgency to adequately address the problem. This was also seen as an important IOC follow-up to UNCED. In order to maintain momentum in the development of the programme the Assembly decided that the Second Session of the Panel should be convened as soon as possible. The Secretary IOC in particular addressed the critical question of resources and commitments and emphasized that the Panel Members have particular responsibilities in this regard; to help obtain resources for national activities. A summary of his opening statement is given in Annex VI.

4 The Representative of the FAO, Mr. U. Barg, Fishery Resources Officer, conveyed, on behalf of Dr. E. Saouma, Director General of FAO, and Dr. W. Krone, Assistant Director General, Fisheries Department, best wishes for a successful Second Session of the Panel. He emphasized the relevance of impacts of harmful algae on fisheries and aquaculture as well as on seafood quality. A summary of his statement is given in Annex VI.

1.1 OBJECTIVES OF THE IOC-FAO INTERGOVERNMENTAL PANEL ON HARMFUL ALGAL BLOOMS

5 The Terms of Reference, as set out in Resolution XVI-4 of the Sixteenth Session of the IOC Assembly (Annex IV), and the objectives of the Panel were outlined by the IOC Secretariat.

2. ADMINISTRATIVE ARRANGEMENTS

2.1 ADOPTION OF THE AGENDA

6 **The Panel adopted** the Agenda as given in Annex I.

2.2 DESIGNATION OF RAPPORTEUR

7 **The Panel adopted** the proposal by France to elect Dr. R. Kifer (United States of America) as Rapporteur for the Session.

3. SUMMARY DESCRIPTION OF THE HAB PROGRAMME : SCIENCE BACKGROUND AND GOALS

8 The Chairperson, Dr. B. Dybern, summarized the scientific background and goals for the IOC-FAO Harmful Algal Bloom Programme (HAB Programme). He outlined how harmful algal blooms have occurred throughout recorded history, yet the public health and economic impacts of these phenomena have increased during the last several decades. This expansion relates in part to the increasing exploitation of coastal waters (due to waste disposal, maritime commerce and other anthropogenic influences), as well as to the dispersal and proliferation of algal populations associated with natural oceanographic and meteorological processes. There are short-term, medium-term and long-term aspects to the problems arising from harmful algal blooms. In the short-term, the emphasis must be on mitigating effects of harmful algal events. In the medium-term, the focus will be on understanding, modelling and prediction, with the eventual long-term focus of preventing or eliminating

the problems. The overall goal of the HAB Programme, as indicated below, embraces these 3 time scales as well as the range of related scientific and administrative problems:

To foster the effective management of, and scientific research on, harmful algal blooms in order to understand their causes, predict their occurrences, and mitigate their effects.

9 There are three major divisions of the problem - educational, scientific and operational. The educational programme element can be separated into 2 branches : information networks; training and capacity building. The scientific programme element can be separated into 3 branches : ecology and oceanography; taxonomy and genetics; and toxicology and toxin chemistry. The operational programme element can be divided into 3 branches : resource protection; monitoring; and public health and seafood safety. There are many interactions between the divisions, e.g., fisheries management questions benefit from knowledge of the ecology and dynamics of blooms; monitoring is based on information about ecology, oceanography, taxonomy, and toxicity.

10 Harmful Algal Bloom Programme Elements and Goals:

EDUCATIONAL PROGRAMME ELEMENTS

Information Network : To develop, encourage and maintain the flow of information, technology and expertise to scientists, administrators and the general public

Training : To promote and facilitate the development and implementation of appropriate training programmes in order to distribute the necessary knowledge and expertise on a global basis.

SCIENTIFIC PROGRAMME ELEMENTS

Ecology and Oceanography : To understand the population dynamics of harmful algae.

Taxonomy and Genetics : To establish the taxonomy and genetics of the causative organisms at the appropriate levels.

Toxicology and Toxin Chemistry : To determine the physiological and biochemical mechanisms responsible for toxin production and accumulation, and to evaluate the effect of phycotoxins on living organisms.

OPERATIONAL PROGRAMME ELEMENTS

Resource Protection : To develop and improve methods to minimize the environmental and economic consequences of harmful algae.

Monitoring : To promote and facilitate the development and implementation of appropriate monitoring programmes.

Public Health and Seafood Safety : To protect public health and ensure seafood quality.

11 The detailed HAB Programme Plan is included as Annex V.

4. HAB PROGRAMME DEVELOPMENTS IN THE INTERSESSIONAL PERIOD

PROGRAMME SUPPORT

4.1 HARMFUL ALGAL BLOOM PROGRAMME OFFICE

12 At the First Session of the Panel, through Recommendation IPHAB-I.2, the Panel recommended IOC to proceed with the establishment of the HAB Programme Office within the IOC Secretariat. The IOC Assembly (March 1993) endorsed the Recommendation and the Programme Office has now been established. Since 1991 Denmark has seconded a staff member specifically for the HAB Programme (H. Enevoldsen), and as of 1 May 1993 an additional Danish Associate Expert has been assigned to the HAB Programme Office (H. Ravn). On behalf of IOC the Secretary IOC expressed his high appreciation of the large support from Denmark and its Danish International Development Aid Agency (DANIDA).

4.2 ESTABLISHMENT OF HAB SCIENCE AND COMMUNICATION CENTRES

13 Reference was made to the Seventeenth Session of the IOC assembly, March 1993, where Denmark and Spain offered to establish HAB Science and Communication Centres. The IOC welcomed the establishment by Denmark and Spain of such Centres (Document SC/MD/101, para. 80). The Centre concept has been discussed currently, including during the First Session of the Panel (Document IPHAB-I/3, Annex VIII). Their establishment was also recommended by the Bremen Maritime Training Center (BMTC)-IOC Workshop, Bremerhaven, 1992 (IOC Workshop Report No.97).

14 With respect to the establishment of a Center in Vigo, Spain, Ms. B. Reguera informed that there had been a workshop in Vigo to identify the needs and the ideas in relation to a HAB Science and Communication Centre. The project is now being further developed.

15 With respect to the establishment of a Centre in Copenhagen, Denmark, Prof. O. Moestrup informed that a project proposal had been prepared and submitted for funding to the Danish International Develo, ment Aid Agency, DANIDA. The Centre will be co-sponsored by the University of Copenhagen, the Ministry of Fisheries (National Marine Fisheries Institute), and the Ministry of the Environment (National Environmental Research Institute). The centre will in particular focus on providing assistance to developing countries. The Secretary IOC thanked Prof. Moestrup personally for his efforts to facilitate the implementation of the HAB Programme.

16 **The Panel welcomed and encouraged** these and similar developments and stressed the need for coordination and interaction between the Centres as well as between the Centres and the HAB Programme Office.

4.3. SURVEY ON RESOURCES AND NEEDS IN MEMBER STATES

17 On the initiative of the Chairperson a survey on resources and needs in relation to harmful algae was carried out in IOC Member States. The questionnaire was circulated during spring 1993. The aim of the survey was to obtain more detailed information on which countries have resources (expertise and facilities) and which countries have a need for training, assistance and cooperation within the various fields of harmful algae research and management. The information has been stored in a data-base and will be circulated to Panel Members when it has been processed. This overview will hopefully help the Panel and the HAB Programme Office to further develop the HAB Programme and as a reference for proposed activities.

EDUCATIONAL PROGRAMME ELEMENTS

INFORMATION NETWORK

4.4 HARMFUL ALGAE NEWS, THE IOC NEWSLETTER ON TOXIC ALGAE AND ALGAL BLOOMS

18 The state of the IOC Newsletter on toxic algae and algal blooms "Harmful Algae News" was presented by the Editor, Dr. T. Wyatt. The first issue was published in early 1992. Currently, 2.000 copies of the Newsletter are distributed. The interest in receiving "Harmful Algae News" on a regular basis has been strong and the number of subscribers is increasing. The Editor reported with regret that the Newsletter had only been issued three times in 1993 instead of four. The delay of the Newsletter is mainly caused by manuscripts which arrive to the Editor after the deadline is passed. The Editor requested the Panel to encourage their colleagues to contribute to the newsletter. The Editor noted that his term as Editor had ended, but that he was prepared to continue, if approved by the Panel.

19 **The Panel gratefully acknowledged** the efforts of Dr. T. Wyatt and **noted** with satisfaction the development of the Newsletter.

4.5 IOC DIRECTORY OF EXPERTS

20 The Secretariat reported on the updated edition of the International Directory of Experts in Toxic and Harmful Algal Blooms and Their Effects on Fisheries and Public Health, first published in 1990. The Directory is being compiled by Dr. A. White of the US National Marine Fisheries Service, and the updated and expanded directory will be published by the IOC. Questionnaires are now being distributed to the international HAB community to collect the appropriate information. Publication is planned for first half of 1994. The directory will be available on paper and diskette.

21 **The Panel noted** the importance and usefulness of an updated directory of experts and managers and emphasized the need to insure that also experts, managers, monitoring people, and aquaculture experts in developing countries are included.

4.6 IOC MANUAL ON HARMFUL MARINE PHYTOPLANKTON

22 As reported and approved at the First Session of the Panel a Manual is in preparation (outline can be found in Annex VII). The Manual will include widely different information on the taxonomy, toxicology and epidemiology of harmful algal blooms, and will be distributed freely to institutions in developing countries. The final manuscript is expected to be ready in mid 1994. The Representative of IUPAC, Dr. D. Park, raised the question about how the new analytical methods for toxins were covered. As one of the co-Editors Dr. D. Anderson noted that the authors of the chapter on toxin analysis, chemical methods, will review the manuscript to ensure the information is updated. The representative of WHO, Dr. R. Plestina, asked if the toxicology aspects would be covered in this Manual. These aspects will not be covered in detail, but a chapter on Epidemiology will be included. The inclusion of comprehensive guidelines in relation to management and contingency planning was discussed (see item 7.5).

23 **The Panel noted** with satisfaction that the preparation of the Manual is proceeding well, and **urged** that the printing and publication of the Manual be given highest priority.

4.7 PROPOSAL FOR ESTABLISHMENT OF A CEC SCIENTIFIC AND TECHNICAL COOPERATION NETWORK ON HARMFUL PHYTOPLANKTON

24 A summary description of the proposal can be found in Annex VII. The proposal was submitted the first time in November 1992. In June 1993 the proposal was rated "B" which means that the proposal is of a good quality but will not be funded in its present form. Nevertheless the CEC encouraged IOC to re-submit a

redrafted proposal. All co-proposers have been requested to provide the Coordinator (IOC) with input and assistance in the redrafting. The deadiine for re-submission is 15 November 1993.

25 **The Panel recommended** that the proposers redraft the Proposal and resubmit it.

4.8 IOC/WESTPAC INFORMATION LEAFLET SERIES

26 To supplement the IOC Manual on Harmful Marine Phytoplankton (see item 4.6) a short leaflet publication on taxonomy, ecology and toxicology of harmful algal species will be printed and distributed in 1994. The leaflet will be translated into local languages to facilitate the dissemination of information in the respective countries.

27 **The Panel noted** with satisfaction this initiative.

TRAINING

4.9 IOC-DANIDA TRAINING COURSE ON THE TAXONOMY OF HARMFUL MARINE PHYTOPLANKTON

28 The IOC Secretariat reported on the IOC-DANIDA Training Course which was held at the University of Copenhagen, 18-28 august, 1993. 125 applications were received for the 10 seats available for participants from developing countries. Owing to the large number of applicants the participants was increased to 15. The experience from this course will serve as background for a more comprehensive training programme including several additional aspects of harmful algae events. The feedback from the Participants, which will be included in the Report of the Course, will be valuable for the formulation of objectives and target groups for a future training programme. More details can be found in Annex VII.

29 **The Panel noted** with satisfaction the successful implementation of this first training course emerging from the HAB Programme, and **took note** of the high number of applicants for the Course as an indication of the need for more courses in the future.

4.10 BMTC-IOC-POLARMAR INTERNATIONAL WORKSHOP ON TRAINING REQUIREMENTS IN THE FIELDS OF 'EUTROPHICATION IN SEMI-ENCLOSED SEAS' AND 'HARMFUL ALGAL BLOOMS'

30 An International Workshop was held 29 September to 3 October 1992, in Bremerhaven, Germany. The Workshop was organized by Bremen Maritime Training Centre, BMTC (State of Bremen), and was co-sponsored by IOC, the Mediterrenean Action Plan (MAP), and a number of other co-sponsors. The Workshop had 65 participants.

31 The Workshop consisted of 12 keynote presentations followed by detailed discussions on training needs in developing countries in particular in relation to eutrophication and algal blooms. A central idea in the Workshop was to have scientists and specialists from developing countries define the training needs in their respective countries. The Workshop prepared an elaborate set of recommendations which have been, and will continue to be, an important basis for the training activities within the HAB Programme. The Report is published as IOC Workshop Report No. 94.

32 **The Panel noted** with content the approach and results of the Workshop and **acknowledged** the value of the Report as an important basis for the development of a HAB training and capacity building programme.

4.11 IOCARIBE WORKSHOP ON RED TIDES AND MASS MORTALITY OF MARINE ORGANISMS

33 The Workshop was held in Cumana, Venezuela, 16-19 September 1992. The conclusions and recommendations of the Workshop are included in Annex VII. The Recommendations provide specific guidelines for future regional activities, in particular in relation to training. A HAB Network has been established in the Region. The Network will be coordinated by Dr. A. Barbera-Sanchez, CONICIT, Cumana, Venezuela.

34 **The Panel noted** the Recommendations of the Workshop and emphasized that they should be taken into account when planning HAB Training and Capacity Building Programme activities.

4.12 WESTPAC EXPERT MISSIONS IN RELATION TO TRAINING

35 The Chairperson of the WESTPAC Task Team on HAB, Dr. Y. Fukuyo, reported that the importance of the HAB Programme is now being recognized in the WESTPAC Region. Nevertheless, awareness is still incomplete among scientists and officials. To obtain better understanding and hopefully higher priority, repeating seminars on scientific topics and management issues are important. Through conducting seminars each Member State can establish scientist networks and identify focal points. An Expert Mission to facilitate this process has been initiated as follows: Indonesia, July 1993; Philippines, July-August 1993; Indonesia, Philippines, China, November 1993; and Thailand, December 1993.

36 **The Panel welcomed** the initiative and **recognized** the need to facilitate regional and national HAB programmes.

SCIENTIFIC PROGRAMME ELEMENTS

ECOLOGY
and
OCEANOGRAPHY

4.13 ICES-IOC STUDY GROUP ON THE DYNAMICS OF HARMFUL ALGAL BLOOMS

37 Mrs. B. Reguera, Chairperson of the ICES-IOC Study Group on the Dynamics of Harmful Algal Blooms, reported on the work and results of the Study Group.

38 The activities of this group can be considered as a development, by ICES, of the "Ecology and Oceanography" scientific element of the Harmful Algal Bloom Programme Plan (Annex X). At the 81st Statutory Meeting of ICES, Dublin, Ireland, September 1993, it was decided to upgrade the Study Group to a Working Group, and IOC was invited to also co-sponsor the new Working Group. The results of the last meeting of the Study Group, Charleston, USA, 8-11 February 1993, and the Terms of Reference of the new Working Group are included in Annex VII.

39 **The Panel recognized** the importance of the efforts of ICES in relation to harmful algae. **The Panel noted** with satisfaction the progress of the Study Group and its transformation into a Working Group. **The Panel welcomed** the invitation to IOC to also co-sponsor the new Working Group.

4.14 SCOR-IOC WORKING GROUP 97 ON THE PHYSIOLOGICAL ECOLOGY OF HARMFUL BLOOMS

40 The Scientific Committee on Ocean Research established a Working Group at its Executive Council meeting, November 1991, to examine available data on the physiological ecology of harmful blooms. The WG is chaired by Dr. D. Anderson and will meet for the first time in La Rochelle 23-24 October 1993. The Terms of Reference and a list of Members can be found in Annex X.

41 **The Panel noted** with satisfaction that the Working Group is starting its activities. **The Panel stressed** the need to assure that there is no duplication of efforts between this Working Group and the ICES-IOC

Working Group on the Dynamics of Harmful Algal Blooms. **The Panel requested** the Chairpersons of the two Working Groups to clarify their respective Terms of Reference and coordinate their activities in order to avoid duplication of efforts.

5. NATIONAL STATEMENTS

42 National statements providing information on national activities and developments in relation to research and management of harmful algae were presented by Argentina, Australia, Brazil, Canada, Denmark, Egypt, France, Germany, Italy, Japan, Norway, Philippines, Portugal, Spain, Sweden, Thailand, UK, Uruguay, and the USA. The Statements are summarized in Annex VIII.

6. HAB PROGRAMME INTERACTION

6.1 INTERACTION WITH OTHER ORGANIZATIONS

43 At the First Session of the Panel in June 1992 the Representatives of UNEP, CEC, ICES and SCOR outlined their activities related to harmful algae and how these could interact with a global programme on harmful algal blooms (Document IOC-FAO/IPHAB-I/3). At the Second Session the Representatives from WHO (IPCS) and IUPAC were invited to outline their activities related to harmful algae and how these interact with the HAB Programme.

WHO (IPCS)

44 The WHO International Programme on Chemical Safety (IPCS) was presented by Dr. R. Plestina (details are included in Annex IX). The Programme was initially set up to provide assessment of the risks to human health and the environment from exposure to chemicals, whatever their origin, man-made or natural, or wherever they are found. The Programme provide guidance to countries on how to use such assessments, and also seeks to strengthen national capabilities to prevent and treat harmful effects. In 1984 the IPCS published an Environmental Health Criteria document on Aquatic (Marine and Freshwater) Biotoxins covering toxicology of the most important biotoxins such as Paralytic Shellfish Poisons (PSP, ciguatera toxins, Diarrhetic Shellfish Poison (DSP), etc. It is now felt that an updating and revision of human health risk evaluation of phycotoxins is timely and very much needed, particularly concerning possible harmful effects of low level exposure. The preparation for the revision and updating of the human health risk evaluation of phycotoxins is underway.

45 The Panel was informed in detail about the existing FAO-WHO Joint Expert Committee on Food Additives (JECFA) concerning human health risk evaluation of various food contaminants.

IUPAC

46 The International Union for Pure and Applied Chemistry (IUPAC) was introduced by Dr. D. Park (details are included in Annex IX). The IUPAC Commission on Food Chemistry is composed of eight working groups whose activities focus on mycotoxins, aquatic biotoxins, elemental analysis, natural plant toxins, etc. The Commission has sponsored nine symposia on mycotoxins and/or phycotoxins. The last was held in Mexico city, 8-11 November 1992, and the next will be held in Rome in 1996. The IUPAC-CFC works closely with AOAC International on method validation studies. Commission members also coordinate activities with Codex Alimentarius, FAO, and the European Community BCR. IUPAC-CFC is looking forward to future collaborative activities with IOC.

6.2 INTERACTION WITH OTHER IOC PROGRAMMES

47 At the First Session of the Panel several IOC Programmes were presented in detail with the view to provide the Panel with the necessary information to avoid overlap and facilitate interaction. The Programmes presented at the First Session were Training Education and Mutual Assistance (TEMA), the Programme on Global Investigation of Pollution in the Marine Environment (GIPME), the Regional IOC Commissions for the Western Pacific (WESTPAC) and the Greater Caribbean (IOCARIBE).

48 To complete the presentation of relevant programmes, the Expert Groups under GIPME and the Global Ocean Observing System (GOOS) were introduced and an introduction was also given to IOC follow-up initiatives to the United Nations Conference on Environment and Development - UNCED, and how the HAB Programme links with Agenda 21 and its Conventions.

GIPME

49 The Global Investigation of Pollution in the Marine Environment (GIPME) Programme has two levels of activities, global and the regional marine pollution monitoring, MARPOLMON. At the global level, programme implementation is carried out by three Groups of Experts: The IOC-UNEP-IAEA Group of Experts on Methods, Standards and Intercalibration (GEMSI), Group of Experts on Effects of Pollutants (GEEP) and Group of Experts on Standards and References Material (GESREM), whose activities under MARPOLMON are pursued through a network of national and regional laboratories. GIPME is interested in the problem of harmful algal blooms because of the implications for public health and protection of living marine resources.

50 Areas of mutual interest and overlapping activities of the GIPME Experts Groups and the HAB Programme were outlined and clarified by Dr. M. Moore (GEEP), Dr. R. Dawson (GEMSI), and Dr. R. Boyd (GESREM). A summary is included as Annex X.

51 **The Panel welcomed** the inclusion of the GIPME Expert Groups in the Panel and **acknowledged** the work carried out within the Groups and its importance for the HAB Programme. **The Panel urged** IOC, UNEP, IMO and IAEA to facilitate the work of the GIPME Expert Groups and help provide the necessary resources.

GOOS

52 The Global Ocean Observing System (GOOS) was introduced by Dr. A. Tolkachev from the GOOS Support Office at the IOC Secretariat. GOOS was initiated by IOC and is now developed by IOC in co-operation with WMO, UNEP and ICSU. It will be developed as a global network, coordinated internationally, for systematic ocean observations to meet the needs for forecasting climate variability and change; for assessing the health or state of the marine environment and its resources, including the coastal zone; and for supporting an improved decision making and management process -one which takes into account potential natural and man-made changes in the environment and their effects on human health and resources. GOOS is thus an international co-ordinated system for operational data collection (measurements), data analysis, exchange of data and data products, technology development and transfer.

53 Five modules of GOOS have been defined which represent user interests and applications. They are inter-related and will share observations, data and data networks and facilities, as needed within the one integrated system. Particular relevant to harmful algae occurrences are the modules on 'Monitoring and Assessment of Marine Living Resources', 'Assessment and Prediction of the Health of the Ocean' and 'Monitoring of the Coastal Zone Environment and its Changes'. The *Ad hoc* Panel for 'Monitoring and Assessment of Marine Living Resources' will have its first session in San José, Costa Rica, 7-10 December 1993. The Panel for 'Assessment and Prediction of the Health of the Ocean' held its first session in Paris, 23-26 February 1993.

54 Interaction with the relevant Panels, possibly through designation of an HAB expert, should be considered. Collaboration with GOOS is also relevant e.g. in relation to training activities on monitoring of harmful algae.

55 **The Panel noted** that some international (IOC-UNEP-WMO Coastal Monitoring, International Mussel Watch) and national GOOS- linked monitoring programmes already exists (Norway, Finland, European Seawatch) which include harmful algae.

6.3 IOC FOLLOW-UP TO UNCED

56 At the Seventeenth Session of the Assembly of the IOC, February-March 1993, it was stressed that the follow-up to UNCED should be considered as a high priority activity for the Commission. An *ad hoc* Intersessional Working Group on the IOC Follow-up to UNCED was established during the Assembly (Resolution XVII-18, within Document SC/MD/101 Annex II). UNCED fully recognized the need for a scientifically based information basis and methods for the management. Harmful Algae is one universally

occurring problem requiring urgent scientific and managerial attention in this context. In several areas of concern within the comprehensive programme of action adopted by UNCED, Agenda 21, harmful algae are included; (i) their occurrence can be an indicator of the health of coastal zone waters which is very central in, and part of, Integrated Coastal Area Management; (ii) the transfer of non-indigenous species through de-ballasting; (iii) the synergistic effects of harmful blooms on stressed ecosystem; (iv) the uncertainty in relation to global climate change and effects of changing radiation balance, including U.V. change, etc.

57 The Harmful Algal Bloom Programme is designed to foster the effective management of, and scientific research on, harmful algal blooms in order to understand their causes, predict their occurrences, and mitigate their effects. There is a relationship between this programme and the GOOS Module on the Assessment and Prediction of the Health of the Ocean (see below). This programme includes operational elements concerning resource protection and monitoring, closely related to the Article 7 and Annex I of the Convention on Biological Diversity. A number of training and information activities, which in particular refer to Article 12, Article 13 "Public awareness and Education", and Article 17 "Exchange of Information" of the Convention on Biological Diversity, have been implemented and planned. (Training Courses, Newsletter and Manual). With respect to the Article 8 of the Convention, an ICES-IOC Study Group on the Dynamics of Harmful Algae Blooms and a SCOR-IOC Working Group on the Physiological Ecology of Harmful Algae Blooms have been established (both as parts of the scientific element of the HAB Programme).

58 Two relevant activities with respect to the Convention of Climate Change, Article 5: "Research and Systematic Observation", are the ICES-IOC Working Group on Dynamics of Harmful Algal Blooms and the SCOR-IOC Working Group 97 on the Physiological Ecology of Harmful Algal Blooms.

59 Over the last 20 years, the number of observed blooms of various (phytoplankton) dinoflagellate species have increased throughout the world. Some phytoplankton grown at high light intensities present UV absorbing substances. This phenomena may also provide UV protection to other organisms present in the water column, and may be related to the climate change. For example it has been discussed in the literature whether the presence of compounds with high UV absorbance in Alexandrium excavatum and Gyrodinium cf. aureolum from the Southern hemisphere (Mar del Plata, Argentina), is an adaption to photo-protection against deleterious UV radiation. In the Northern hemisphere Phaeocystis pouchetii is reported to form massive near-surface blooms in the marginal ice-edge zone around Antarctic during spring and summer. It has been proved that this marine phytoplankton contain UV-B protecting compounds. This is an example of a new approach related to climate change aspects which may effect the frequency of global algal blooms (see further Item 7.14). HAB research projects, as parts of the follow-up to UNCED, especially the Convention of Climate Change, article 5, must be developed with respect to environmental parameters such as e.g., sunlight and wind velocity to understand the increased number of certain algal blooms. This could also be prepared as a Global Environmental Facility (GEF) project in close relation to national projects.

60 **The Panel welcomed** the IOC initiative to actively pursue the decisions of UNCED. **The Panel recognized** the need for taking into account Agenda 21 and the two Conventions when setting priorities for the HAB Programme.

7. SETTING OF PRIORITIES, IDENTIFICATION OF RESOURCES, ACTION TO BE TAKEN, AND RELEVANT INTERACTION WITH OTHER PROGRAMMES AND ORGANIZATIONS

61 Based on Document IOC-FAO/IPHAB-II/Inf. 5, which had been circulated prior to the Session, the Panel revisited the objectives in the HAB Programme Plan (Document IPHAB-I/3). After thorough discussion, priorities were set, action to be taken was suggested, and resources were sought identified and committed. Appropriate interaction with other programmes and organizations were established or identified.

62 **The Panel endorsed** a number of inter-sessional activities to be implemented by Member States and IOC Secretariat. The discussion and the activities to be implemented are summarized below. Each activity, the action recommended, and how it relates to the specific objectives in the Programme Plan can be found in Annex XI.

PROGRAMME SUPPORT

7.1 STAFF

63 The present secondment by Denmark of two Associate Experts (H. Enevoldsen and H. Ravn) to the HAB Programme Office will end during 1994. Nevertheless it is hoped that one post will be extended (H. Ravn). The secondment of additional staff to the Programme Office is crucial for the continued strong development of the HAB Programme. An appropriate level of staffing was considered to be one senior and one to two younger staff members (see Document IOC-FAO/IPHAB-I/3, Annex VII).

64 The Representative of the United States referred to the Seventeenth Session of the IOC Assembly, March 1993, where the United States indicated their willingness to wholly or partly provide the support for a Senior Assistant Secretary for OSLR. A number of Member States informed the Panel that they as Panel Members would investigate the possibility for secondments by their respective countries.

65 **The Panel recognized** the need for staff to coordinate and help implement the Programme. **The Panel strongly encouraged** Member States to second staff members to the HAB Programme Office, and **urged** the Secretary IOC to pursue the secondment of a Senior assistant Secretary for OSLR and/or HAB. **The Panel adopted** Recommendation IPHAB-II.1.

7.2 GROUP OF EXPERTS

66 Referring to Recommendation IPHAB-I.3 and Resolution XVII-2 of the Seventeenth IOC Assembly, the need for, and appropriateness of, establishing a Group of Experts on Harmful Algal Blooms was analyzed. Concern was expressed considering the cost and difficulty of establishing such a Group, which would require very broad representation of various scientific and managerial aspects. It was agreed that for the time being it would be more cost efficient to use the Panel as the guiding and expert mechanism. Several Representatives stressed the need to have better represented the management and aquaculture interests in the Panel.

67 **The Panel decided** not to establish a Group of Experts for the time being, but to establish intersessional Task Teams as necessary to address specific tasks (see items 7.15, 7.17, 7.19 and 9).

7.3 BROCHURE ON THE HAB PROGRAMME

68 **The Panel endorsed** the preparation of a brochure on the HAB Programme outlining the goals, the main activities, contact points, etc. The brochure should be addressed to administrators, politicians, funding agencies, and the general public.

EDUCATIONAL PROGRAMME ELEMENTS

INFORMATION NETWORK

7.4 HARMFUL ALGAE NEWS, THE IOC NEWSLETTER ON TOXIC ALGAE AND ALGAL BLOOMS

69 **The Panel urged** Dr. T. Wyatt to continue as Editor. Dr. Wyatt accepted. **The Panel** encouraged the IOC Secretariat to continue its efforts, and to distribute the Newsletter as widely as possible. **The Panel agreed** that the Newsletter should continue to contain scientific as well as public awareness news items.

7.5 MANUALS

70 It was discussed in detail the extent to which the Manual on Harmful Marine Phytoplankton, under preparation (see 4.6), should include management aspects. It was concluded that the Manual under preparation will focus on technical methods and therefore not give detailed advice on management questions. The need for a section in the Manual, or alternatively a separate manual, with practical cost efficient guidance in relation to management and mitigation techniques was stressed by several Member States and the FAO Representative.

71 **The Panel recommended** the preparation of guidelines and advice specifically on management and contingency planning in relation to fisheries and aquaculture.

7.6 NETWORKS

72 Referring to objective 6.1.1., v), in the Programme Plan (Annex V) the Panel had a general discussion on the importance of strengthening the HAB Programme through national, regional, and global networks.

73 The importance of good regional networks was stressed. Such networks have been or are being established in the WESTPAC Region (coordinator: Dr. R. Corrales, The Philippines), in the IOCARIBE Region (coordinator: Dr. A.B. Sanchez, Venezuela), and the EEC (proposed coordinator: IOC). Truly global networks might not be efficient and suitable for rapid communication, but was considered very important for all other kinds of communication. In global communication and dissemination of information it was agreed that Harmful Algae News is an appropriate mechanism. At the national and regional level E-mail and fax were considered as effective means of communication.

74 **The Panel recommended** regional networks to be established in the context of and in association with IOC Regional subsidiary Bodies where networks are not already established.

7.7 FACT SHEETS ON TOXINS

75 The preparation, distribution and maintenance of fact sheets for administrators, the medical community and the general public (Annex VI: HAB Programme Plan, 6.1.1, vi) was thoroughly discussed. In particular the question of how efficiently, and with what kind of information, the medical community could be reached caused concern. The appropriate dissemination of the right information to the right people should be carefully evaluated to avoid misfortunate and panic situations.

76 **The Panel concluded** that the problem of phycotoxins as related to human health, should be addressed to JECFA (FAO/WHO Joint Expert Committee on Food Additives (see items 6.1 and 7.16, and Annex IX) for consideration. **The Panel decided** to approach WHO/IPCS and/or the Codex Alimentarius Commission, to initiate a process for a JECFA evaluation of aquatic phycotoxins.

7.8 DISTRIBUTION OF REFERENCE BOOKS AND PROCEEDINGS

77 The Panel was requested to advise on how literature could be made available to research and management institutions in developing countries (HAB Programme Plan 6.1.1, vii). To the extent possible the HAB Programme Office will endeavor to negotiate discount prices with relevant publishers. As an example IOC has obtained a discount price on the Proceeding of the 6th International Conference on Toxic Marine Phytoplankton. The Representative of IUPAC Dr. J.M. Fremy (CNEVA, France) offered that copies of the Proceedings of the Symposium on Marine Biotoxins, Paris, January 1991, could be made available to the Programme Office for distribution to appropriate institutions in developing countries. It was suggested to announce the availability of the Proceedings in Harmful Algae News. The Chairperson encouraged ICES to provide its relevant publications, via the HAB Programme Office, free of charge to relevant institutions in developing countries.

78 **The Panel urged** its Members to bear in mind the provision of free of charge copies of relevant publications whenever they have a chance to facilitate such an arrangement.

TRAINING

7.9 HAB TRAINING AND CAPACITY BUILDING PROGRAMME

79 Based on the recommendations of the BMTC-IOC-POLARMAR International Workshop on Training Requirements in the Fields of 'Eutrophication in Semi-enclosed Seas' and 'Harmful Algal Blooms'(see item 4.10), the recommendations of the IOCARIBE Workshop on Red Tides and Mass Mortality of Marine Organisms (see item 4.11), and the results of the IOC survey on resources and needs in relation to HAB research and training in Member States, **the Panel recognized** the strong need for and appropriateness of developing a comprehensive training and capacity building programme on harmful algae.

80 **The Panel agreed** that a 'HAB Training and Capacity Building Programme' be prepared based on the recommendations of the Panel and Document IOC-FAO/IPHAB-II/Inf.6 (Inf.6 is a draft 'HAB Training and Capacity Building Programme' with commitments or potential commitments listed). During the discussion of training activities already proposed (see below) several Member States offered to support or to investigate their possibilities to support specific training courses or workshops. Japan will support several activities in the WESTPAC Region and Spain will investigate possibilities for cooperation in the IOCARIBE Region based on the Recommendations of the IOCARIBE Cumana Workshop (item 4.11).

81 As one of the organizers Dr. A. Zingone (Italy) reported on a series of training courses on phytoplankton taxonomy, which have been held over a number of years in Naples with the support of the former UNESCO Division of Marine Sciences (now a part of the unified marine science programme of UNESCO; the Intergovernmental Oceanographic Commission and Marine Related Issues, IOC/MRI). A course in this series is planned for 1994 or 95. **The Panel welcomed** this information and **urged** that this be organized within the framework of the HAB Programme.

82 **The Panel adopted Recommendation IPHAB-II.2.**

SCIENTIFIC PROGRAMME ELEMENTS

7.10 SCIENCE PROGRAMME IMPLEMENTATION

83 **The Panel recognized** that an international HAB research programme can develop only through the coalescence of complementary national or regional planning and implementation/activities and the provision of national or regional funding. **The Panel recommended** that participating nations actively initiate and implement specific science planning workshops, specifically on HAB, in their countries and work with their national funding agencies to identify and allocate resources. This planning, while national, should be articulated in such a way as to identify <u>when</u> and <u>why</u> multi-national and international efforts are desirable to meet the needs of both the science, policy, economics and management issues related to harmful algae. Some indication of the probability for success should be given as well as an indication of the relevance and usefulness of the results. These planning activities should be initiated with an eye towards integration with those of other countries and those of international organizations (IOC, ICES, SCOR, etc). The nature of bi/multi/international participation in national programs should be part of the national planning activities, both with regard to cross-developed world and developed-developing country cooperation. Also the national plans should elaborate on the mechanisms for accessing resources for international cooperation within their countries (aid-type resources) and how those resources can be used for the implementation of the plans.

84 These national or regional science planning workshops are needed from developed as well as developing countries where expertise and experience are insufficient for countries or regions to undertake such activities above, **the Panel and the HAB Programme Office will provide guidance and assistance as necessary.**

85 **The Panel recommended** that the Secretary IOC meet with representatives of regional funding agencies to communicate the need for priority status for HAB research proposals including those emerging from the ICES-IOC and SCOR-IOC Working Groups. **The Panel adopted Recommendation IPHAB-II.3.**

ECOLOGY
and
OCEANOGRAPHY

7.11 ICES-IOC WORKING GROUP ON HARMFUL ALGAL BLOOM DYNAMICS

86 **The Panel stressed** the importance of the activities proposed by the ICES Working Group on Harmful Algal Bloom Dynamics. With reference to the Terms of Reference of the Working Group, and the invitation from ICES to IOC to co-sponsor the WG **the Panel recommended** that IOC accept the invitation to co-sponsor the WG and the activities planned for 1994. **The Panel noted** that the co-sponsorship of IOC could allow scientists outside the ICES area to participate in the planned activities.

7.12 TRANSFER OF HARMFUL ALGAL SPECIES VIA BALLAST WATER

87 Most international bulk carriers transport cargo in one direction only, and use water as ballast when empty. Over one hundred different species of animals and plants have been found in ballast tanks of ships. **The Panel recognized** that the problem of transfer of harmful algae via ballast water was of major concern. The International Maritime Organization (IMO) and ICES (WG on Introductions and Transfers of Marine Organisms) are already addressing the problem.

88 **The Panel requested** the Chairperson and the HAB Programme Office to further investigate the possibilities and need for interaction with, or support to, the activities of IMO and ICES, and to report back at the Third Session of the Panel.

7.13 LONG-TERM TREND MONITORING OF CHANGES IN PHYTOPLANKTON SPECIES COMPOSITION OVER DECADEL TIME-SCALES

89 The proposed expansion of the Continuous Plankton Recorder (CPR) to coastal routes will increase the value of CPR data in the evaluation of long term trends in the occurrence of harmful algal events. **The Panel stressed** the need for the CPR to be developed or complemented to monitor dinoflagellates more efficiently.

90 **The Panel urged** Member States and relevant organizations to support the CPR.

7.14 FOLLOW-UP TO UNCED: ROLE OF UV-RADIATION

91 The importance of UV-radiation to species succession and population dynamics of phytoplankton was discussed (see also item 6.2) also in relation to the question in this respect raised by UNCED (Agenda 21, Chapter 17). Several Panel Members doubted whether UV is an important factor in the regulation of growth and occurrence of phytoplankton. It was noted that so far only few scientific papers have thoroughly dealt with the question and that the role of UV therefore is not yet well documented. **The Panel agreed** that it would be desirable to review the state of knowledge in order to confirm or refute the arguments currently used in semi-scientific or popular contexts, and to identify appropriate research to clarify the role of UV in relation the occurrence of harmful algae, e.g. through a small workshop as a follow-up to UNCED.

92 **The Panel recommended** that the question also be addressed by the SCOR-IOC Working Group 97 on the Physiological Ecology of Harmful Algal Blooms.

TAXONOMY
and
GENETICS

7.15 TASK TEAM ON TAXONOMY OF HARMFUL ALGAE

93 Recently the number of manuals and reference books on (harmful) phytoplankton taxonomy has been increasing (e.g.: Marine Phytoplankton, C.R. Thomas ed., 1993; Red Tide Organisms in Japan, Y. Fukuyo ed., 1990; ICES Identification Sheets) and the IOC Manual on Harmful Marine Phytoplankton is on its way (see item 4.6). **The Panel recognized** that there is a need to help coordinate the various efforts, to avoid overlap, to make taxonomic recommendations, and to develop identification standards for preparation of manuals, reference materials and training standards. **The Panel decided**, with reference to the HAB Programme Plan, objective 6.2.2, ii, to establish a Task Team to make taxonomic recommendations.

94 **The Panel invited** Prof. O. Moestrup to take the lead of the Task Team, assisted by Dr. Y. Fukuyo and Dr. M. Elbraechter. Prof. Moestrup accepted the invitation and proposed that the activities of the Task Team should wait until the HAB Centre in Copenhagen is established. **The Panel adopted** Resolution IPHAB-II.1.

7.16 COMPUTERIZED TAXONOMIC DATA BASES OF HARMFUL SPECIES

95 At the past workshops on the development of a global HAB programme (Takamatzu, Paris, Newport) the need for computerized taxonomic data bases has been listed as a priority. **The Panel encouraged** the efforts of the Expert Centre on Taxonomic Identification (ETI), Amsterdam, to develop a computerized taxonomic data base of harmful phytoplankton species. The data base is being developed as a Linnaeus II programme in cooperation with the Botanical Institute, University of Copenhagen.

96 **The Panel instructed** the IOC/MRI Representative on the ETI Board to actively support the development of the programme.

TOXICOLOGY
and
TOXIN CHEMISTRY

7.17 TASK TEAM ON AQUATIC BIOTOXINS

97 A Task Team was formed to initiate, catalyze and activate interaction between relevant organizations and Member States with interest in the chemistry and toxicology of algal toxins. The Task Team will function as a forum for coordination and interaction in particular between WHO, IUPAC, GIPME (GEEP, GESREM, GEMSI), and the HAB Programme. Other important organizations in this context, such as the Community Bureau of Reference of the EEC and the International Society for Toxicology, will be invited to participate. The Task Team will endeavor to facilitate the preparation and supply of toxins and reference material. The Task Team will establish a communication network (fax and e-mail) and produce a document on the current status of algal toxin chemistry and toxicology. Dr. R. Kifer (USA) offered to support the Task Team to develop the current status documents during the intersessional period. Dr. Plestina (IPCS-WHO) indicated an interest in joint publication of documents. The Task Team will work intersessionally by correspondence and meet on an opportunistic basis.

98 **The Panel adopted** Resolution IPHAB-II.2. **The Panel noted** that the participation of a FAO expert on biotoxins in food would be useful.

7.18 AVAILABILITY OF MARINE BIOTOXIN STANDARDS AND REFERENCE MATERIALS TO DEVELOPING COUNTRIES

99 Marine biotoxin standards are essential for the protection of human health with respect to the effects of harmful algae on fisheries and shellfish aquaculture. Many developing countries rely heavily upon this food source, and have an increasing need for materials and standards. Currently, some standards are made available without charge to developing countries upon request to the U.S.A. and Japan. However, recent developments by the National Research Council (NRC) of Canada have greatly increased the quantity and availability of such materials. Unfortunately, the NRC is obliged to charge for all of its materials on a cost-recovery basis.

100 **The Panel considered** it to be of highest priority to facilitate the provision of toxin standards and reference material to developing countries in addition to training in methods of chemical analysis of phycotoxins. **The Panel urged** Canada to provide its toxin standards and reference materials to developing countries. The Representative of Canada expressed his willingness to make an effort in this respect. **The Panel adopted Recommendation IPHAB-II.4.**

OPERATIONAL PROGRAMME ELEMENTS

MONITORING

7.19 DESIGN AND IMPLEMENTATION OF MONITORING OF HARMFUL ALGAE

101 A chapter in the IOC Manual on Harmful Marine Phytoplankton (see 4.6) will address management and monitoring in relation to harmful algae. However, the management chapter will only be one of several chapters and the space available will therefore be limited. In order to provide a more comprehensive source of information and guidance on design and implementation of monitoring programmes it was suggested that an IOC report be prepared in which examples of monitoring systems from all over the world are presented in detail. The report would be a source of inspiration to designers of future and current monitoring systems. The report could be followed-up by an international workshop on the topic.

102 **The Panel recommended** that a report on monitoring systems on harmful algae be prepared and also **recommends** that the report be followed-up by an international workshop. The workshop should be directed towards improved design of monitoring programmes in order to protect resources. **The Panel noted** that the proposed workshop would be a part of the HAB Training and Capacity Building Programme (see 7.9).

103 **The Panel decided** to establish a Task Team on Management and Monitoring to help facilitate the report and the workshop. The Task Team should be activated upon request from the Secretary IOC. **The Panel invited** Norway to take the lead of the Task Team. **The Panel adopted Resolution IPHAB-II.3.**

7.20 LINKAGE BETWEEN GOOS AND THE HARMFUL ALGAE BLOOM PROGRAMME

104 **The Panel stressed** that monitoring of the occurrence of harmful algae should be seen as an integrated element in the Global Ocean Observing System (GOOS), and that this should be remembered when designing and implementing national monitoring programmes which will link to GOOS.

105 **The Panel agreed** that HAB monitoring programmes should be developed through GOOS and it is therefore very important to establish close links with the GOOS bodies, particularly those dealing with design and planning of the modules on Assessment and Prediction of the Health of the Ocean and the Monitoring and Assessment of Marine Living Resources.

106 **The Panel requested** its Chairperson to communicate with the Chairperson on IOC Committee of the GOOS and, particularly, with the GOOS Panels on Health of the Ocean and Marine Living Resources on the possible ways of interaction between HAB and GOOS.

107 **The Panel also agreed** that close collaboration will be required with GOOS in supporting continuation and expansion of CPR survey recommended for use within the IOC-UNEP-WMO Pilot Monitoring Activity on plankton structure in the coastal waters.

PUBLIC HEALTH
and
SEAFOOD SAFETY

7.21 PROTECTION OF PUBLIC HEALTH

108 **The Panel concluded** that the problem of phycotoxins as related to human health, should be addressed to JECFA (FAO/WHO Joint Expert Committee on Food Additives (see 6.1, 7.7, 7.15, and Annex IX) for consideration. **The Panel decided** to approach WHO/IPCS and/or the Codex Alimentarius Commission, to initiate a process for a JECFA evaluation of aquatic phycotoxins.

8. COORDINATION AND COOPERATION IN SOUTH EAST ASIA

109 Several intergovernmental and multi- and bilateral HAB activities are planned and are in different stages of implementation in the southeast Asian region. Examples are activities within the IOC Subcommission for the Western Pacific Ocean (WESTPAC), the ASEAN-Canada Cooperative Programme on Marine Science (see National Statement Canada), the China-USA (NSF) Cooperative Programme, scientific surveys supported by the Japanese Ministry of Education, Culture and Science, and a bi-lateral scientist exchange programme of Japan (JSPS). There is obviously a potential and a need for collaboration to minimize duplication of efforts.

110 **The Panel recommended** that the IOC endeavor to send a representative to relevant workshops of the donors and recipients of the above mentioned programs (WESTPAC, APEC, CIDA/ASEAN) in order to match objectives, synchronize and compare action plans, and identify equipment and training needs.

111 **The Panel also recommended** that Panel Members identify and communicate with their national contact persons for APEC to reinforce the need for the APEC harmful algae projects and the necessity that it be designed to complement other programs in the region. **The Panel adopted** Recommendation IPHAB-II.5.

9. FUNDING

112 It was considered that the need for more resources is most pronounced in developing countries and that developed countries in many cases could assist in filling these needs. On-going activities in ICES, SCOR and other GO's and NGO's could be of great help if extended to contain direct assistance to developing countries, and it was noted with satisfaction that IOC and FAO would do their best to facilitate resource transfer through their sub-programmes and their joint activities with other organizations. It was also pointed out that experience within WESTPAC could be of great help when planning activities in other regions and especially those including developing countries.

113 Since the problem of harmful algae is global, with local implications, it is suitable for Global Environment Facility (GEF) funding. A programme proposal should be prepared on basis of the IOC-FAO Harmful Algal Bloom Programme and Panel Members should help obtain support in their governments for the proposal through their national focal points for GEF.

114 The IOC and FAO Secretariats were asked to look more specifically into these matters in the intersessional period and in particular to investigate how resources could be transferred from developed to developing countries.

115 **The Panel recognized** that multilateral aid agencies such as UNDP and GEF could be a significant source of support for HAB training and capacity building in developing countries. **The Panel noted** that the IOC and FAO Secretariats have access to agencies, individuals, and programmes that are relevant to the HAB Programme, but require the specific knowledge of experts to design and articulate proposals. **The Panel decided**

that a Task Team be formed to work with the HAB Programme Office and the involved Governments to prepare and submit proposals to appropriate agencies. **The Panel adopted** Resolution IPHAB-II.4.

10. OPERATION OF THE IOC-FAO INTERGOVERNMENTAL PANEL ON HAB

116 **The Panel decided** to continue its activities intersessionally under the co-ordination of the Chairperson. Dr. B. Dybern, Sweden, was reelected as Chairperson.

117 **The Panel agreed** that the next Session should be held in October-November 1994. **The Panel adopted** Recommendation IPHAB-II.6.

11. ADOPTION OF RESOLUTIONS AND RECOMMENDATIONS

118 **The Panel adopted** a set of resolutions and recommendations which summarized the findings of the Second Session of the IOC-FAO Intergovernmental Panel on Harmful Algal Blooms, Paris, 14-16 October 1993. The Resolutions and Recommendations are included as Annex II.

119 **The Panel requested** the Chairperson to present the Summary Report, Resolutions and Recommendations to the Twenty-seventh Session of the IOC Executive Council, planned for 5 to 13 July 1994, in Paris.

12. CLOSURE

120 In his concluding remarks, the Chairperson thanked the Members of the Panel for their active involvement and participation. He noted with content that more Member States had been present that at the First Session of the Panel in June 1992. Nevertheless, the Chairperson expressed the hope that there would be even more participants for the Third Session, in particular representatives covering management issues. He recalled the need for support to secure participation from developing countries. He also noted with satisfaction that the Panel is now taking action not the least through the formation of the four Task Teams.

121 The Chairperson thanked the IOC Secretariat for its efforts in developing the HAB Programme, and the Rapporteur for his support during the Session. The meeting stands adjourned until a date for the next Session has been communicated at the latest in connection with the Twenty-seventh Session of the IOC Executive Council, July 1994.

ANNEX I

AGENDA

1. **OPENING**

    1.1 OBJECTIVES OF THE IOC-FAO INTERGOVERNMENTAL PANEL ON HARMFUL ALGAL BLOOMS

2. **ADMINISTRATIVE ARRANGEMENTS**

    2.1 ADOPTION OF THE AGENDA
    2.2 DESIGNATION OF RAPPORTEUR

3. **SUMMARY DESCRIPTION OF THE HAB PROGRAMME : SCIENCE BACKGROUND AND GOALS**

4. **HAB PROGRAMME DEVELOPMENTS IN THE INTERSESSIONAL PERIOD**

5. **NATIONAL STATEMENTS**

6. **HAB PROGRAMME INTERACTION**

    6.1 INTERACTION WITH OTHER ORGANIZATIONS
    6.2 INTERACTION WITH OTHER IOC PROGRAMMES
    6.3 IOC FOLLOW-UP TO UNCED

7. **SETTING OF PRIORITIES, IDENTIFICATION OF RESOURCES, ACTION TO BE TAKEN, AND RELEVANT INTERACTION WITH OTHER PROGRAMMES AND ORGANIZATIONS**

8. **COORDINATION AND COOPERATION IN SOUTH EAST ASIA**

9. **FUNDING**

10. **OPERATION OF THE IOC-FAO INTERGOVERNMENTAL PANEL ON HAB**

11. **ANY OTHER BUSINESS**

12. **ADOPTION OF RESOLUTIONS AND RECOMMENDATIONS**

13. **CLOSURE**

ANNEX II

RESOLUTIONS AND RECOMMENDATIONS

Code	Title
	Resolutions
Resolution IPHAB-II.1	Task Team on Algal Taxonomy
Resolution IPHAB-II.2	Task Team on Aquatic Biotoxins
Resolution IPHAB-II.3	Task Team on Design and Implementation of HAB Monitoring Programmes
Resolution IPHAB-II.4	Task Team on HAB Project Development
	Recommendations
Recommendation IPHAB-II.1	Staffing of the HAB Programme Office
Recommendation IPHAB-II.2	HAB Training and Capacity Building Programme
Recommendation IPHAB-II.3	HAB Science Programme Implementation
Recommendation IPHAB-II.4	Availability of Toxin Standards to Developing Countries
Recommendation IPHAB-II.5	HAB Cooperation in South East Asia
Recommendation IPHAB-II.6	Operation of the Panel

Resolution IPHAB-II.1

TASK TEAM ON ALGAL TAXONOMY

The IOC-FAO Intergovernmental Panel on Harmful Algal Blooms,

Recognizing the growing need to help coordinate the various efforts of organizations and institutions in relation to harmful algal taxonomy,

Considering the increasing number of publications on algal taxonomy,

Decides, with reference to the HAB Programme Plan, objective 6.2.2, ii (Annex V), to establish an *ad hoc* Task Team to initiate, catalyze and activate interaction between organizations and institutions which have activities concerning taxonomy of harmful algae and to make taxonomic recommendations, with the Terms of Reference to:

(i) establish a communication network (eg. by fax or e-mail);

(ii) make taxonomic recommendations;

(iii) develop identification standards for preparation of manuals, reference materials and training standards;

(iv) help avoid overlap of activities;

(v) prepare a progress report to be submitted to IPHAB-III;

Decides also that the *ad hoc* Task Team will be composed of: Prof. O. Moestrup (Denmark) Chairperson, Dr. M. Elbrachter (Germany), Dr. Y. Fukuyo (Japan), Dr. A. Zingone (Italy),

Invites Member States with special interest in harmful algal taxonomy to propose an expert to participate in the activities of the Task Team;

Notes that the Task Team will work by correspondence and will meet on an opportunistic basis. The HAB Programme Office (IOC) will inform Task Team members of meeting possibilities. Costs related to meetings will not be covered by the IOC.

Resolution IPHAB-II.2

TASK TEAM ON AQUATIC BIOTOXINS

The IOC-FAO Intergovernmental Panel on Harmful Algal Blooms,

Considering the growing need for aquatic biotoxin reference materials and standards,

Decides to establish an *ad hoc* Task Team to initiate, catalyze and activate interaction between organizations which have activities concerning toxin chemistry and toxicology with respect to toxic marine phytoplankton, with the Terms of Reference to:

(i) establish a communication network (eg. by fax) and produce a document on the current status of algal toxin chemistry and toxicology;

(ii) facilitate the isolation, identification and/or elucidation of the structures of toxins; the preparation and supply toxins and reference materials; the development of new analytical methods for toxins, specifically (a) alternative assay methods to replace tests such as mouse and other bioassay organisms, while improving the sensitivity, specificity and reproductibility of all methods; and (b) simple field assay kits;

(iii) help define the fate and effects of algal toxins in the marine food web; elucidate mechanisms of toxicity to human health; determine the mechanisms responsible for the adverse reactions in fish and other marine organisms caused by toxic substances;

(iv) advice on how to reduce risks to humans due to exposure to the toxins through consumption of seafood or direct contact;

(v) prepare a progress report to be submitted to IPHAB-III;

Decides also that the *ad hoc* Task Team will be composed of: Dr. Y. Yasumoto (Japan; IUPAC) Chairperson, Dr. D. Park (IUPAC) Co-Chairperson, Dr. R.K. Boyd (GESREM), Dr. R. Dawson (GEMSI), Dr. J.M. Frémy (IUPAC), Dr. R. Kifer (USA), Dr. M. Moore (GEEP), Dr. R. Plestina (WHO), Dr. H. Ravn (IOC);

Invites Member States with special interest in aquatic biotoxins, FAO, BCR (EEC), and IST to propose each an expert to participate in the activities of the Task Team;

Notes the the Task Team will work by correspondence and will meet on an opportunistic basis. The HAB Programme Office (IOC) will inform Task Team members of meeting possibilities. Costs related to meetings will not be covered by the IOC.

Resolution IPHAB-II.3

TASK TEAM ON DESIGN AND IMPLEMENTATION OF HAB MONITORING PROGRAMMES

The IOC-FAO Intergovernmental Panel on Harmful Algal Blooms,

Recognizing the need for a comprehensive source of information and guidance on design and implementation of monitoring programmes as a source of inspiration to designers of future and improved monitoring systems,

Decides to establish an *ad hoc* Task Team to initiate, catalyze and activate interaction between organizations and institutions which have activities concerning management and monitoring, with the Terms of Reference to:

(i) establish a communication network (eg. by fax and e-mail);

(ii) prepare a report where examples of monitoring systems on harmful algae from all over the world are presented in detail;

(iii) assist in the organization of an international workshop directed towards improved design of monitoring programmes in order to protect resources;

(v) prepare a progress report to be submitted to IPHAB-III;

Invites Norway to chair the *ad hoc* Task Team,

Invites further Member States with special interest in design and implementation of monitoring programmes

on harmful algae to propose each an expert to participate in the activities of the Task Team;

Notes that the Task Team will be activated upon request from the Secretary IOC and the HAB Programme Office. It will work by correspondence and will meet on an opportunistic basis. The HAB Programme Office (IOC) will inform Task Team members of meeting possibilities. Costs related to meetings will not be covered by the IOC.

Resolution IPHAB-II.4

TASK TEAM ON HAB PROJECT DEVELOPMENT

The IOC-FAO Intergovernmental Panel on Harmful Algal Blooms,

Recognizing that the need for more resources is most pronounced in developing countries and that developed countries in many cases could assist in filling these needs,

Noting that on-going activities in ICES, SCOR and other NGO's and GO's could be of great help if extended to contain direct assistance to developing countries,

Recognizing that multi lateral aid agencies such as UNDP and the Global Environment Facility (GEF) could be a significant source of support for HAB training and capacity building in developing countries,

Noting that the IOC and FAO Secretariats have access to agencies, individuals, and programmes that are relevant to the HAB Programme, but require the specific knowledge of experts to design and articulate proposals,

Decides to establish an *ad hoc* Task Team to work with the HAB Programme Office to prepare and submit proposals to appropriate agencies, with the Terms of Reference to:

(i) establish a communication network (eg. by fax and e-mail);

(ii) prepare a programme proposal(s) on basis of the IOC-FAO Harmful Algal Bloom Programme;

(iii) with the assistance of Panel Members obtain support in their governments for the proposal through their national focal points for GEF;

(iv) prepare a progress report to be submitted to IPHAB-III;

Decides also that the *ad hoc* Task Team will be composed of: Dr. D.M. Anderson (USA) Chairperson, Dr. B. I. Dybern (Sweden), and Ms. B. Reguera (Spain);

Invites Member States with special interest to propose each an expert to participate in the activities of the Task Team;

Notes that the Task Team will work by correspondence and will meet on an opportunistic bas's. The HAB Programme Office (IOC) will inform Task Team members of meeting possibilities. Costs related to meetings will not be covered by the IOC.

Recommendation IPHAB-II.1

STAFFING OF THE HAB PROGRAMME OFFICE

The IOC-FAO Intergovernmental Panel on Harmful Algal Blooms,

Recalling the Terms of Reference for the HAB Programme Office (IOC-FAO/IPHAB-I/3 Annex VII) and the level of staffing recommended,

Recognizing the importance of the secondment by Denmark and USA of staff with respect to the development and implementation of the HAB Programme,

Recognizing the continued need for staff to coordinate and help implement the Programme,

Noting that three types of staff can be seconded to the HAB Programme office by Member States:

(i) direct secondment of junior and senior professionals

(ii) secondment of Associate Experts through the UNESCO Associate Experts Scheme (usually young people)

(iii) support for M.sc., Ph.d, or Ph.d. students to work as Interns at the Programme Office at the IOC secretariat for a 3-6 month period (Interns are provided with a contract but only a symbolic salary),

Encourages strongly Member States to second staff members to the HAB Programme Office;

Urges the Secretary IOC to pursue the secondment of a Senior Technical Secretary for the HAB Programme and/or a Senior Assistant Secretary for OSLR.

Recommendation IPHAB-II.2

HAB TRAINING AND CAPACITY BUILDING PROGRAMME

The IOC-FAO Intergovernmental Panel on Harmful Algal Blooms,

Having reviewed the recommendations of the BMTC-IOC-POLARMAR International Workshop on Training Requirements in the Fields of 'Eutrophication in Semi-enclosed Seas' and 'Harmful Algal Blooms', the recommendations of the IOCARIBE Workshop on Red Tides and Mass Mortality of Marine Organisms, and the results of the IOC survey on resources and needs in relation to HAB research and training in Member States,

Recognizing the strong need for and appropriateness of developing a comprehensive training and capacity building programme on harmful algae,

Recommends that a 'HAB Training and Capacity Building Programme' be prepared and implemented based on the recommendations of the Panel and Document IOC-FAO/IPHAB-II/Inf.6;

Recommends further that:

(i) all HAB related training and capacity building activities should be implemented after thorough assessment of capabilities of the trainers and their facilities;

(ii) selection of applicants should be done in consultation with the IOC and/or FAO Secretariats and the respective Member States;

(iii) the Training Programme include regional courses on various topics and regional aspects, taking into account the knowledge and capabilities of the participants;

(iv) the Training Programme include specialized courses in specialized laboratories with the view to train future trainers;

(v) the Training Programme include individual training supported through fellow-ships and grants (IOC-UNESCO and bi-lateral) which will allow individuals from developing countries to work for a period at relevant advanced laboratories;

Urges Member States to assist in the identification of resources for the implementation of the 'HAB Training and Capacity Building Programme'.

Recommendation IPHAB-II.3

HAB SCIENCE PROGRAMME IMPLEMENTATION

The IOC-FAO Intergovernmental Panel on Harmful Algal Blooms,

Recalling that the Scientific Programme Elements of the HAB Programme are based on the needs of Member States,

Recognizing that an international HAB research programme can develop only through the coalescence of complementary national or regional planning activities and implementation with the provision of national or regional funding,

Noting that national or regional science planning workshops, specifically on HAB, are needed from developed as well as developing countries where expertise and experience are insufficient for countries or regions to undertake activities,

Recommends that participating Member States actively initiate and implement such HAB science planning research workshops in their countries and work with their national funding agencies to identify and allocate resources;

Recommends further that these workshops:

(i) identify when and why multi-national and international efforts are required to meet the needs of both science and policy, economics and management to solve issues related to harmful algae,

(ii) indicate the probability for success, as well as the relevance and usefulness of the results,

(iii) plan and initiate activities with an eye towards integration with those of other countries and those of international organizations (IOC, ICES, SCOR, EEC, etc) in such a way that bi/multi/international participation in national programs becomes part of the national planning activities, both with regard to cross-developed world and developed-developing country cooperation,

(iv) assure that the national plans elaborate on the mechanisms for accessing resources for international cooperation within their countries (aid-type resources) and how those resources can be used for the implementation of the plans;

Requests the Panel Members and the HAB Programme Office to provide guidance and assistance as necessary;

Recommends further that the Secretary IOC meet with appropriate representatives of regional and international funding agencies to communicate the need for priority status for HAB research proposals including those emerging from the ICES-IOC and SCOR-IOC Working Groups.

Recommendation IPHAB-II.4

AVAILABILITY OF TOXIN STANDARDS TO DEVELOPING COUNTRIES

The IOC-FAO Intergovernmental Panel on Harmful Algal Blooms,

Recognizing that marine toxin standards and reference materials are essential for the protection of human health with respect to the effects of harmful algae on shellfish aquaculture,

Noting that many developing countries rely heavily upon shellfish as food source, and have an increasing need for toxin materials and standards,

Noting further that currently, some standards and reference materials are made available without charge to developing countries by the U.S.A. and Japan,

Acknowledging with appreciation that recent developments by the National Research Council (NRC) of Canada have greatly increased the availability of such materials,

Being aware of that the NRC is obliged to charge for all of its materials on a cost-recovery basis,

Acknowledging that Canada has a commendable record in assisting developing countries gain expertise in the biological aspects of harmful algal blooms,

Recommends that:

(i) the National Research Council Canada be approached through GIPME-GESREM with a view to finding a mechanism whereby the Canadian materials can be made available to developing countries;

(ii) other Canadian government agencies, such as the Canadian International Development Agency (CIDA) and similar development agencies in other Member States, be approached with a view to extend the present assistance with provision for standards and reference materials in addition to training in methods of chemical analysis of phycotoxins.

Recommendation IPHAB-II.5

HAB COOPERATION IN SOUTH EAST ASIA

The IOC-FAO Intergovernmental Panel on Harmful Algal Blooms,

Noting that several intergovernmental and multi- and bilateral HAB activities are planned and are in different stages of implementation in the southeast Asian region,

Recognizing that there is an obvious potential for collaboration to minimize duplication of efforts,

Recommends that the IOC Secretariat sends, if appropriate through the IOC Sub-Commission for the western Pacific (WESTPAC), a representative to workshops of the donors and recipients of such programs (APEC, CIDA-ASEAN) to:

(i) match objectives

(ii) synchronize and compare action plans

(iii) identify equipment and training needs;

Urges Member States to identify contact points;

Recommends further that Panel Members identify and communicate with their national contact persons for APEC to reinforce the need for the APEC red tide/toxic algae project and the necessity that it be designed to complement other programs in the region.

Recommendation IPHAB-II.6

OPERATION OF THE IOC-FAO INTERGOVERNMENTAL PANEL ON HARMFUL ALGAL BLOOMS

The IOC-FAO Intergovernmental Panel on Harmful Algal Blooms,

Recommends that the Joint IOC-FAO Intergovernmental Panel on HAB continue its work until otherwise decided by IOC and FAO. The Terms of Reference should remain unchanged.

ANNEX III

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ANNEX IV

TERMS OF REFERENCE OF THE *Ah hoc* IOC-FAO INTERGOVERNMENTAL PANEL ON HARMFUL ALGAL BLOOMS

The IOC Assembly, at its Sixteenth Session, Paris 7-21 March 1991, adopted the following resolution with respect to the formation of an *Ad hoc* Intergovernmental Panel on Harmful Algal Blooms in order to identify adequate resources for a sufficiently broad programme to solve some of the real problems caused by algal blooms;

Resolution XVI-4

AD HOC INTERGOVERNMENTAL PANEL ON HARMFUL ALGAL BLOOMS

The Intergovernmental Oceanographic Commission,

Recalling that the IOC, at the Fourteenth Session of its Assembly, endorsed the development of the sub-programme on Harmful Algal Blooms, and that the Twenty-third Executive Council, through its Resolution EC-XXIII.1, endorsed the programme development so far,

Being aware of the increasing socio-economic risks posed by toxic algae and harmful algal blooms to marine organisms, fisheries, aquaculture, human health and the coastal environment,

Approves the formation of an *Ad hoc* Intergovernmental Panel on Harmful Algal Blooms, with the Terms of Reference shown in the Annex hereto;

Invites FAO to co-sponsor the *Ad hoc* Panel;

Invites Member States which intend to be involved in the implementation of a programme on Harmful Algal Blooms to nominate their representatives for the *Ad hoc* Panel and inform the Secretary IOC accordingly;

Decides to review, at the Seventeenth Session of the Assembly, the Terms of Reference of the *Ad hoc* Panel, in conjunction with the Commission's review of the overall organization of the OSLR Programme;

Instructs the Secretary to convene the First Session of the *Ad hoc* Panel as soon as possible.

Annex to Resolution XVI-4
Terms of Reference
of the *Ad hoc* Intergovernmental Panel on Harmful Algal Blooms

1. FUNCTIONS

The *Ad hoc* Intergovernmental Panel on Harmful Algal Blooms is established to meet the scientific, managerial, implementation, and resource needs of the Harmful Algal Blooms Programme.

The Panel will carry out the following functions:

1.1 Review and identify programme requirements;

1.2 Promote efficient and cost-effective implementation of the HAB programme and prepare recommendations on this implementation to the Assembly and Executive Council;

1.3 Identify the resources necessary to meet HAB programme needs;

1.4 Ensure effective interaction and communication with regional intergovernmental (e.g., ICES, ICSEM and GFCM) as well as regional and global non-governmental (e.g., SCOR) organizations involved in research on toxic algae and harmful algal blooms; and

1.5 Report to the Twenty-fifth Session of the Executive Council and the Seventeenth Session of the Assembly.

2. COMPOSITION

The membership of the *Ad hoc* Panel is open to Member States of IOC (and FAO, if it agrees to co-sponsor the Panel) which have declared to the Secretary IOC their involvement or intention to participate in the development and implementation of the Harmful Algal Bloom Programme on a global, regional, or national scale. The Panel shall include the Chairman of the OSLR Guiding Group of Experts, representatives of IOC regional and other subsidiary bodies, and of other interested international organizations, particularly SCOR. Invitations to participate in Panel activities may be extended to scientific experts at the request of the Panel and with the approval of the Secretary of the IOC.

3. ORGANIZATION OF THE SESSIONS

3.1 The Panel will, prior to the closure of each Session, elect from its members a Chairman who will serve in that capacity until the closure of the next Session.

3.2 The Sessions shall, in principle, be arranged without financial costs to IOC. Sessions will be conducted, documentation will be provided, and the report of each session will be prepared in English and in other working languages of the Commission as appropriate and required.

3.3 Secretariat support for the Panel will be provided by the Secretary IOC.

ANNEX V

IOC-FAO HARMFUL ALGAL BLOOM PROGRAMME PLAN

(Revised extract from IOC Workshop Report No. 80)

6.1. EDUCATIONAL PROGRAMME ELEMENTS

6.1.1 Information Network

Goal: To develop, encourage and maintain the flow of information, technology and expertise to scientists, administrators and the general public.

Objectives:

i) Produce a regular newsletter for reporting bloom occurrences, recent publications, meetings, new techniques, requests for assistance and general information.

ii) Prepare and publish a manual containing standardized methodology for the study of harmful algae (this book could be modelled after the UNESCO Phytoplankton Manual).

iii) Prepare identification sheets and reference slides for harmful species, preserved material and video documentation, updated as necessary.

iv) Compile lists of experts grouped according to areas of expertise, updated as necessary.

v) Ensure rapid communication of harmful events, new problem species, methodologies and other common information to researchers, administrators and medical personnel.

vi) Prepare, distribute and maintain fact sheets on toxin for administrators, the medical community and the general public.

vii) Facilitate worldwide distribution of reference books, conference proceedings and equipment.

viii) Ensure the distribution of material with respect to public safety and education.

6.1.2 Training

Goal: To promote and facilitate the development and implementation of appropriate training programmes in order to distribute the necessary knowledge and expertise on a global basis.

Objectives:

i) Facilitate workshops and training programmes on taxonomy, ecology, toxin extraction and analysis, management strategies, public health and safety and mitigation techniques.

ii) Promote access to equipment and the extensive training of selected individuals in regions that lack adequate facilities and properly trained personnel for toxin analysis.

6.2 SCIENTIFIC PROGRAMME ELEMENTS

6.2.1 Ecology and Oceanography

Goal: To understand the population dynamics of harmful algae.

Objectives:

i) Develop the necessary understanding of bloom dynamics of harmful algae, which includes the phases of bloom progression (excystment or bloom initiation, exponential growth, aggregation, toxicity, as well as death, grazing, encystment, sinking or dispersal) and the succession of phytoplankton species.

ii) Develop numerical models (and eventually reliable predictions) of toxic blooms based on hydrodynamic, chemical and biological principles as well as the unique hydrography, chemistry and plankton composition determined by regional research programmes.

iii) Determine the role of nutrients (total amounts and ratios) in the dynamics of harmful algal events; investigate the relative importance of natural versus anthropogenic sources.

iv) Elucidate the importance of human activities in the dispersal of certain harmful species (e.g., via ship ballast water; transfer of shellfish stocks).

v) Derive quantitative relationships among the biological, physical and chemical parameters with respect to the bloom-forming species which can be used in a local management context through predictive models and management strategies.

vi) Determine the ecological role of toxicity in the population dynamics of toxic species and the consequences of toxicity to living resources.

vii) Design appropriate experimental and field studies to develop the required understanding of the hydrography, ecology and oceanographic conditions controlling the population dynamics of harmful species.

viii) Determine the ecophysiological capabilities of causative species (K_ρ, v_{max}, allelopathic substances, grazer repellant, life-cycle strategies).

ix) Establish long-term trend monitoring stations to document changes in phytoplankton species composition and associated physical and chemical variables over decadal time-scales.

x) Develop studies on cyst assemblages to document the areal distribution of harmful, cyst-forming species in order to identify risk areas for harmful algal blooms.

xi) Encourage analysis of sediments, especially from anoxic basins, that can provide evidence (cysts, frustules, etc.) for the prior occurrence of harmful species in regions where recent introductions are suspected.

6.2.2 Taxonomy and Genetics

Goal: To establish the taxonomy and genetics of the causative organisms at the appropriate levels.

Objectives:

i) Develop and maintain the capability to recognize, characterize and identify harmful species by morphological criteria, including ultrastructural and phenotypic variability and also by different life stages such as resting cysts.

ii) Establish a group to make taxonomic recommendations and to develop identification standards for preparation of manuals, reference materials and training standards.

iii) Determine the genetic heterogeneity within species and isolates with respect to mating compatibility and molecular characteristics.

iv) Support existing and establish new regional culture collections specializing in harmful species and create a centralized international culture collection of harmful species.

v) Promote the development of new, rapid, automated identification, discrimination and counting techniques such as, image analysis, flow cytometry and immuno-labelling.

vi) Encourage and enable the development of computerized taxonomic data bases of harmful species.

vii) Organize and conduct intercalibration exercises.

6.2.3 Toxicology and Toxin Chemistry

Goal: To determine the physiological and biochemical mechanisms responsible for toxin production and accumulation and to evaluate the effect of phycotoxins on living organisms.

Objectives:

With respect to physiology:

i) Establish the biosynthetic pathways of toxin production in algae including defining the role of endo- or exocellular bacteria and viruses.

ii) Determine the physiological mechanisms underlying variable toxicity among strains of species or within single strains grown under different conditions.

iii) Define the toxin accumulation, chemical conversion and depuration processes in contaminated seafood.

iv) Determine the processes of toxin degradation.

With respect to chemistry:

v) Isolate, identify and/or elucidate the structure of toxins.

vi) Prepare and supply toxin standards and reference materials.

vii) Develop new chemical analytical methods for toxins, specifically:

1. alternative assay methods to replace such tests as mouse and other bioassay organisms, while improving the sensitivity, specificity and reproductibility of all methods; and

2. simple field assay kits.

With respect to toxicology:

viii) Define the fate and effects of algal toxins in the marine food web.

ix) Elucidate mechanisms of toxicity to marine animals.

x) Determine the mechanisms responsible for the mass mortalities of fish and other marine organisms caused by toxic substances.

xi) Establish pathological indicators to determine toxins responsible for mortalities and other impacts.

6.3 OPERATIONAL PROGRAMME ELEMENTS

6.3.1 Resource Protection

Goal: To develop and improve methods to minimize the environmental and economic consequences of Harmful Algae.

Objectives:

i) Assist managers in designing, evaluating and improving cost-effective procedures for selecting and protecting aquaculture sites; applying methods for early warning of toxicity and mass mortalities; and developing management strategies.

ii) Assist managers in applying scientific results as quickly and effectively as possible to resolve management, mitigation, public safety, public education and public relations problems.

iii) Assist managers in developing strategies and procedures for protecting the tourist and amenity value of coastal areas.

6.3.2 Monitoring

Goal: To promote and facilitate the development and implementation of appropriate monitoring programmes.

Objectives:

i) Provide a source of information and guidance on design and implementation of monitoring programmes.

ii) Interact with, and encourage, long-term regional, national and international monitoring plans and programmes to identify trends and cycles in the frequency of harmful algal blooms, their resulting toxicity for marine life, and suspected causes (e.g., climatological, hydrographical, or nutrient changes).

iii) Ensure the compatibility (e.g., techniques, type of data collected) of plankton and toxin monitoring programmes with basic studies of algal bloom dynamics and ecology.

6.3.3 Public Health and Seafood Safety

Goal: To protect public health and ensure seafood quality.

Objectives:

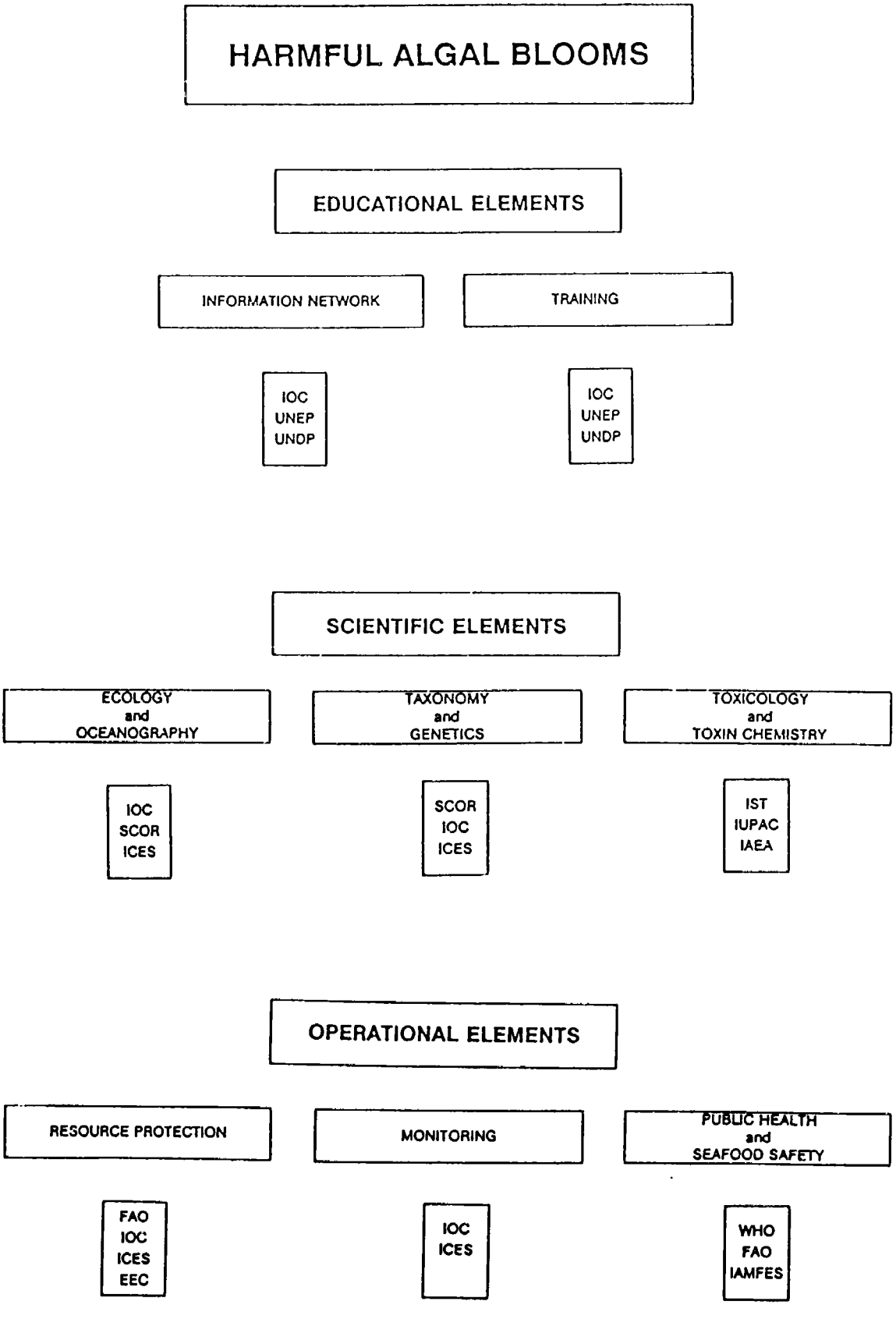
i) Facilitate monitoring for toxic species and seafood toxins.

ii) Encourage standardization of methods for toxin detection and levels for market closure.

iii) Facilitate testing of techniques for the mitigation of noxious blooms: (e.g., forced sedimentation, aeration, sea surface scum collection).

iv) Where appropriate, assist with measures to avoid or mitigate harmful events.

v) Develop antidotes against seafood toxins.


HARMFUL ALGAL BLOOMS
EDUCATIONAL ELEMENTS
INFORMATION NETWORK
TRAINING
IOC
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UNDP
SCIENTIFIC ELEMENTS
ECOLOGY
and
OCEANOGRAPHY
TAXONOMY
and
GENETICS
TOXICOLOGY
and
TOXIN CHEMISTRY
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RESOURCE PROTECTION
MONITORING
PUBLIC HEALTH
and
SEAFOOD SAFETY
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ANNEX VI

OPENING STATEMENTS

OPENING ADDRESS
by
Secretary IOC, G. Kullenberg

It gives me great pleasure to welcome all of you here to this 2nd Session of the IOC-FAO Intergovernmental Panel on Harmful Algal Blooms.

Harmful algal blooms often appear and develop in an as yet unpredictable way. There is a real need to investigate them in order to try and find ways of controlling their harmfulness and occurrence. Due to the size of the problems this can be achieved only through international cooperation.

The Intergovernmental Panel on Harmful Algal Blooms (IPHAB) was formed at the Sixteenth Session of the IOC Assembly, March 1991, in order to identify adequate resources for a broad programme to try and solve some of the problems caused by harmful algae. The Panel is co-sponsored by FAO, which we are pleased to have represented here today as a part of the Panel Secretariat. The Panel was formed after preliminary programme developments since the Fourteenth Assembly in 1987.

The Terms of Reference for this Panel were provided by the Sixteenth Session of the IOC Assembly, and retained by the Seventeenth Assembly in March 1993.

The HAB Programme Plan and proposals (Document IOC-FAO/IPHAB-I/3) were adopted by the Seventeenth Session of the IOC Assembly in February-March 1993 and many Delegates pointed out the importance of and urgency to adequately address the problem. In order to maintain momentum in the development of the programme the Assembly decided that the Second Session of the Panel should be convened as soon as possible.

The First Session adopted four recommendations, including: the programme, later adopted by the IOC Assembly; the establishment of a Programme Office, which has been done; the establishment of an IOC-FAO Group of Experts, which is an outstanding item; and, the continuation of the Panel, which is done.

The First Session of the Panel initiated the process, created awareness about the HAB Programme, and endorsed it. The Second Session, which starts today, should continue the process, but, hopefully, will also be able to ensure that the programme implementation rate can be maintained and even increased, so that more actions can be taken in the next intersessional period.

It has taken time and effort to plan an interdisciplinary and international programme on harmful algae. But now we have it,- and we should stick to it. We now have a programmatic framework for a broad variety of activities involving a number of other organizations and agencies, and for the time being staff at the Programme Office located in the IOC Secretariat to help with organizatorial matters and implementation. To become a success the HAB Programme, as all international programmes, basically must be driven through the interest, commitment and active participation of Member States and their dedicated institutions, and individuals.

The HAB Programme is now at a stage where, in accordance with the programme plan, it is time to carefully and critically set priorities, and at the same time identify the resources needed to implement these priorities and ensure that these resources are made available for the Programme. One mechanism to do so is through this Intergovernmental Panel where national representatives can set priorities and identify resources, in cash as well as in kind, for the implementation of the priorities. Members of the Panel are encouraged to go to their Governments, Governmental Institutions, Universities etc. and identify resources for HAB activities at the national, regional or global level as appropriate and possible and obtain the related commitments. Without this identification of resources and related commitments, even a well planned international programme will eventually

become nothing but an empty shell. It is stressed that I am not talking about resources to the IOC Secretariat, but to the Programme implementation, which is essentially a national responsibility. The international part of the resources requirements are usually small, less than 10% of the total required.

Of course there are important and relevant regional and international funding possibilities (UNDP, WB, GEF, EEC, Regional Development Banks etc.) but the success of seeking support from these sources is highly dependent on the back-up from the national level through the appropriate official channels and mechanisms. Applications must usually be sent from the Governments.

You, as the National Representative of your country have the experience, knowledge and network to facilitate the implementation of a global programme on harmful algal blooms.

A number of core items are specifically identified as requiring attention. The development of a training and capacity building programme is essential since almost all Member States participating in the Programme have a need for training of scientists, managers or technicians at various levels. This is a TEMA activity of the IOC. In 1993 and 1994 courses will be held on various aspects of HAB. These courses have been made possible only through the co-sponsorship by WHO, Denmark, Germany and Japan. The goal is to prepare a training programme for a 3 to 5 year period covering taxonomy, toxin chemistry, monitoring and management aspects of harmful algae.

Training activities are expensive (~ 50.000 US $/course) and the IOC is unable to fund training courses on its own. Therefore the Panel Members, e.i. you are all requested to help identify institutions and agencies which can host, organize and co-sponsor training courses.

The IOC Assembly has endorsed the establishment of a Programme Office for the HAB Programme within the IOC Secretariat, and the Secretary IOC has established such an Office (you are welcome in Bonvin Building, Office 4.07). Presently the Programme Office is staffed by two Associate Experts provided by Denmark specifically for the HAB Programme. Associate Expert posts are time-limited and although there are presently two Associate Experts this will only be the case for a limited period of time. To secure continuous and stable programme development and implementation, it is crucial to seek secondment by Member States of a programme specialist. The present situation in Unesco does not include possibilities for availability of regular programme posts.

The coastal zones are subject to increasing population pressure. The United Nations Conference on Environment and Development (UNCED) (Rio, June 1992) realized this and emphasized the application of Integrated Coastal Area Management and solutions to the problem of land based sources of marine pollution. At the same time the UNCLOS (UN Convention on the Law of the Sea) provision of EEZ (Exclusive Economic Zones) puts the management and sustainable development responsibilities on the adjacent coastal states.

UNCED fully recognized the need for a scientifically based information basis and methods for the management. Harmful algae is one universally occurring problem requiring urgent scientific and managerial attention in this context. In several areas of concern within the comprehensive programme of action adopted by UNCED (known as Agenda 21) harmful algae are included; (i) their occurrence can be an indicator of the health of coastal zone waters which is very central in, and part of, Integrated Coastal Area Management; (ii) the transfer of non-indigenous species through de-ballasting; (iii) the synergetic effects of harmful blooms on a stressed ecosystem; (iv) the uncertainty in relation to global climate change and effects of changing radiation balance, including U.V changes, etc.

The IOC has a responsibility to respond to Agenda 21 as well as the Convention on Biological Diversity within the IOC mandate. The HAB Programme should also be seen in this broader perspective when identifying priorities.

Hopefully we will succeed in solving some of the above questions at the Second Session of the Panel and I, as the Secretary IOC, the HAB Programme Office and the rest of the IOC Secretariat will do our best to facilitate the Session.

OPENING ADDRESS
by
Fisheries Officer, FAO, U. Barg

FISHERY RESOURCES AND HARMFUL ALGAL BLOOMS

Harmful phytoplankton events continue to be a major concern in many parts of the world. Cases of human illness and sometimes death have been reported to occur after consumption of seafood contaminated with phycotoxins. Severe economic losses have been experienced when contaminated seafood, in particular bivalves, had to be banned from national or international markets, or when mass mortalities of wild and farmed fish resulted from deoxygenation of waters or gill clogging associated with algal blooms. Commercial capture fisheries may also be affected in the long-term when benthic communities are being subject to recurrent events of hypoxia or anoxia following the decay of algal biomass.

In many regions, fishermen, fish farmers as well as fishery scientists and administrators recognize the risks associated with harmful algal blooms. Evidently, consumer confidence is at stake, and both marketability of seafood as well as the sustainability of the fishery and aquaculture industries may be seriously affected.

1. Living aquatic resources need to be protected

Advice is urgently needed by fishery managers on the development of appropriate low-cost monitoring procedures to detect algal blooms threatening coastal areas where shellfish is harvested and fish and shrimp are farmed. Coastal pollution assessment and monitoring activities should, where required, be designed to include early warning schemes related to possible occurence of harmful algal blooms.

The formulation of contingency plans, including containment and mitigation measures, designed to safeguard aquaculture activities and sites, require the assessment of area-specific information on time, frequency and geographical distribution of recurrent events of algal blooms. Scientific and technical advice is required on on-farm measures to be implemented before, during and after events of harmful algal blooms, including advice on detoxification of contaminated produce.

In many cases, it would be useful that criteria and key factors related to harmful algal blooms be defined for inclusion into coastal aquaculture development plans or coastal area management programmes for the adequate designation of minimum-risk areas suitable for aquaculture development.

2. Human health needs to be protected by ensuring that seafood is safe for consumption

In many countries there is a need to facilitate routine hygienic inspection of seafood prior to harvesting or marketing. The development of appropriate low-cost analytical methods for toxin detection and monitoring, in particular simple field assay kits, would help preventing exposure of humans to seafood contaminated with algal toxins.

Very often training is required in the fields of fish inspection and seafood quality assurance in order to strengthen national capacities in the design and implementation of monitoring and control programmes related to harmful algal blooms. Training activities should be designed to focus on 1) biology and physiology of the seafood involved, 2) pathology and epidemiology of the different biotoxins, 3) application of analytical methods, and 4) planning and implementation of monitoring and control procedures.

Maximum allowable toxin levels in seafood should be determined with due consideration of site - or area-specific factors, species caught or farmed, and detoxification measures which are locally feasible. Regulatory measures may require the standardization of toxin detection methods.

3. Research should focus on most urgent information needs

At present, research on harmful algal blooms is certainly required to understand their causes, their temporal and spatial dynamics and, in particular, their effects on wild and farmed fish. Scientifically-based advice is urgently required on fate, distribution and effects of phycotoxins in the marine food web as well as on mechanisms responsible for massive kilss of fish and shellfish caused by toxic substances. Research on toxin degradation and depuration in contaminated seafood should generate viable technologies for detoxification.

4. International collaboration

International collaboration is required to avoid duplication of efforts. Formulation of well-defined and specific objectives of HAB-related programmes is crucial. It is important that activities are implemented which focus on priority needs taking into account the very limited financial reosurces available and the seafood safety conditions prevailing in some countries. HAB-related efforts should be geared to provide clear guidance in the formulation of effective prevention and control measures aiming at the protection of both human health and fishery resources.

ANNEX VII

INFORMATION ON HAB PROGRAMME DEVELOPMENTS IN THE INTERSESSIONAL PERIOD

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EDUCATIONAL ELEMENTS

INFORMATION NETWORK

1.1 *HARMFUL ALGAE NEWS* - **an IOC newsletter on harmful algae and algal blooms;**

Issue No. 6 of *Harmful Algae News* has been published and No. 7 is under preparation. HAN is intended as an quarterly newsletter, but practical aspects has so far prevented more than 3 issues a year. As of 1 October 1993 the total number of subscribers were more than 1700. During summer 1993 an Editorial Team composed of regional co-editors was established in order to support the Editor in his efforts to make HAN a broad newsletter scientifically and geographically. The members of the Editorial Team are listed below.

To secure a varied and inspiring HAN the idea of special issues on a selected topic or geographical region has been introduced. The first special issue (HAN No. 6) was devoted to the problem of domoic acid in North America.

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1.2 ● Directory of Experts

An updated and expanded edition of this international Directory is being prepared to assist countries facing toxic and harmful algal bloom emergencies by facilitating rapid access to scientists, fisheries managers, public health officials, and physicians who are experienced in dealing with toxic and harmful algal blooms and their consequences to fisheries, aquaculture, and public health. The Directory will also serve to expedite contact among the international community of experts in harmful algae and related issues. The Directory will be prepared and published as a cooperation between the IOC and NOAA (USA). Publication is planned for early 1994.

1.3 ● IOC Manual on Harmful Marine Phytoplankton (Editors G.M. Hallegraeff, D.M. Anderson & A. Cembella)

The IOC Manual on Harmful Marine Phytoplankton, including methodologies, taxonomy, and monitoring and management issues is planned to be published in 1994. An outline of the Manual is found below.

Introduction
Diversity of harmful algae phenomena, impacts, global spreading, eutrophication (Hallegraeff)*

Methods

- **Taxonomic methods** (Fukuyo, Taylor)
- **Field sampling** (Franks/ D.M. Anderson)*
- **Culturing and counting methods** (Guillard, Throndsen)
- **Toxin analysis**
  - **Chemical methods**
  - **PSP** (Oshima)
  - **DSP** (Quilliam, Wright)*
  - **ASP** (Wright, Quilliam)*
  - **NSP** (Baden)
  - **Ciguatera** (Lewis, Legrand)*
  - **Cyanobacterial toxins** (Cembella, Baden, Hall)
  - **Cysts** (D.M. Anderson, Fukuyo)*
  - **Nutrients** (Valderrama)*

Taxonomy

- **Dinoflagellates** (Taylor, Fukuyo, Balech)
- **Prymnesiophytes** (Moestrup, Thomsen)
- **Diatoms** (Hasle, Fryxell)*
- **Raphidophytes** (Hara)*
- **Cyanobacteria** (Carpenter, Carmichael)*
- **Cysts** (Matsuoka, Fukuyo)*

Monitoring and management

- **Environmental monitoring** (Smayda)
- **Management of shellfish resources** (Shumway, Von Egmond, Hurst)*
- **Management of finish resources** (White, Tangen, Okaichi)*
- **Epidemiology** (Baden, Fleming, Bean)

Algal culture collections (R.J. Andersen, Taylor)

Agencies and addresses (Enevoldsen, White)

*chapter outline received

PROPOSED REVIEWERS:

Introduction
Diversity of harmful algae phenomena, impacts, global spreading, eutrophication (Hallegraeff); **reviewer Anderson, Smayda, Taylor**

Methods
- **Taxonomic methods** (Fukuyo, Taylor); **reviewer Steidinger, Sournia**
- **Field sampling** (Franks/D.M. Anderson); **reviewer Taylor, Holligan**
- **Culturing and counting methods** (Guillard, Throndsen); **reviewers Jeffrey, Tomas**
- **Toxin analysis**
  - **Chemical methods**
    - **PSP** (Oshima); **reviewer Yasumoto, Hall**
    - **DSP** (Quilliam, Wright); **reviewer Yasumoto, Lassus**
    - **ASP** (Wright, Quilliam); **reviewer Bates, Pocklington**
    - **NSP** (Baden); **reviewer Steidinger**
    - **Ciguatera** (Lewis) Legrand); **reviewer Yasumoto, Scheuer**
    - **Cyanobacterial toxins** (Codd, Carmichael); **reviewer Falconer**
  - **Non-chemical detection methods** (Cembella, Baden, Hall); **reviewer Yasumoto**
- **Cyst** (D.M. Anderson, Fukuyo); **reviewer Dale, Matsuoka**
- **Nutrients** (Valderrama); **reviewer Graneli, Smayda**

Taxonomy
- **Dinoflagellates** (Taylor, Fukuyo, Balech); **reviewer Steidinger**
- **Prymnesiophytes** (Moestrup, Thomsen); **reviewer Green, Inoue**
- **Diatoms** (Hasle, Fryxell); **reviewer Takano, John**
- **Raphidophytes** (Hara); **reviewer Takano, Heywood**
- **Cyanobacteria** (Carpenter, Carmichael); **reviewer Sournia, Baker**
- **Cysts** (Matsuoka, Fukuyo); **reviewer Dale, McMinn**

Monitoring and management
- **Environmental monitoring** (Smayda); **reviewer Elbrachter, Holligan**
- **Management of shellfish resources** (Shumway, Von Egmond, Hurst); **reviewer Bricelj**
- **Management of finfish resources** (White, Tangen, Okaichi); **reviewer Horner**
- **Epidemiology** (Baden, Fleming, Bean); **reviewer Todd**

Algal culture collections (R.J. Andersen, Taylor); **reviewer Jeffrey, Tomas**

Agencies and addresses (White, Enevoldsen); **reviewer McLean**

1.4 ● IOC cosponsorship

The HAB Programme is a cosponsoring the Sixth International Conference on Toxic Marine Phytoplankton, Nantes, France, 1993. The IOC support will cover the participation of scientists from developing countries.

1.5 ● Proposal for a SCIENTIFIC AND TECHNICAL COOPERATION NETWORK ON HARMFUL PHYTOPLANKTON, "HUMAN CAPITAL AND MOBILITY", Commission of the European Communities, Directorate General XII for Science, Research and Development.

1.5.1 SUMMARY DESCRIPTION OF THE PROPOSAL

The occurrence of toxic algae and algal blooms is having increased impact on public and commercial activities. Therefore the understanding and prediction of, and management responses, harmful algae are major concerns throughout the world. A strengthening of the European scientific community working with harmful phytoplankton would be a core contribution to solve some of the problems associated with harmful phytoplankton and would help it to take a lead within the field.

The proposed Cooperation Network on Harmful Phytoplankton will link teams and laboratories with complementary capacities within the four main areas of research on harmful phytoplankton namely: (i) ecology, (ii) taxonomy, (iii) toxin-chemistry, and (iv) toxicology. To achieve significant steps in the understanding of the mechanisms underlying the occurrence of harmful algae, the toxin production and toxicity, the structure of the toxic compounds, and the taxonomy, it is crucial that the involved scientific communities join their efforts. Interdisciplinary research is required, as well as dialogue with users of the results. The establishment of an European Network would significantly enhance the environment for cooperation and give the scientific community a high visibility internationally.

The goal is to exchange experience and students, to train human capital, and where appropriate to facilitate the preparation of joint research projects and assessments.

The development of the proposed Network will have two phases. The first will be the establishment of the Network, the second the implementation, further development and potential expansion of it.

The established Network will act as the European forum for the further development, coordination and implementation of research projects, monitoring programmes, inter-calibration and training, based on the areas of priority identified in phase 1. Research projects developed in phase 1 should be implemented by the participating institutions. It is envisaged that development and standardization of methods will be an area of high priority as well as the exchange of researchers and doctoral students through fellowships.

Relationship to International Research Programmes: Ten of the twelve Institutions proposing the European Network are the national representatives in the Joint IOC-FAO Intergovernmental Panel on Harmful Algal Blooms. The Panel is the intergovernmental guiding body for the international IOC-FAO Harmful Algal Bloom Programme (HABP). The HABP is a research, management and training programme on harmful marine phytoplankton.

1.5.2. MANAGEMENT - DISSEMINATION OF RESULTS

The twelve proposing research institutions agreed to nominate the Intergovernmental Oceanographic Commission (IOC) as an appropriate coordinator for the Network. IOC Headquarters are located in Paris and their Harmful Algal Bloom Programme staff is provided by an European Community Member State. The IOC has already a long experience in coordination, cooperation and administrative procedures at the international level. An European Network on Harmful Marine Phytoplankton will enhance its visibility internationally through the linkage to IOC.

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The proposal was submitted the first time in November 1992. In June 1993 the proposal was rated "B" which means that the proposal will not be funded in its present form. Nevertheless the CEC has encouraged to re-submit a redrafted proposal. All co-proposers have been requested to provide the Coordinator with input and assistance in the redrafting. The deadline for re-submission is 15 November 1993.

1.6 ● Establishment of HAB Science and Communication Centres

The establishment of HAB Programmme activity centres was originally proposed at the Twenty-fifth Session of the IOC Executive Council (Paris 10-18 March 1992) and the idea was further elaborated at the first Session of IPHAB (23-25 June 1992). For a clarification of the question of "Programme Office" versus "HAB Centre", please see Annex VIII in the Report of the First Session of IPHAB.

At the Seventeenth Session of the IOC Assembly (Paris, 25 February-11 March, 1993), Denmark and Spain offered to host and establish HAB Science and Communication Centres (for details see Document IOC-FAO/IPHAB-II/Inf.1).

TRAINING

2.1 ⊜ IOC-Danida Training Course on the Taxonomy of Harmful Marine Phytoplankton, 16 - 28 August 1993, University of Copenhagen - cosponsored by Danida (Denmark).

More than 125 applications were received for the 10 seats available for participants from developing countries. The overwhelming interest made the selection difficult since the majority of applicants had a relevant CV.

The course had 15 participants: the 10 from developing countries, and 5 from developed countries. Professor Øjvind Moestrup and Dr. Jacob Larsen from Botanical Institute, University of Copenhagen, and Dr. Yasuwo Fukuyo, University of Tokyo, held a well prepared Course and supplemented each other well. Their taxonomical expertise covers most geographical regions of the world, an aspect which also is important in relation to future training courses. In the planning of the Course the organizers had emphasized the active participation of the trainees in the course by everyone to present a lectures on HAB problems in their respective home countries.

Six invited specialists gave lectures on various subjects in relation to harmful algae. Dr. H.A. Thomsen, University of Copenhagen talked about critical identification of *Alexandrium* sp. with demonstration of video techniques. Dr. G. Ærtebjerg, National Environmental Research Institute informed about planning and implementation of monitoring programmes. Dr. P. Andersen, Bio/Consult talked about monitoring and control of shellfish in relation to toxic algae. Physiological and ecological aspects of dinoflagellates were presented by Dr. P. J. Hansen, the National Environmental Research Institute. A computerizes identification program (Linneus II) was presented by Drs. Astrid Nieland, Expert Center on Taxonomical Identification, Amsterdam. The Program is being developed in cooperation with the Botanical Institute, University of Copenhagen. The toxicological and toxin chemistry aspects of toxic phytoplankton were presented by Dr. Helle Ravn, IOC.

A report of the training course is in preparation.

2.2 ⊜ BMTC-IOC-POLARMAR INTERNATIONAL WORKSHOP ON TRAINING REQUIREMENTS IN THE FIELDS OF 'EUTROPHICATION IN SEMI-ENCLOSED SEAS' AND 'HARMFUL ALGAL BLOOMS'

An International Workshop on was held 29 September to 3 October 1992, in Bremerhaven, Germany. The Workshop was organized by Bremen Maritime Training Centre, BMTC (State of Bremen), and was co-sponsored by IOC, FAO, and a number of other co-sponsors. The Workshop had 65 participants.

The Workshop prepared an elaborate set of recommendations on training activities which will be an important basis for the training activities within the HAB Programme. The Report is published as IOC Workshop Report No. 94.

2.3 ⊙ IOCARIBE Workshop on Red Tides and Mass Mortality of Marine Organisms, Cumana, Venezuela, 16-19 September, 1992.

A copy of the full Workshop Report (in Spanish) is available at the HAB Programme Office.

Conclusions an recommendations:

1. It is necessary to increase our information and technology related to the study of toxic red tides.

2. The simplest and cheapest methodology for the identification of the responsible organisms is conventional taxonomy using morphological characteristics. In any case, one day we will have a chemical method which will be less laborious than the conventional method.

3. Species suspected of being infected should be cultivated and analyzed by any valid method in order to determine their toxic potentiality.

Recommendations

1. Three short courses should be organized simultaneously, as follows:

A. Sampling and identification of phytoplankton:

- Various types of sampling exercises
- Methods of stabilizing and preserving by light(laser?) and electronic microscopes
- Setting up of permanent preserves
- Microphotography techniques
- Use of practical guides and classes which will be elaborated specially for this course.

B. Extraction and analysis of toxins:

- Methods used for extracting liposoluble and hydrosoluble toxins
- Biological tests with animals to determine the level of toxicity
- Revision of the HPLC basis and demonstration of the method used
- Basis for the epidemiological study

C. Culture and yield of phytoplankton

- Preparation of different types of culture methods
- Isolation and purification
- Increase in culture yields
- Related techniques for working with cultures
- Measurement of the growth rate
- Quantization of the concentration of algae in the area

2. These courses should be spread over four years and should be held in a different country each time.

3. The number of participants should be a function of the amount of human and material resources required. Notwithstanding, the number of participants may be decided by the host country.

4. A committee should be set up to co-ordinate the selection of the site for the course and to collaborate in the allocation of the economic resources involved.

5. Research efforts should be increased to streamline toxicity-determining immunological techniques that

would be quicker, cheaper and more reliable than animal tests.

6. Collections of uni-algae should be maintained as a reference and experimental material.

7. Growth of algae in cost efficient cultures should be investigated in order to prepare commercial fertilizers, extracts of macro-algae etc., which will serve to cultivate large outputs.

8. In geographical zones where toxic red tides are possible, the biological and physiochemical parameters of the water should be studied together with aspects such as :

- Circulation and formation patterns (above all in bays and gulfs)
- Dumping/discharge in soft water and changes in salinity
- Temperature and light fluctuations
- Life cycle and adaptation of potentially toxic species.

9. An information centre should be set up to facilitate the acquisition of up-dated reference bibliographies and to maintain a directory of the people working on this theme and its current research.

2.4 ● Development of a HAB Training Programme:

The Training Programme is planned to be composed of 3-4 main modules on Taxonomy, Toxin Chemistry and Toxicology, Management Strategies, and Mitigation Techniques. Please see Document IOC-FAO/IPHAB-II/Inf.6.

Some Courses have already been planned:

- IOC/WESTPAC Training Course on the Taxonomy of Harmful Marine Phytoplankton, WESTPAC Region, 1994, cosponsored by the State of Bremen (Germany) and Japan.

The Course is not yet planned in detail.

- IOC-WHO-FAO-State of Bremen Training Course on Qualitative and Quantitative Determination of Algal Toxins, Europe, 1994 - cosponsored by WHO and the State of Bremen (Germany).

The goal of the course is to give the participants a theoretical as well as a practical introduction to qualitative and quantitative determination methods of toxins from marine phytoplankton.

The main objectives of the Course are: 1: Improvement of the participants chemical and toxicological skills in order to enable them to make reliable qualitative and quantitative determination of toxins from planktonic algae and contaminated food; and 2: Long-term: The obtained experience will be used in the design of comprehensive training programme on harmful algae and in particular in the preparation of a training module on qualitative and quantitative determination of toxins from harmful marine phytoplankton. The training activities will focus on improving related human resources as well as technology and knowledge transfer in order to develop national capabilities for management of harmful algal events.

SCIENTIFIC ELEMENTS

ECOLOGY and OCEANOGRAPHY

3.1 ● ICES-IOC (Study) Working Group on the Dynamics of Harmful Algal Blooms

The activities of the ICES/IOC Study Group on the Dynamics of Algal Blooms (now re-established as the Working Group on Harmful Algal Blooms Dynamics) can be considered as a development, by ICES, of the "Ecology and Oceanography" box from the Scientific elements of the IOC programme on Harmful Algal Blooms (IOC Workshop Report No. 80, pp. 7, 8 and 14). The setting up of this group was recommended at the last ICES Statutory Meeting by the Chairpersons of the Hydrography and the Biological Oceanography Committees. The Terms of Reference were: "*to plan and propose a programme to study the dynamics of HABs in coastal oceans*". Since its very beginning it has been developed in close connection with the IOC programme on HAB. The Group met in Vigo, Spain, 7-9 April 1992. It was agreed that a population dynamics approach would be the most suitable way to attain a substantial improvement in our knowledge about the initiation, proliferation and dissipation of harmful algal populations, and ways to evaluate the different gain and loss terms to the system were discussed. The research programme is intended to include modelling, experimental and field components. The ultimate goal of the programme for each regional case, would be to develop a numerical model that allows an accurate prediction of the blooms. Three regions were chosen, as suitable sites where a pilot programme could be developed: Iberia (Spanish-Portuguese Atlantic Coast), Gulf of Maine (USA), and Skagerrak/Kattegat (Scandinavia). A common characteristic of the projects is that they are sites that experience recurrent blooms of noxious species, and that basic information about the timing and circumstances of their occurrence is already available.

It was soon made obvious that the group would need to work in close cooperation with physical oceanographers to progress in the understanding and modelling of physical-biological interactions affecting the algal population dynamics. The first steps towards this cooperation were taken during the second meeting of the group (Charleston, USA, 8-11 February 1993) by means of a joint session with the ICES Working Group on Shelf Seas Oceanography. At that second meeting, the group discussed the utility of mesocosm experiments for the understanding of algal population dynamics, and examined the cyst phase of potentially harmful species. Since mesocosm experiments can contribute to the understanding of at least some features controlling algal populations, there was agreement that some boundary conditions might be placed on potential algal growth dynamics by experiments conducted with these devices. The potentially important rôle which cysts can play in population dynamics was accepted, since it is obvious that excystment and encystment rates can influence parameter values in the population growth equations. The group agreed that the most important parameter to estimate was the **algal division rate (μ)**, and recommended that an **ICES Workshop for Intercomparison of Methods for Measuring Dinoflagellates Division Rates *in situ*** should be developed, in a place where the flux rates due to physical processes are amenable to easy measurement and the probability of encountering a toxic species is high.

During the joint session, there was a presentation and systematic discussion of the three pilot project drafts, as well as of other examples of physical and biological processes associated with bloom developments. The biologists posed questions to the hydrographers. The different approaches which the two groups of scientist use to solve their problems soon became evident. Many biologists were insufficiently aware of the role which modelling can play in advancing their work and achieving results, i.e. in the design of sampling strategies, interpretation of data, and forecasting. It was recommended that an ICES Workshop on Modelling the

Population Dynamics of Harmful Algal Blooms take place to enhance the dialogue between existing groups of biological and physical oceanographers. Emphasis should be placed on population dynamics, including the importance of physical inputs, and temporal and spatial scales.

The group finally discussed the need to continue and enhance work within ICES on harmful algal blooms, including the enlargement the actual bloom database to include a worldwide data base (which might gradually occur with IOC participation). At the last ICES Statutory meeting the Council agreed to upgrade the existing group and to include the word 'dynamics'in the new name which encompasses a multidisciplinary (hydrography and ecology) aspect which the participants considered to be very important in defining the uniqueness of the proposed Working Group. The terms of reference of the newly established ICES/IOC WG on "Harmful Algal Blooms Dynamics" are:

i) continue the development of an understanding of the dynamics of harmful algal blooms, including experimental aspects of HAB dynamics;

ii) review progress in the implementation and/or execution of physical-biological interactive investigations in the pilot study areas (Gulf of Maine, Skagerrak-Kattegat, Iberia);

iii) review the workshop on Modelling the Population Dynamics of Harmful Algal Blooms, and propose further steps to improve the dialogue between physicists and biologists;

iv) finalize planning of the Workshop on "Intercomparison of *in situ* Growth Rate Measurements";

v) consider the integration of ongoing research activities on harmful algae phenomena in the ICES area into the existing global international programme on harmful algal blooms (IOC-FAO/OSLR/HAB);

vi) evaluate strategies useful in investigating HABs, and in mitigating their detrimental effects on marine ecosystems, e.g., the efficacy of regional HAB monitoring systems;

vii) consider the development of a HAB database;

viii) collate and discuss national reports on harmful algal blooms (HABs);

The activities to be carried out during 1994 are:

1. ICES/IOC Workshop on "Modelling the population dynamics of Harmful Algal Blooms"
   Convenors: W. Fennel (Germany) and P. Tett (U.K.)
   Vigo (Spain), 4-7 May 1994.

2. ICES/IOC Working Group on "Harmful Algal Blooms Dynamics"
   Chairperson: B. Reguera (Spain)
   Vigo (Spain), 9-12 May 1994
   (including a joint session, 9-10 May with the WG on Shelf Seas Oceanography, chaired by H. Dahlin)

3. ICES/IOC Workshop on "Intercomparison of *in situ* Growth Rate Measurements"
   Chairperson: M.A. Sampayo (Portugal)
   Aveiro (Portugal), 25-29 July 1994.

Participants from countries outside ICES, especially those interested in establishing HAB dynamic studies in other geographical regions, are invited to attend the WG on Harmful Algal Blooms Dynamics and the Workshop on Modelling the Dynamics of HABs.

The report of the latest meeting of the Study Group (Charleston, USA, 8-11 February, 1993) is available from the ICES Secretariat.

3.2 ● SCOR-IOC Working Group 97 on the Physiological Ecology of Harmful Algal Blooms, La Rochelle, France, 25-26 October 1993.

Terms of Reference:

(i) to review and analyze data on the physiological ecology and biochemical aspects of harmful algal blooms, especially those resulting in toxic episodes, paying particular attention to nutritional, environmental and physiological factors; and

(ii) to assemble within two years the Working Group findings and submit for publication a report summarizing the state of knowledge and identifying the areas of future research. ICES and IOC are being asked to co-sponsor this group.

ANNEX VIII

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ARGENTINA

Bloom forming and/or toxic species

A large number of exceptional plankton blooms in Argentinean waters during the last 10 years have included dinoflagellates, flagellates and ciliates. Most of the mentioned blooms have been produced in frontal systems. Blooms of *Alexandrium tamarense. Prorocentrum micans and Phaecoystis pouchetii* have been observed in the frontal system of Peninsula Valdes. Several discolorations and a toxicity outbreaks have been reported in the Rio de la Plata frontal system. A *Mesodinium rubrum* red tide has been related to the shelf break front generated by the turbulent flux of the Malvinas current. Blooms of the dinoflagellates *Gyrodinium* cf. *aureolum*, *Gyrodinium sp.* and an unidentified small thecate dinoflagellate has been associated to the advection of low salinity waters from Rio de la Plata to the shelf break front. Recently an unusual bloom of *Alexandrium catanella* was recorded in Southern Argentina during summer of 1991. Besides the above mentioned species, *Gymnodinium catenatum* PSP producer, *Dinophysis fortii* and *Dynophysis acuminata* DSP producers, *Pseudonitzchia pungens f. multiseries* and *Pseudonitzchia australis* domoic acid producers. have also been found in the Argentine sea.

Paralytic Shellfish Poisoning (PSP)

The first toxic outbreak of Paralytic Shellfish Poisoning (PSP) was detected in the Argentine sea, during the spring of 1980, as a consequence of the death of the fishermen due to intoxication by mussels ingestion. This outbreak reached extremely high toxicity levels (50,000 g STX eq./100 g of *Mytilus edulis* tissue). Since this initial bloom of *Alexandrium tamarense,* the toxic area expanded, through successive stages, to cover nearly all of the Argentine coastal ecosystem. Every year incidents of toxic blooms of this species now occur

in these areas. Recently an unusual PSP toxicity outbreak produced by *A. catenella* was recorded in Southern Argentina and Chile. Its intensity duration and extension resulted in a high number of human intoxications. In the southern Argentina region the highest toxicity values (127,000 g STX eq./100 g) were detected near Ushuaia city. To our knowledge, this is the highest toxicity values recorded for a PSP outbreak.

A public health program is in existence. When toxic levels reach 80 g STX eq/100 g of shellfish meat, the shellfish areas are closed to harvesting and patrolled. The mouse bioassay method is used to detect PSP. Up to the present, human deaths and serious illnesses have been recorded, besides and an indeterminate number of mild intoxications, but there have been no intoxications from commercially harvested shellfish.

Ecological studies

At present, the general understanding of toxic blooms dynamic is limited. Our results indicate the presence of *A. tamarense* cysts in the whole study area. Then it is not surprising that *A. tamarense* is at present a common minor component of the spring bloom observed in the most part of the neritio Argentine ecosystem, associated to sub-antarctic shelf waters. Results obtained from an exploratory analysis of the Mar del Plata shellfish toxicity area (1980-1990) showed a significant correlation between maximum toxicity levels and the sunlight/wind velocity quotient. These meteorological conditions may regulate the phytoplankton composition of the spring bloom; *A. tamarense* growth being favored by calm periods and high solar radiation.

In coastal areas, phytoplankton blooms are often connected to elevated concentrations of nutrients, particularly the combined forms of nitrogen and phosphorus, and have often been regarded as an effect of eutrophication. However, the occurrence of dinoflagellate blooms in remote pristine areas of the Argentine sea, suggests that other mechanism might as well operate in triggering and maintaining phytoplankton blooms.

Recent data indicated that the springtime decrease in the ozone layer is significant in this Southern region of South America. Associated with ozone depletion there is an increase in the levels of biologically harmful ultraviolet radiations. There is a growing concern that the change in the specific composition of phytoplankton is one of the expected effects of the increase of UVB. Both physical conditions of the springtime environment and the biological responses of toxic dinoflagellates must be considered in future efforts to evaluate the effects of UVR increase in toxic dinoflagellates blooms in this austral region.

AUSTRALIA

Background

Algal blooms are a natural occurrence fresh, estuarine and coastal waters in Australia. The first report of toxicity of an algal bloom dates from the last century with a record of the toxic cyanobacterium *Nodularia spumigena* (Francis, 1878). However, since then, harmful algal blooms have apparently increased in frequency and magnitude and there are now serious problems, particularly with paralytic shellfish poisoning, and toxicity due to cyanobacterial blooms.

At present there is no single national agency dealing with harmful algal blooms, but a collection of federal and state agencies. Harmful algal blooms in fresh waters are managed separately from those in eustuarine and coastal waters.

The harmful algal bloom problems and related activities in Australian waters are listed below. Shellfish quality assurance and toxic cyanobacterial blooms have the greatest environmental and economic impact.

Shellfish quality assurance

Since 1986 blooms of *Gymnodinium catenatum* in south-east Tasmania have caused prolonged (up to six months) closures of oyster and mussel farms in late summer-autumn. In 1993 blooms were more extensive than before, affecting previously "safe" areas. A monitoring program for PSP toxins has been in place since

1986.

Elsewhere blooms of toxic *Alexandrium catenella* (Port Phillip Bay, Sydney Harbour) and *A. minutum* (port River, Adelaide) have not affected commercial shellfish stocks. There is concern that *Alexandrium* cysts beds in areas of cultivation of the Sydney rock oysters (new South Wales) pose a potential threat to this industry.

The shellfish industry in Australia is currently worth approximately $ 200 per annum.

While testing for domoic acid (ASP) is available, and DSP and NSP testing is planed, there are no problems associated with these toxins so far.

Agencies involved:

Australian Shellfish Sanitation Advisory Committee (ASSAC)
Australian Quarantine an Inspection Service (AQIS)
National Food Authority (NFA)
Fishing Industry Research & Development Corporation (FIRDC)

Toxicity testing:

Paralytic Shellfish Poisoning (PSP)

Department of Community and Health Services, Tasmania
Contact - R. Brown

Domoic acid (ASP)

State Chemistry Laboratory, Victoria
Contact - J Sang

Planned expansion

- PSP and ASP testing by State Government Chemistry Centre of WA
  Contact - C Soames
- DSP and NSP testing by Department of Primary Industry and Energy, Queensland. Contact
- R Lewis

Toxic cyanobacterial (blue-green algal) blooms in Australian fresh and estuarine waters

Cyanobacterial blooms have significant impacts on drinking water supplies, human health, tourism and real estate values. While historically causing problems, national attention was focussed on cyanobacterial blooms in 1991 when 1000 km of the Darling-Barwon Rivers in New South Wales and South Australia developed toxic *Anabena circinalis* blooms. Financial costs are enormous ($ 100's millions) in direct costs with problems arising directly from the bloom (e.g. consumption and upgrading sewage treatment plants.

Monitoring and guidelines are regulated by State Blue Green Algal Task Forces (TAG) with a threshold level of microcystin in drinking water of 1 $\mu g\ L^{-1}$ being set.

Agencies

State Blue Green Algal Task Forces (TAG) (South Australia, Western Australia, Queensland, New South Wales, Victoria)
Australian Centre for Water Quality Research (ACWQR)
Commonwealth Scientific and Industrial Research Organization (CSIRO), Divisions of Water Resources

and Fisheries
Land and Water Resources Research and Development Corporation (LWRRDC)
Natural Resources Management Strategy (NRMS)
Commonwealth Environmental Protection Authority (CEPA)

Toxicity testing

Microcystin testing

Victorian State Chemistry Laboratory, HPLC (Contact - C Rayner)
Queensland Government Chemistry Laboratory, HPLC (Contact - Des Connell)
Australian Centre for Water Quality Research, HPLC (Contact - M Burch)
CSIRO) Division of Water Resources, Griffith Laboratory, HPLC and Protein phosphatase assay (Contact - G Jones)

Nodularin testing

CSIRO Division of Water Resources, Griffith Laboratory (Contact - G Jones)

Mouse bioassay

Australian Centre for Water Quality Research, Flinders University (Contact - M Burch)
University of New England (Contacts I Falconer, M Choice)
Western Australia Department of Agriculture (Contact J Allen)
PSP testing (due to cyanobacteria containing PSP toxins):
Australian Centre for Water Quality Research; CSIRO Division of Water Resources

Ballast water introductions of toxic dinoflagellates (and other harmful marine organisms)

Ballast water has been identified as a significant vector for the introduction of toxic dinoflagellates (and other harmful marine organisms) into Australian waters. On 1 February 1990 the Australian Quarantine and Inspection Service (AQIS) introduced special ballast water quarantine measures in order to reduce the potential for ballast water introductions. These measures include evidence that the port of origin was free of toxic dinoflagellates, and reballasting at sea. Australia has acted as the lead nation for a working group of the International Maritime Organization (IMO). Since 1990 $ 6000,000 has been spent on ballast water research, including monitoring for dinoflagellate cysts in ships' ballast water and Australian ports.

Agencies:

Scientific Working Group on Ballast Water of the Australian Quarantine and Inspection Service (AQIS)
University of Tasmania (Contact - G Hallegraeff)
BHP (Broken Hill Pty) (Contact - G Rigby)
CSIRO Division of Fisheries (Contact C Bolch)

Monitoring of ships' ballast water for dinoflagellates cysts:

Cyst surveys of ballast tanks of ships entering Australian ports and sediments of Australian ports (AQIS; G Hallegraeff, University of Tasmania; C Bloch, CSIRO Division of Fisheries)
Implications for translocation of shellfish stocks between states (Contacts - S Standley, Tasmanian Department of Sea Fisheries; P O'Connor, NSW)

Coastal eutrophication and algal blooms

While there is considerable concern in Australia about coastal eutrophication, most work has focussed on the physics and chemistry of the systems, and not the biology. CSIRO has a large Coastal Zone Programme

which is investigating the interaction between catchments and estuaries but this does not include algal bloom research. The Port Phillip Bay Eutrophication Project has recently supported analysis of a phytoplankton data set from the mid 1980's.

Agencies:

Environment Protection Authority, NSW (Contact - S Hardiman)
Waterways Commission, Western Australia (Contact - V Hosja)
Universities (Tasmania, Monash)
CSIRO (division of Fisheries)

Port Phillip Bay eutrophication project:

Contact - G Harris, CSIRO Project Office

Ciguatera in Great Barrier Reef Region

Ciguatera is a continuing problem in Australia's tropical waters on the coast (Barrier Reef region). In recent years poisoning have been few. However the Queensland Department of Primary Industries and Energy still maintains a small research group working principally on toxicology of ciguatera. In 1993 the DPIE Laboratory at Bribie Island, Queensland hosted an International Ciguatera Workshop.

Agencies:

Department of Primary Industries and Energy, Queensland (Contacts - R Lewis, M Holmes)

Fish health in intensive aquaculture systems

There have been isolated cases of fish kills in Australian waters from *Gymnodinium mikimotoi* or related species (Port Phillip Bay, Victoria in the early 1950's, and Murdunna, south east Tasmania in 1989). More recently (1993) *Gymnodinium catenatum* blooms in south east Tasmania may have been responsible for the development of club gills in caged atlantic samon. This has serious implications for the $ 47 m per year industry.

Agencies:

Department of Primary Industries and Energy, Launceston, Tasmania (Contact - J Handlinger)
University of Tasmania at Launceston (Contacts - B Munday, B Nowak)

Algal bloom monitoring for Tasmanian fishfarm industry:

Contacts - SALTAS, G Hallegraeff, University of Tasmania

Culture collection and taxonomy of marine phytoplankton:

Culture collections:

The CSIRO Culture Collection of Microalgae, Hobart, Tasmania consists of 500 algal strains of marine and freshwater origin, including 150 strains of toxic phytoplankton, with representatives of all toxic dinoflagellates and toxic cyanobacteria in Australian waters. This therefore represents an unique collection of harmful algal bloom species. (Contacts S Jeffrey; J LeRoi; S Blackburn)

The Culture Collection, Australian Centre for Water Quality Research, Adelaide, South Australia contains isolates of all species of toxic cyanobacteria in Australian inland and estuarine waters (Contact - P Baker)

Taxonomy:

Taxonomic data for Australian phytoplankton include the following:

Bass strait plankton flora (University of Melbourne) (Contact - D Hill)
North West Shelf diatom flora (Curtin University) (Contact - J John)
Surveys for toxigenic *Alexandrium* and *Pseudonitzschia* (University of Tasmania) (Contact - G Hallegraeff).

NATIONAL STATEMENT : BRAZIL

Despite the large extent of the Brazilian coast, information about economic and/or health impacts caused by harmful algal blooms (HAB) are scarce. Latest report about a red tide phenomenum in Brazil dates from the beginning of this century (Faria, 1914). Other few cases were reported, of HAB in coastal lagoons, embayments and at exposed sandy beaches (Sato et al. 1963; Machado, 1979; Huszar et al., 1992; Petrobas, 1992).

The paucity of information might be related to: a) the absence of large and significant HAB at the Brazilian coast. In this case, oligotrophic conditions of the Brazilian current would probably contribute to minimize eutrophication processes occurring in the coastal region; b) HAB phenomena does occur, but the characterization and evaluation of impacts are poorly reported owing to the reduced number of scientists involved in phytoplankton research at Brazilian Universities and Institutes.

A recent ongoing project aims to collect information about the occurrence of HAB in Brazil (Odebrecht, in preparation). Initial data indicate that cyanobacteria, dinoflagellates and chlorophycean are the principal organisms observed during HAB events. High abundance of the cyanobacteria *Oscilatoria (Trichodesmium) erythraeum* have been associated to red tide phenomena in the northeast, southeast, and south Brazil, and small coccoid cyanobacteria cells have been associated to fish mortality in some coastal lagoons of Rio de Janeiro State.

Surface cell accumulation of unidentified chlorophycean, aesthetic disturbance, was observed at Cabo Frio coast near Rio de Janeiro. Massive shellfish mortality occurred in March 1993 at an exposed sandy beach in southern Brazil and was related to the presence of several potentially toxic dinoflagellates. The yet most extensive red tide phenomenum was reported from the same part of the Brazilian coast (Machado, 1979).

The participation of Brazil in the development and implementation of the HAB program of IOC is of special interest due to:

a) the occurrence of HAB, which has been observed in different coastal areas of Brazil, indicates that a potential environmental problem does exist;

b) the scarcity of reliable information regarding the study of HAB, indicates that personal training efforts should be enhanced;

c) the need for cooperative research between Brazil and other countries.

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CANADA

The Science Sector of Canadian Department of Fisheries and Oceans (DFO) continues to conduct a large research program on harmful algal blooms and is essentially as submitted at the First Session of IPHAB. The National Research Council has a successful program with emphasis on identification of unknown toxins and the preparation of standards for calibration of analytical equipment. The Development of Health and Welfare and the Inspection Branch of DFO constitute 30 % of Canada's resources. These departments are concerned with monitoring and management of the shellfish industry. In addition 11 Universities have identified phytotoxin programs. These programs are in the areas of taxonomy, physiology, biochemistry of toxin production, toxicology of phytotoxins, and phytoplankton dynamics.

Recently, a harmful algal bloom submissions for research are being solicited from Universities, with support from Government Agencies, through a special Federal Government targeted research funding initiative.

The ASEAN Canada Co-operative Program on Marine Science Phase II is one of several ASEAN regional marine programs being funded by the Canadian International Development Agency (CIDA). ASEAN stands for the Association of South East Asian Nations. Its membership includes the Philippines, Malaysia, Singapore, Thailand, Brunei-Daressalam and Indonesia. Its activities are expected to complement rather than duplicate activities being undertaken by other regional programmes.

The cooperation Program Phase II is a continuation and expansion of activities begun under Phase I which was successfully completed between 1983-1987. Malaysia is the ASEAN appointed Project Co-ordinators while a private Canadian Consultancing company is the executing agency for CPMS-II.

CPMS-II was formulated with the theme "Establishment of Environmental Criteria for Development and Management of Living Marine Resources and Human Health Protection". The goal of CPMS-II is to support the regional effort of ASEAN countries to cooperatively optimize marine resource based benefits through environmental maintenance in a manner that ensures the integrity of the resource base and promotes human health.

The broad objective is to upgrade ASEAN marine science capabilities through cooperative endeavours jointly undertaken by participating ASEAN countries and Canada. This is to be achieved through the execution of these technical studies.

1) development of tropical marine environmental quality criteria
2) undertaking marine pollution monitoring and baseline studies
3) investigation of toxic algal blooms leading to contamination of shellfish and marine fishkills;

CPMS-I declared the following objectives with respect to harmful algal blooms and which were carried over to phase II:

1) Manpower development
2) Research on the biology, ecophysiology and toxicological properties of dinoflagellates
3) Fostering institutional linkages within the ASEAN region, Canadian institutions and other organizations such as IOC/WESTPAC.

The study is intended to develop capabilities in each ASIAN country for investigating and understanding the biology of harmful algal blooms and to respond to outbreaks of harmful algae by implementing standard management procedures divised to minimize possible public health and other impacts.

Current Activities

1 Development of a Algal Bloom altest network
2 Enhanced monitoring in Indonesia and Malaysia
3 Culture of *Pyrodinium bahamense*
4 Nutrient studies in Manila Bay and the Philippines
5 Detection methods for low level toxins
6 Distribution of phytoplankton in the upper Gulf of Thailand
7 Preparation of a red tide information poster
8 Information acquisition (library materials)
9 Training of trainers in phytoplankton taxonomy on identification
10 Technical workshop

ASIA-Pacific Economic Cooperation (APEC)

APEC was established at a meeting of Foreign and Economic Ministers in Canberra in 1989 to better manage the growing interdependence of trade and commerce in the Pacific Region and to support sustained economic growth. APEC provides a forum for discussion on a broad range of economic issues of importance to the region. Membership includes Australia, Brunei-Daressalam, Canada, the People's Republic of China, Hong Kong, Indonesia, Japan, Republic of Korea, Malaysia, New Zealand, Republic of the Philippines, Singapore Chinese Taipei, Thailand and United States. APEC senior officials oversee 10 working groups, covering broad areas of economic, educational and environmental co-operation. Two of which are Fisheries and Marine Resource Conservation.

The objective of the Marine Resource Conservation Working Group is to promote initiatives in the APEC Region which will protect the marine environment and resources therein and ensure continuing socio-economic benefits results through maintenance of marine environmental quality. One of three initiatives is concerned with harmful algal blooms. A project on toxic algae will develop recommendations for human resource development and technical and information exchange mechanisms. The objectives to enhance members'capacity for research and management of the effects of harmful algal blooms. This will lead to improvement in the Regions ability to protect human health, support the aquaculture industry and enhance trade through improved assurance of shellfish product safety.

Task teams will:

1) identify appropriate mechanisms and institutions that can address the human resource development requirements that have been identified

2) review existing and emerging technologies suitable to addressing specific harmful algae management and research issues, and

3) provide an assessment of the most appropriate information exchange mechanism that meets the needs of the Marine Resource Conservation Working Group and is compatible with other working group networks.

A specific requirement of the project task teams is that they identify institutions and potential funding sources external to APEC, both from private and public sectors that may become involved in the implementation of their recommendations. It is intended that task teams will assess.

ASEAN-CANADA Cooperative Program on Marine Science in terms of possible overlap with their recommended activities and the potential opportunity for cooperative action.

DENMARK

Harmful algal blooms in Danish waters are well known, and research projects as well as monitoring programmes has been developed during the last years. Algal blooms is a major issue in the research projects of the University of Copenhagen, Botanical Institute, the National Environmental Research Institute, Roskilde, and of the Danish Institute for Fisheries and Marine Research, Charlottenlund. The work at the University of Copenhagen is focus on research on taxonomy. The work at the National Environmental Research Institute on toxic and non toxic occurrences algae includes monitoring, consultancy and scientific investigations. The Institute has, since the 1980s, been the Danish Center for national and international exchange of information on occurrences of algal blooms in Danish marine waters. The work at the Danish Institute for Fisheries and Marine Research is focus on the biological oceanographic aspects of algal blooms. The monitoring of toxic shellfish with respect to harmful algal blooms in Danish waters is guided and controlled by the Ministry of Fisheries.

A research project on harmful algae

From 1990 and until 1993, a Danish team from the University of Copenhagen, the Botanical Institute and the Division of Marine Chemistry, and National Environmental Research Institute (Coordinator: Dr. Helle Ravn) collaborated in joint projects, particularly concerning the ecophysiology, biological oceanography, toxin chemistry and toxicology of *Chrysochromulina* spp. and *Alexandrium* spp..

The project *Toxic Algae in Danish Waters* was funded by the Ministry of the Environment, and the aim of the project was to investigate biological as well as chemical aspects of phytoplankton species causing problems in Danish waters.

Taxonomy

The University of Copenhagen is the center for taxonomic research and a large culture collection, *The Scandinavian Culture Collection*, with species from many parts of the world.

Taxonomy studies on marine phytoplankton, especially dinoflagellates, widely distributed in the world has been described. With respect to the above mentioned project, electron microscopic investigations and physiological investigations on marine phytoplankton from Danish coastal waters have been studied and described (Prof. Øjvind Moestrup & Dr. Jacob Larsen, University of Copenhagen).

Ecology and biological oceanography

Ecology and biological oceanography with special emphasis on interaction between microalgae and nutrients and potential grazers, were studied in the laboratory and in the field. Vertical migration and adaption of the dinoflagellate *Gyrodinium aureolum* to low light environments have been studied in the Laboratory. (Dr. Hanne Kaas & Dr. Per Juel Hansen, National Environmental Research Institute, Dr. Kathrine Richardson, Danish Institute for Fisheries and Marine Research).

Toxin chemistry

In collaboration with Dr. Oshima and Prof. Yasumoto, Tohoku University, Japan, an equipment for analysis of Paralytic Shellfish Poison (PSP) toxins has been developed at the National Environmental Research Institute, and the group participated in *The First BCR Inter-comparison of Methods on Analysis of Saxitoxin and other PSP toxins in solution*, with Dr. H. van Egmond, Rijkinstituut voor Volksgezondheid en Milieuhygiene, Bilthoven, the Netherlands, as co-ordinator. The PSP equipment has e.g. been used for physiochemical investigations of the production of PSP toxins in Danish species of *Alexandrium*. Toxin profiles of "new" toxic dinoflagellates has been studied, and the present isolation and elucidation of new toxins are in progress. Furthermore, chemical analysis such as analysis of Amnesic Shellfish Poison (ASP: Domoic acid), and analysis

of hemolytic compounds, by Thin Layer Chromatography (TLC), and spectrophotometry has been performed.

Preliminary toxicity tests with *Artemis salina* has been performed (Dr. Helle Ravn, National Environmental Research Institute & Dr. Carsten Christophersen, University of Copenhagen).

International interaction and activities

Since August 1991 and May 1993 Danish International Development Agency (DANIDA) has supported the *IOC-FAO Harmful Algal Bloom Programme* with two Associate Experts and funds for training activities.

In august 1993 the University of Copenhagen, Botanical Institute, was the organizer of an international *IOC-DANIDA Training Course on the Taxonomy of Harmful Marine Phytoplankton.* This course was organized for participants from developing countries.

Lately, ICES identification sheets on Marine Phytoplankton have been prepared of the University of Copenhagen.

A taxonomic data base of harmful phytoplankton species is being developed as a Linnaeus II programme of the Expert Centre on Taxonomic Identification (ETI), Amsterdam in co-operation with the Botanical Institute at the University of Copenhagen. (Prof. Øjvind Moestrup, Dr. Helge Thomsen & Dr. Jacob Larsen).

In 1993 a proposal for an Science and Communication Centre on Harmful have been prepared and submitted to DANIDA. The centre will be co-sponsored by the University of Copenhagen, the National Environmental Research Institute, and the National Marine Fisheries Institute. The centre will in particular focus on providing assistance to developing countries.

The National Environmental Research Institute is one of the eleven proposers of the *Establishment of a CEC and Technical Cooperation Network on Harmful Phytoplankton.*

EGYPT

Egypt is interested in participating to the IOC-FAO Intergovernmental Panel on HAB for better understanding of its harmful effects to marine natural resources and to public health. Egypt wants to interact with other Member States at the IOC-FAO International Programme.

Two Egyptian Scientific Institutes are carrying out research work on Harmful Algae, but with limited resources available. They are looking to co-operate with International Organizations, Regional Programmes on bilateral activities especially in the Mediterranean. Egypt is interested also in toxic organization in fresh water.

We would like to call that our interest will be basically on the management of economic aspects of controlling their harmful effect on fisheries and marine production and trading of these products.

FINLAND

HABs in Finnish waters

The problems caused by harmful algal blooms in Finnish lakes and coastal waters of the Baltic Sea are mainly due to the blooms of hepatotoxic or neurotoxic cyanobacteria. Several cases of kills of domestic animals caused by cyanobacteria have been reported both from lakes and the Baltic Sea. Therefore HAB research in Finland has concentrated on this group of organisms. There are, however, signs that toxic blooms of other algal groups occur in the Baltic Sea but these are not systematically studied in Finland. Examples of these are the bloom formed by a haptophyte *Prymnesium parvum* in the SW coast of Finland 1990, which caused a fish kill. It has also been suggested that the mass mortality of sea birds in the eastern Gulf of Finland in spring 1992 was caused by some unknown toxic organism. It has to be kept in mind, also that several toxic and potentially toxic dinoflagellate and other species are present in the Baltic Sea. Because shellfish is not farmed in the Baltic Sea their potential toxic effect has never appeared.

Ongoing scientific and operational HAB activity in Finland

Plankton organisms have been included both in the national monitoring programmes of lakes and coastal waters as well as in the monitoring carried out within the Baltic Sea Monitoring Programme since 1970s. During the recent years a monitoring programme and early warning system of HABs based on unattended measurements has been initiated as a national and international co-operation. In 1993 weekly telephone meetings between monitoring agencies along the Finnish coast were started.

Finland has a long tradition of the fresh water and Baltic sea plankton research. The country has experience in algal taxonomy and culturing. At present there are several ongoing pelagial research projects which investigate the ecology and dynamics of toxic algal and cyanobacterial blooms.

Toxicological research has so far concentrated on toxic cyanobacteria. Since 1985 research has included 1) scanning of the toxicity of the mass-occurrences 2) isolation of a comprehensive culture collection of toxic cyanobacteria 3) investigations of factors regulating toxin production 4) identification of toxin structures 5) development of methods for toxin detection and 6) studies of the behaviour of toxins in water purification.

Scientists and authorities have in co-operation trained local environmental and health authorities to identify the most common bloom-foming cyanobacteria and distributed instructions for action for the public and water works. Simple biological and chemical methods for detecting toxicity of cyanobacteria have been developed and research is going on to develop more modern molecule biological methods to identify toxic species. Studies of the decomposition of toxins and potential risks from irrigation water containing cyanobacteria have also been started.

Main needs for new HAB research in Finland

The examples of toxic blooms caused by other organisms than cyanobacteria from 1990 and 1992 (see above) in the Gulf of Finland show that the risk for these blooms is real and most probably will increase as a consequence of eutrophication. Finland has relatively good facility to start studies in this field but so far funding for this purpose has not been allocated. Especially there is a need for 1) permanently employed algal taxonomist and 2) capability to chemical identification of other than cyanobacterial toxins.

FRANCE

In 1983, thousands of diarrhea cases resulting from the consumption of DSP-mussels were reported in South Britanny. To prevent such events, IFREMER (National Research Institute for Sea Resources) decided in 1984 to both establish a monitoring network and asked several scientists to dedicate their research to harmful algae. In 1989, the CNRS (National Agency for fondamental Research), the Ministry of the Environment and the Ministry of the Sea Joined IFREMER to finance this research and encourage new scientists to get involved in the HAB field. A national Programme was established in 1989, in order to avoid redundancies and to focus the research on actual priorities.

For practical reasons, the National Programme on Harmful Algae is practically divided in two major subprograms with separated topics: (i) Determination of the environmental conditions and specific ecophysiological capabilities which lead to harmful algal events (acting manager: Dr. Brigitte Berland, Station marine d'Endoume, Chemin de la Batterie des Lions, 13007 Marseille). (ii) Origin, chemical structure, bioaccumulation, effects and analysis of phycotoxins (acting manager: Dr. Patrick Lassus, IFREMER-DEL, BP 1049, 44037 Nantes Cedex). Field and laboratory researches are focussed on four species: *Alexandrium minutum*, *Dinophysis* spp., *Gymnodinium nagasakiense* (alias *Gyrodinium aureolum*) and *Gamberdicus toxicus*. Other potentially harmful species are only surveyed.

More details on ongoing research and actual organization of the monitoring network "REPHY" (acting manager: Mrs. Catherine Berlin, IFREMER-DEL, Nantes) can be find in the report of the First Session (June 1992) of the IOC-FAO Intergovernmental Panel on Harmful Algal Blooms, or asked to cited actual mangers.

An unknown algal event occurred in late 1992 and early 1993. In November 1992, seawater collected near mussel ropes contained an unusual high density of *Dinophysis* spp. Mice used to test DSP died immediately with PSP symptoms. HPLC analysis ascertained the presence of paralytic toxins; below the international toxic level (i.e. 80 μg toxin/ 100 g meat), however. On the other hand, the toxic profile was different from that of typical PSP local species *Alexandrium minutum*; which anyhow was absent in the water, and other PSP species as well. In early December, the phenomenon had disappeared.

A new toxic episode began 26 January 1993; again with no PSP species present neither in the water nor in the sediment (cysts). Moreover, toxicity spreaded to the oyster bed of Bassin de Marennes-Oléron and mussel beds of Bassin d'Arcachon. In mid February, the toxicity had disappeared.

At the moment, both the producing organism and the chemical structure of the toxin are still unknown.

GERMANY

The Delegate wishes to state again the continuing interest of Germany in the IOC Programme on HAB. Although harmful algal blooms did not cause considerable harm in German waters in the last 2 years, we are aware that this situation can change again any time. Special concern is given to the increasing knowledge on the occurrence of toxic cyanoprokaryots in the Baltic Sea in respect to the reported mortality of 2 dogs associate with the mass development of *Nodularia* in a brackish lake in 1990.

A regular monitoring programme of coastal waters in respect of the occurrence of potentially toxic algae is going on.

In addition, Germany wishes to support developing countries with regard to prevention and combat of harmful consequences of algal blooms, in particular with respect to training activities. Toward this goal, an international workshop was carried out in 1992 in Bremerhaven with about 70 participants, mainly from

developing countries. The aim of this workshop was to identify training needs for developing countries in the field of harmful algal blooms. The workshop was co-sponsored by State of Bremen and IOC.

As a first following-up measure of this workshop, a training course on "Identification and Quantification of Algal Toxins" for participants mainly from the Mediterranean and Black Sea region is planned for 1994. This course will be funded by the State of Bremen, IOC, the Mediterranean Action Plan, WHO.

In the frame of bilateral co-operation with China, 2 Chinese scientists worked for 6 months at the Biologische Anstalt Helgoland on Taxonomy and ecophysiology of Harmful Algae. This co-operation will be continued.

National research projects related to harmful algae are going on. At the moment 14 scientists in 9 institutions are working on Harmful Algae. Topics covered are: taxonomy, cyst survey, ballast water tanks, ecophysiology, improvement of toxin analytic methods.

ITALY

In the last years, the accumulation of high quantities of "mucilage" has been recorded along the Italian coasts of the Adriatic Sea. This phenomenon had a severe economic impact on fishery and touristic activities. A number of co-ordinated scientific projects have recently been focused on this area, all of them including investigations on the effects of eutrophication on algal blooms, which are listed below:

MARE - *Nutrients in the Northern Adriatic Sea: consequences of N/P/Si loads and different ratios for the development of microalgae, with particular reference to harmful species.*

Researchers from 7 European Research Institutes participate in this project, that has been supported by EEC program Environment.

ELNA - *Eutrophic limits of the Northern Adriatic*

This project, to which researchers from 5 different agencies participate, is supported by EEC program Environment.

An ecosystem approach to understanding pollutant inputs, and algal blooms and mucilage production in the Adriatic Sea.

This project is funded by the EEC program STEP

Operational project of research and experimentation activities for the protection of the Adriatic Sea

This project is supported by the Italian Ministry of the University and Scientific and Technological Research. It involves the participation of researchers from about 30 Italian scientific institutions. It promotes the Development of knowledge aimed at management of environmental problems of the Adriatic Sea Ecosystem.

JAPAN

HAB occurrence in 1992 and 1993

Red tides

In 1992 number of red tide recorded 250 cases with 25 harmful ones, of which economic loss was 640 million yen. Between January and July 171 cases of red tide occurred in western Japan. The case number decreased from that in the same period of 1992 about 15%, maybe because of unusual climate condition of low temperature and long continuous rain. Among the red tides 9 cases associated with economic loss such as mass mortality of fish and decolorization of seaweed. Total amount of the loss is 61 million yen with the highest 38 million yen. Causative organisms of the mass mortality was *Heterosigma akashiwo, Chattonella marina* and *Chattonella* sp. and those of decolorization was *Thalassiosira* sp.

Toxic algal blooms

Between January and July 21 and 22 monitoring unit areas were closed by PSP and DSP toxins, respectively. Toxicity in shellfish was rather low comparing previous several years, because blooming period of causative species in each area was rather short and cell density was low. Ban of the harvest in most of the areas was rifted within 2 months.

Research activity on HAB

National activity

Many research projects has been implemented under the Ministry of Education, Science and Culture, Fisheries Agency, and Environment Agency. Important subjects are as follows:

Interaction of bacteria to blooming mechanism.
Analysis of environmental characteristics to forecast occurrence of red tides.
Establishment of rapid and handy detection method of toxins in shellfish.
Elucidation of physiological depuration system of contaminated toxins in shellf sh.
Classification of harmful plankton using monoclonal antibody.

International activity

Overseas scientific co-operative researches and studies has been conducted using support from the Ministry of Education, Science and Culture, the Japanese Society for Promotion of Science, and other agencies. Project entitled "Mechanisms of bloom and spread of toxic red tides in SE-Asia" is one of the main activity which is carried under co-operation with scientists in China, Indonesia, Malaysia, the Philippines and Thailand. Through this kind of project, information and technique exchange, training of young prominent scientist, sharing the same standard for basic scientific study such as taxonomy and toxicology, and implementation of local seminar and workshop are performed.

NORWAY

The national research programme "Causes and consequences of harmful algal blooms" has been terminated. The program started in 1990 as a response to the damage which algal blooms could inflict (an on occasion did inflict) on the aquaculture industry, on fisheries and on marine ecosystems in general.

The program included projects on alga; ecophysiology, nutrient regeneration, algal taxonomy, grazing and toxicology. The program also included projects in mathematical modelling of physical, chemical and

biological parameters in marine systems (fjordal and coastal) of practical relevance in regard to possible damaging effects of algal blooms.

Some 13 scientists were employed in the programme, directly involved in carrying out research which combined laboratory experimentation, mesoscale systems and extensive cruise work during various natural blooms. Contact and co-operation was maintained with parallel efforts in Scandinavia and Europe. The Programme budget was nearly 25 million N.Kr for three year period.

The programme has published a final administrative report (in Norwegian) including the reports from all involved projects and a list of 97 scientific publications (largely in English) 61 of which are published, 20 "in print" and 16 "submitted". The final report may be obtained from Norges Forskningsråd, Avd. NFFR, Stensberggata 26, p.b. 2700 St. Hanshaugen, N-0131 Oslo, Norway.

A report of results obtained during the Program (in Norwegian) directed mainly to industry (aquaculture and fisheries) and to the managerial level, will become available in 1994.

The National Department of Environment Protection has established a secretariat for marine monitoring (HOV). HOV publishes reports on marine conditions as to sea temperature, wave activity, sea level and ice conditions. HOV also reports (weekly) on algal bloom conditions in Norwegian waters with special attention to developing blooms of nuisance algae.

Address: HOV-senteret, DNMI, Allegaten 70, N-5007 Bergen, Norway.

THE PHILIPPINES

Paralytic shellfish poisoning (PSP) in the Philippines due to *Pyrodinium* red tides has apparently increased in severity in recent years. From 1983 and up to the present red tide occurrence in the country, a total of 1446 PSP cases with 82 death have been recorded (DOH/BFAR, unpublished data). Aside from the health problems, the phenomenon is also associated with dislocation of affected fishermen and economic losses. The 1992 red tide outbreak in Manila Bay alone caused the displacement of around 35,000 marginal fishermen directly and indirectly involved in the shellfish industry and the whole fishing industry was almost at "standstill" because other aquatic products were not bought by consumers for fear that they, too, are contaminated with the red tide toxin.

Research, however, has been initiated just recently i.e. in the 1990's, due primarily to lack of training manpower and equipment for this specific field of research. A few marine scientists and chemists working in other related fields had to be re-trained or further trained to work initially in collaboration with some foreign experts. At present, works are being undertaken on the biology and ecology of the causative organisms. A culture of the organism has been established at the Marine Science Institute since 1991. An oceanographic study has been started in Manila Bay to help understand the dynamics of the bloom in this area which has been plagued by the menace since 1987. A newly Agency's (CIDA) Marine Science Program is the "ASEAN-Canada Red Tide Project" with various sub-projects in the region. In the Philippines, the following components are included in this project 1) Ecophysiological studies on *Pyrodinium bahamense* var. *compressum* 2) Manila Bay Oceanographic Studies and 3) ASEAN-Canada Red Tide Awareness and information Networking (Coordinator: Dr. R.A. Corrales).

A nationwide "Training on Red Tide Monitoring and Data Management" had been recently implemented by the U.P.- Marine Science Institute with funding from the Department of Agriculture's Fisheries Sector Program. The trainees were from government agencies and interested and committed universities. Aside from trained personnel, the other output include 1) "Field and Laboratory Manual for Philippine Red Tide Monitoring and Date Management" - topics included are standard methods on plankton (particularly *Pyrodinium*) identification and quantification, selecting and sampling of sentinel species, shellfish toxicity determination, physical and chemical hydrography measurements, epidemiology, data management and decision-making. 2)

A software called "Red Tide Data System" to standardize collection and storage of monitoring data to facilitate nationwide information exchange 3) A "Red Tide Information System" (using CDSIS) a data base of available information from books, journals and reprints, and 4) A video production for instruction purposes and for education of the laymen 5) Nationwide networking of trained personnel and trainers.

The Government, specifically the Congress of the Philippines are now in the process of considering two possible Bills for Legislation. These are 1) National Shellfish Sanitation Code and 2) The creation of a National Harmful Algal Commission.

Red tide occurrence:

The first recorded *Pyrodinium* red tide in the Philippines occurred 1983 in Samar, central Philippines and since 1987 the phenomenon has been recurring annually in various localities of the country. Cases of paralytic shellfish poisoning (PSP) also coincided with the red tide recurrence.

Management strategies:

To mitigate the adverse effects of red tide, early detection of the phenomenon through monitoring is important.

The Red Tide Task Force under the Inter-Agency Committee on Environmental Health was created to co-ordinate the national red tide monitoring programme in the Philippines. Monitoring of the coastal waters with history of red tides are being conducted to detect the presence of the red tide organism in the seawater and to determine the toxin level in shellfish.

In 1992, the Red Tide Task Force lowered the maximum tolerable limit of 80 μg per 100 g of shellfish meat set by the World Health Organization to 40 μg per 100 g since there are cases of paralytic shellfish poisoning (PSP) in the Philippines with toxin level of 40 μg per 100 g.

As soon as the red tide organism has been detected in the seawater, the Task Force issues warnings through mass media to alert/advice the consumers particularly children to refrain from eating too much shellfish and as soon as the toxin level in shellfish reaches the regulatory limit of 40 μg per 100 g, the Inter-Agency Committee on Environmental Health imposes a temporary ban gathering, harvesting, marketing and transporting of shellfishes from the red tide affected areas. Checkpoints are established at strategic locations, such as piers, airports and bus routes, to ensure that no contaminated shellfish are moved out of the red tide areas. Likewise, information on red tide are disseminated through lectures, broadcast and print media; brochures and leaflets are also distributed to the general public. The Task Force also recommended to the Department of Education, Culture and Sports the inclusion of the phenomena in the textbooks of elementary students. A consultative dialogue between the task force and fishermen was carried out to involve the participation of the fishermen in the formulation and implementation of plans and strategies of managing the red tide in the country. To abate the several effects of the phenomenon on the livelihood of marginal fishermen, shellfish growers and vendors during red tide outbreaks, the Office of the President declares the affected area as a calamity area and releases calamity funds for alternative livelihood projects of affected marginal fishermen.

Needs:

In view of the rapid temporal and partial expansion in the Philippines of problems related to harmful algae, the following needs should be addressed at the national, regional and international levels:

1. Permanent structural organization/personnel and regular source of funds for nationwide monitoring.

2. Equipment for monitoring and research specially in areas where they are most needed.

3. Research on the development of low cost and reliable monitoring

4. Reference materials, (Books, etc.) for research and monitoring

5. Training/Workshop on the practical aspects of harmful algal blooms i.e. mitigation and management

6. Educational materials for the laymen and fishermen

7. Training of trainers who could do then do the national or local training of monitoring personnel.

8. Research in order areas affected or potentially to be affected by the blooms (i.e. aside from Manila Bay) and an other topics relating to harmful phytoplankton to anticipate and recognize potential problems.

PORTUGAL

Harmful algal bloom are affecting the portuguese coast causing serious problems to shellfish fisheries and aquaculture. A noticeable expansion of the affected areas by the blooms has been recently occurring.

It is therefore urgently to establish an adequate research and study programme to clarify the cause and mechanism of the blooms and to develop counter measures.

However it might be difficult both technically and financially to hold a broad programme with substantial results in short time by one country.

In this context we consider the program proposed by the ad hoc planning committee very important to accumulate scientific information. We expect to contribute with our experience to facilitate the implementation of the programme, and that the sciences concerning HAB will progress through co-operative studies among member countries in the program.

Research on harmful algal blooms in Portugal:

The monitoring for harmful algal blooms and their effects has been carried out in Portugal since 1986 through a net work set up by the Portuguese Institute for Fisheries Research (Instituto Nacional de Investigaçao das Pescas - INIP) as a result of the extensive development of PSP caused by *Gymnodinium catenatum* and DSP caused by *Dinophysis* spp.

The ban of shellfish catch and marketing is lifted after two negative successive mouse-tests.

References:

Franca, S. and Almeida, J.F. (1989): *Paralytic shellfish poisons in bivalve molluscs on the Portuguese coast caused by a bloom of the dinoflagellate Gymnodinium catenatum.* In: Okaichi, Anderson and Nemoto (Eds): Elsevier, 93-96 pp.

Sampayo, M.A.M. (1989): *Red tides off the Portuguese coast.* In: Okaichi, Anderson and Nemoto (Eds): Elsevier, 89-92 pp.

Apart from the monitoring program Portugal has also other projects concerned with harmful algal blooms like:

1. - DIFTOX Dynamic of toxic phytoplankton at the Portuguese coast, based on research cruises along the coast and toxin data from shellfish.

2. - Salubrity of bivalves at Setubal Peninsula which includes bacteriological studies as well.

3. - Cultures of toxic species to study toxins production and spectra mainly with *Gymnodinium catenatum* and *Alexandrium lusitanicum.*

4. - Implementation of HPLC method for DSP toxins.

5. - Improvement of HPLC method for PSP toxins detection.

6. - Okadaic acid and DTX1 production from *Prorocentrum lima*

7. - Studies with ictyotoxic species like *Heterosigma akashiwo, Prymnesium parvum, Amphidinium carterae.*

The monitoring has three objectives:

- To collect data on phytoplankton population in Portugal and provide information on the occurrence and distribution of harmful algae.

- To detect and monitor the presence of species toxic to man to propose administrative measures to ensure maximum limitation of harmful effects.

- To detect and monitor the presence of species toxic to marine animals.

The portuguese monitoring system consists of 85 sampling stations:

- 54 survey station on which sampling is performed systematically throughout the year;

- 31 warning station can supplement the monitoring stations if toxic species appear.

These stations are distributed along the entire length of the portuguese coast and inside estuaries and coastal lagoons.

Samples are taken at surface or in a 5 m integrated water column throughout the year with a frequency which varies with the season or with the occurrence of toxic species: twice a month from November to April and once a week from May to October.

All phytoplankton is counted but special attention is given to toxic or suspected to be toxic species.

If a toxic species producing DSP is present: a mouse-test on shellfish hepatopancreas extract is used (Yasumoto's method) with a threshold equal to five hours.

If a toxic species producing PSP is present: a mouse-test is conducted using A.O.A.C. method.

The warning system is activated through the National Health authorities and in event of confirmed toxicity measures are taken to prohibit the catch and marketing of shellfish from the incriminated areas.

SPAIN

Spain established a monitoring programme in various localities in 1977 following a major PSP outbreak in 1976 which affected several European countries. Since then, the monitoring of potentially harmful algae and associated environmental parameters has been carried out by the Instituto Español de Oceanografía (IEO) and the monitoring of toxins in bivalves by the regional and national health authorities (Consejerías de Sanidad y Consumo, Ministerio de Sanidad y Consumo).

The main areas presently involved are the coastal waters of Galicia (NW Spain) and the Ebro Delta region (Northern Mediterranean coast). Following the EEC directive on "Quality of waters for marine cultures", monitoring of coastal waters is being expanded to all Spanish coastal waters and the responsibility has been transferred to the regional governments.

The main problems relevant to the HAB programme are associated with Paralytic Shellfish Poisoning (PSP) caused by *Gymnodinium catenatum* and *Alexandrium minutum*, and Diarrhetic Shellfish Poisoning (DSP) associated with *Dinophysis* spp. These species render the mussels and other bivalves toxic at concentrations of a few thousands cells per liter (PSP), or even a few hundreds per liter in the case of DSP outbreaks associated with *Dinophysis* spp. These occur annually and create serious problems for the mussel culture industry in Galicia, one of the largest in the world with an annual production of around 200,000 t. In recent years, PSP outbreaks associated with *G. catenatum* have been recorded in Málaga (Southern Mediterranean coast), and PSP associated with *A. minutum* in the Ebro Delta region. Problems associated with excess biomass and mucus production, similar to those in the Adriatic Sea, have taken place in the last two years in the eutrophic coastal waters of Valencia (Central Mediterranean coast) causing important losses to fishing and tourism.

National Coordination

A National Programme on Harmful Algal Blooms is not yet established in Spain. Good communication between HAB experts takes place in the "Iberian Workshops on Toxic Phytoplankton and Marine Biotoxins" that have been held every year since 1990.

Closer communication has been developed between the Galician experts (IEO, CSIC, Universities), through quarterly regional meetings for coordination of activities.

A one day meeting was held in Vilaxoán (Pontevedra, Spain) in April 1993, following the III Iberian Workshop, chaired by Rafael Robles, general Director of the Instituto Español de Oceanografía (IEO), to collect scientists opinion's about the establishment of a *"Scientific and Coordination Center for HAB"* in the Centro Oceanográfico de Vigo (IEO). After a unanimous agreement of the participants (from IEO, CSIC, Xunta de Galicia, Spanish Universities), in favour of the interest and advantages of establishing such an office, the scientists offered their support in their respective fields of expertise, and made suggestions about the tasks this Center could undertake. A summary of the suggestions and the list of participants is appended to this report.

International Representation

Phytoplankton experts from the Centros Oceanográficos de Vigo and La Coruña (IEO) have played an active role as members of the different Working Groups and Special Meetings of the International Council for the Exploration of the Sea (ICES) since 1984.

B. Reguera (IEO, Vigo) and T. Wyatt (IIM, Vigo) have participated as invited experts on the IOC-SCOR *ad hoc* Group of Experts to design the IOC Programme on Harmful Algal Blooms (Newport, U.S.A., October 1991).

An ICES/IOC Study Group on the Dynamics of Algal Blooms was established in 1992 (chairperson: Beatriz Reguera, IEO, Vigo) to plan and propose a programme to advance knowledge and predictive capabilities of harmful algae proliferations. Scientists from several Spanish Institutions contributed to this meeting either as members or as invited observers. The Atlantic coast of the Iberian Peninsula was chosen as an appropriate site to develop one of the three ICES pilot programmes (Iberia, Gulf of Maine, Skagerrak-Kattegat) on population dynamics of harmful species. During the second meeting of this group (Charleston, 1993), the interdisciplinary character of the group was consolidated by means of a Joint Session with the ICES Working Group on Shelf Seas Oceanography. The Study Group has now become the "Working Group on Harmful Algal Blooms Dynamics" (still under the chairmanship of B. Reguera), and will constitute an strong link between ICES and the IOC programme on *Harmful Algal Blooms.*

The laboratory of Sanidad Exterior (MSC) in Vigo has been nominated EC Reference Laboratory for Marine Biotoxins (1993).

M. Estrada (ICM, Barcelona) is an invited expert to the SCOR Working Group 97 on Ecophysiology of Harmful Algal Blooms (La Rochelle, October 1993).

B. Reguera (ICES Representative and Spanish Delegate) and T. Wyatt (IOC Consultant) have participated in the two IOC-FAO intergovernmental panels on Harmful Algal Blooms (UNESCO, 1992 and 1993) to pursue the implementation of the programme and identify national resources devoted to it.

Ongoing projects in 1993 related with the different scientific and operational elements of the HAB programme are listed on the following pages. In recent years, new efforts have been devoted to basic and applied research on marine biotoxins. One of the main goals in the near future is the establishment of a large regional programme (Galicia-Portugal) to develop the ICES pilot study on HAB Dynamics. About 4 regional workshops will be developed between 1993 and 1994 between Spanish and Portuguese scientists to review the existing knowledge and finish planning the future programme.

SPANISH RESOURCES DEVOTED TO HAB RELATED STUDIES

1. SCIENTIFIC ELEMENTS

Ecology and Oceanography

1. "Research and Control of Red Tides in the Oceanographic Center of La Coruña" (J. Mariño) Centro Oceanográfico de La Coruña (IEO). IEO project 11.01.

2. "Monitoring of environmental parameters by teledetection" (C. Hernández) Universidad de Santiago de Compostela, Faculty of Physics, La Coruña.

3. "Multidisciplinar oceanographic study in the northwest coast of the Iberian Peninsula" (J.M.Cabanas) Centro Oceanográfico de Vigo (IEO). IEO project 13.01.

4. "MARE" (M.Estrada) ICM (CSIC- Barcelona). An EC project about the eutrophication of the Adriatic Sea, in cooperation with France, Sweden, Italy, Germany, Portugal, Croatia...

5. "Role of algal viruses on the control of red tides" (J.J. Borrego) Universidad de Málaga. Supported by Caja Madrid.

6. "Effects of mussel culturing on nutrients and phytoplankton in Ría de Arosa" (J.Blanco) CIM, Xunta de Galicia.

7. "Study of the interactions phytoplankton-mussels in Ría de Arosa through the analysis of pigments by HPLC" (M.Zapata), CIM, Xunta de Galicia.

8. "Study and monitoring of the oceanographic conditions and the primary production in Ría de Vigo" (F.G. Figueiras) IIM (CSIC-Vigo), supported by CICYT and the Xunta de Galicia.

9. "Multidisciplinary Oceanographic Research in the Eastern Boundary of the North Atlantic" (J.M. Cabanas) IEO-Vigo, (F.F. Pérez) IIM (CSIC-Vigo). A MAST-II project of the EC in cooperation with Portugal (Coordinator), U.K. and Norway.

10. "Dynamics of biomass espectra, metabolism and submicronic particles in microplanktonic food webs in meso and microcosms" (J. Rodríguez) Universidad de Málaga. CICYT project AMB93-061V-CO2-01.

11. "Carbon flux through the pelagic community in an upwelling area" (R. Anadón) University of Oviedo. CICYT project AM92/0834.

12. "Relationships between total, export and new production, and accumulation of biogenic materials in an upwelling area" (A. Bode) Centro Oceanográfico de La Coruña (IEO). CICYT project AM93/0014.

13. "Historical series of oceanographic data" (M. Varela). Centros Oceanográficos de Santander, La Coruña, Vigo and Fuengirola (IEO), and Universidad de Oviedo. IEO project 10.05.

Taxonomy and Genetics

1. "Ecophysiology and taxonomy of toxic dinoflagellates" (B.Reguera) Centro Oceanográfico de Vigo(IEO). IEO project 11.02.

2. "Classification of marine phytoplankton (dinoflagellates) using neural networks" (B.Reguera) Centro Oceanográfico de Vigo (IEO). MAST-II project of the EC, in collaboration with U.K. (Coordinator), and Italy.

3. "Mitogens and cellular proliferation in primitive eucariots: an evolutive approach using protists" (E. Costas) Faculty of Veterinary, Universidad Complutense de Madrid. CICYT project PB91-0369 DGICYT.

4. "A system for the quick detection of toxic algae (dinoflagellates and blue-green algae) in freshwater and seawater" (E. Costas) Faculty of Veterinary, U.Complutense de Madrid. Supported by Fundación Ramón Areces.

5. "Exploration of Microbial Diversity" (I. Bravo) IEO-VIGO. An EC network project of 18 institutions from Germany (coordinator), U.K., Ireland, The Netherlands, France, Portugal, Denmark.

Toxicology and Toxin Chemistry

1. "Determination of PSP toxins in bivalves and in dinoflagellate cultures. Dynamics of intoxication and detoxification in cultivated mussels" (J.M.Franco) IIM (CSIC) Vigo, and Centro Oceanográfico de Vigo (IEO). CICYT project ALI 92-0111-CO2-01.

2. "Study of the toxicity produced by dinoflagellates and the bivalves contaminated by them in the Galician Rías" (A. Martínez)(Coordinator) MSC, Sanidad Exterior de Vigo; (B. Reguera) IEO-Vigo; (J.M. Franco) CSIC-Vigo; (M. Botana) Universidad de Santiago. FISss (MSC) project 89/0015-4.

3. "Study of new bioactive substances from red tides dinoflagellates. Biosynthesis of DSP toxins" (M. Norte) Universidad de La Laguna. MEC Project.

4. "Biochemical and toxicological properties of seafood contaminating biotoxins" (A. Novelli). Universidad de Oviedo. MEC Project.

5. "Biotoxins Analysis in bivalve molluscs: Technology, stability and comparison with bioassay methods" (J. Vieitez) Spanish Association of Canned Seafood (ANFACO), Vigo. CICYT project ALI92-0111-CO2-02.

6. "Development of a fluorescent technique on solid phase for analysis of DSP toxins" (L. Botana) Pharmacology Department. Universidad de Santiago. CICYT (PETRI) funded.

7. "Application of simple strategies to build *trans* fused complex polyetheric systems. Stereo controlled synthesis of the oxocyclic skeleton of Ciguatoxin" (J. Delgado) Universidad de La Laguna; (L. Cándenas) Universidad de Valencia. MEC Project PB92-0487.

8. "Biotin receptor assay for determination of Paralytic Shellfish Poison (PSP) and Diarrhetic Shellfish Poison (DSP)" (L. Botana) Pharmacology Department. Universidad de Santiago. A BCR project of the EC (Spain and Portugal).

9. "Isolation and purification of okadaic acid" (M.Norte) Universidad de La Laguna. Funded by BCR (EC).

10. "Preparation of lyophilized mussel and mussel extract for an interlaboratory study on HPLC method for the analysis of P.S.P." (P.A. Burdaspal), Instituto de Salud Carlos III, Madrid. Funded by BCR (EC).

2. OPERATIONAL ELEMENTS

Monitoring - Resource Protection

Monitoring of Phytoplankton and environmental parameters:

- "Control of the Oceanographic conditions and phytoplankton in the Galician coasts". Centro para control de calidade do medio marino" (J. Mariño). Consellería de Pesca. Autonomous Government of Galicia. Assessed by IEO-La Coruña.

- "Monitoring of phytoplankton along the catalan coast in relation with bivalve cultures" (M. Delgado), ICM (CSIC-Barcelona). Sponsored by the Autonomous Government of Cataluña.

Public Health and Seafood Safety

Monitoring of PSP and DSP toxins (mouse bioassay, and HPLC in some cases):

- Consejería de Sanidad y Consumo. Xunta de Galicia
- Consejería de Sanidad. Generalitat de Cataluña
- Consejería de Salud Publica. Junta de Andalucía.

- Consejería de Sanidad. Generalitat Valenciana

Control of toxins in imports and exports:

- Sanidad Exterior de Vigo, (A.Martínez) MSC (National Reference Center; European Community Reference Laboratory for Biotoxins Analyses).
- Centro Nacional de Alimentación de Majadahonda. (Burdaspal) MSC (Madrid)

3. EDUCATIONAL ELEMENTS

Information Network

- "Harmful Algal News" edition, (T.Wyatt, Y.Pazos), IIM (CSIC), Vigo.

- "Scientific and Technical cooperation network on Harmful Algal Blooms" Proposal to be resubmitted to the EC convocatory on Human Capital and Mobility (November 1993);IOC (coordinator),(B. Reguera) IEO-Vigo, and 11 more institutions from the EC.

- Aulas Ibéricas sobre fitoplancton tóxico y biotoxinas (Spain-Portugal workshops on HAB issues held every year since 1991).

Training

- Analyses of toxins by HPLC and students with grants working on the subject are addressed at several universities:
  . University of La Laguna, Tenerife (M. Norte) DSP toxins.
  . University of Santiago (Coruña) (M.A. Mouriño) PSP toxins
  . University of Vigo (Pontevedra) (J.A.Rodríguez), DSP toxins.
  . University of Santiago, Colegio Universitario Lugo (Lugo) (M.Botana) PSP toxins.

- The C.O. de Vigo (I.E.O.) has carried out training about phytoplankton monitoring, taxonomy, cultures, etc to South American individual visitors, who lived in the laboratory (1-3 months visits).

- European Community Reference Laboratory. Organization of Intercalibration exercises on different techniques for toxins detection and analysis.

ACRONYMS

ANFACO: Asociación Nacional de Fabricantes de Conservas, Pescados y Marisco.

BCR:	Community Bureau for Reference Materials.
EC:	European Communities
CICYT:	Comisión Interministerial de Ciencia y Tecnología
CIM:	Centro de Investigaciones Mariñas (Xunta de Galicia)
CSIC:	Consejo Superior de Investigaciones Científicas
IIM:	Instituto de Investigaciones Marinas (Vigo)
ICM:	Instituto de Ciencias del Mar (Barcelona)
FISss:	Fondos de Investigación Sanitaria de la Seguridad Social
IEO:	Instituto Español de Oceanografía
C.O. Vigo:	Centro Oceanográfico de Vigo
C.O. La Coruña:	Centro Oceanográfico de La Coruña
MAST-II:	Marine Science and Technology (2nd convocatory)
MEC:	Ministerio de Educación y Ciencia
MSC:	Ministerio de Sanidad y Consumo

SWEDEN

Recent blooms:

Aug-Sept. 1992: *Pseudonitschia pseudodelicatissima* on the west coast in quantities up to 9 million cells per l. The species is normally occurring but in much smaller quantities. Mussels were checked for domoic acid. *Mesodinium nibrum* bloom occurred in Skagerrak.

September 1992: *Prorocentrum minimum* in the Baltic (Southern Stockholm archipelago) in quantities up to 800 000 cells per l. This algae was first observed in the Baltic in 1990).

Monitoring programs:

Sweden has a surveillance programme in which 3 reporting centrals are involved. The programme is co-ordinated by the National Environment Protection Board and the centrals run by country governments and SMHI (Swed. Meteorological and Hydrographical Institute). Stations for plankton collection in the reporting programme mostly are the same as for the regular coastal monitoring.

The 3 centrals will be parts of a possible hot line network discussed for the Baltic.

Working groups:

A national working group on HABs has been created in 1993 with the following aims:

1. Enhance contacts between scientists, including physical and chemical oceanographers;
2. Support and co-ordinate research
3. Improve management and information
4. Co-operate internationally.

National programme:

Discussions are carried out on creating a national HAB programme, which also should include already ongoing activities. It is suggested that funds be made available by the National Environment Protection Board, possibly in co-operation with other bodies. The first outline is expected to 1 November 1993 and would contain most aspects on HABs.

THAILAND

Red tide is not a new phenomena to Thai people. Thai fishermen knew this phenomena very well for a long time and referred to it as "Khee Pla-Wan" in Thai word. *Noctiluca scintillans* and *Trichodesmium erythreaum* are the common red tide organisms in Thai waters and sometimes the bloom of these two species caused fish died due to the oxygen depletion.

In 1983 the first outbreak of PSP took place at Pranburi River mouth which located in the western part of the Gulf of Thailand. There were 63 patients and 1 fetal during that event but the causative organism has not been clarified yet and since then PSP has never occurred again.

Red tide in Thai waters now occurred more frequently, especially in the Inner Gulf of Thailand. The finding of *Alexandrium cohorticula* and the bloom of *Chattonella* and *Heterosigma* in some shrimp farms in the eastern part of the Gulf indicated that red tide will be very important problems in the near future.

To minimize the harmful effects and try to predict red tide phenomena, the Red Tide Research committee of the Fisheries Department has been organized to solve the problem by conducting some research projects which are :

Red tide monitoring survey by ultralight aircraft

This project is a co-operative study between Marine Fisheries Division and the Department of Industrial Works and the Environmental Flying Group. The members of this group fly as a sport every week along the coastal areas of the Inner Gulf, once they have observed the seawater discoloration they will inform to the committee immediately, then the committee will set a survey team to collect the samples from that incidence area for identification of the causative organism and for the analysis of seawater quality. The years data of this project revealed that blooming of *Noctiluca* is the mainly red tide phenomena in Thai waters, especially in the Inner Gulf. The blooms occurred seriously during July to September in the eastern part of the Gulf and during December to February in the western part of the Gulf.

The monitoring of red tide organism and seawater quality

This project was carried out in the eastern part of the Gulf by Marine Fisheries Division and for the western part has been carried out by the co-operative study between marine Fisheries Division and the Department of Pollution Control under the supporting fund from ASEAN-Canada Programme on Marine Science Phase II.

The study on biology, physiology and cyst of some red tide organisms under laboratory conditions will be carried out next year.

The training programme

To promote the study of red tide phenomena, the training programme should be held as much as possible and continuously. In May 1993 the in-country training workshop on general biology and ecology of red tide phenomena has been held at Rayong Province by Marine Fisheries Division and Department of Pollution Control which sponsored by ASEAN-Canada Programme on Marine Science Phase II.

An attempt to initiate the red tide center of Thailand

Marine Fisheries Division plan to promote the red tide center of Thailand as soon as possible in order to share and to provide the red tide information among Thai scientists and WESTPAC countries. Other activities such as study programme, training programme and so on will be developed after this center has been already organized.

The red tide studies of other institutes and universities have been listed as the following:

1. Phuket Marine Biological Center has a project on monitoring the algal bloom along the western coast of Thailand.

2. Prince of Songkla University has a project on the ecological study of harmful algae in lake and sea at Songkla area.

3. Institute of Marine Science, Burapha University, has a project on the impact of red tide along the coastal area of Chonburi Province.

4. Chulalongkorn University, Burapha University and Marine Fisheries Division has a cooperative study on harmful algal blooms with some Japanese scientists under JSPS-Core-University Programme, which will start next year.

5. National Research Council of Thailand has a project on measurement of attenuation coefficients of blue green and red light through the sensors installed in oceanographic buoys.

UNITED KINGDOM

The UK monitoring and research programme remains very much as described in the report of the First Session of the IPHAB-I, Annex V, p 31, and the last year was a period of consolidation.

The UK programme is driven mainly by four factors:

1. Concern for seafood safety and public health

2. Compliance with EC Directives

3. Development of alternative methods to replace animal assays

4. Need to minimize the effects of toxic algal blooms on the shellfish industry

A monitoring programme is undertaken in all areas to detect algal toxins in shellfish, requiring some 7,000 assays per year for PSP and DSP combined.

A significant addition has been made to the research activities this year. The Department of Health is funding a project at the Central Public Health Laboratory, Colindale (contact Ann Scoggins), to develop alternative assays for DSP. The first phase is to bring in-house HPLC based analytical methods for DSP up to the present state-of-the-art.

UNITED STATES OF AMERICA

Background

Marine biotoxins and harmful algae represent a significant and expanding threat to human health and fisheries resources throughout the United States. A summary of these problem is given in Annex V of the report of the First Session of The IOC-FAO Intergovernmental Panel on Harmful Algal Blooms (IOC-FAO/IPHAB-1/3). Briefly, the nature and extent of the HAB problem in the U.S. has changed considerably over the last two decades. Where formerly a few regions were affected in scattered locations, now virtually every coastal state is impacted, in many cases over large geographic areas and by more than one harmful or

toxic algal species. Virtually all of the major marine toxin syndromes of algal origin occur in the U.S.. These include: paralytic shellfish poisoning (PSP), neurotoxic shellfish poisoning (NSP), amnesic shellfish poisoning (ASP), ciguatera fish poisoning (CFP), and mortalities of farmed and wild fish. In addition, blooms of non-toxic but noxious or harmful algal species occur that cause economic losses and/or marine faunal mortalities due to oxygen depletion or light absorption. Other blooms adversely affect the aesthetics of the coastal environment.

Recent developments

In the past, the U.S. approach to the HAB problem has been to manage threatened resources through harvesting restrictions and toxin monitoring, and to provide relatively minor and often unsustained research support. Few government agencies were committed to in-house research on HAB's or marine biotoxins in any significant way, so research progress was heavily reliant on the academic community. This approach has changed in recent years, as several major agencies, notably the NOAA National Marine Fisheries Service (NMFS) and the Food and Drug Administration (FDA) have now joined forces with the academic community and are directing agency resources and personnel to HAB problems. Unlike those countries with co-ordinated national research and monitoring programmes for HAB's however, the U.S. did not have a national programme or strategy that attempted to focus the approach to this diverse problem.

National plan

Over the last 12 - 18 months, this situation has changed considerably. The first major step was an NMFS-sponsored workshop in which participants from federal and state agencies, as well as the academic community and the fisheries industry met to identify major impediments to progress in the area of marine biotoxins and harmful algae, and to recommend solutions. The goal of the workshop was to prepare a framework for action that would lead to effective management of fisheries, public health, and ecosystem problems related to marine biotoxins and harmful algae.

Twenty-eight major impediments to progress were identified and recommendations made as to how to overcome them. These are too numerous to list here, can be summarized as follows:

Deficiencies related to biotoxins: Toxin standards are largely unavailable; standard sample preservation and handling protocols do not exist; existing assay methods are inadequate for monitoring and research; molecular pharmacology and pharmacokinetics of marine biotoxins are poorly understood; diminution or loss of toxin production can occur in laboratory algal cultures; mass culturing of most toxic species is difficult.

Lack of information on harmful algae: Algal bloom dynamics and species succession are complex and not yet predictable; the relative effects of natural versus anthropogenic influences on population size, species composition, bloom longevity, and toxin production are unknown; knowledge of the physiology of growth and toxin production is inadequate; toxin standards and rapid assay methods are lacking; availability of isolates of toxic or harmful algae is limited.

Lack of information on impacted fisheries resources and protected marine resources: Toxin uptake, metabolism, and depuration in shellfish, fish, and other marine animals is poorly known; toxin sensitivities of different life history stages, and long-term effects of algal metabolites on growth, reproductive success and recruitment are unknown; movement of toxins through the food web is poorly understood; databases are inadequate and not readily accessible to potential users; methods for rapid field assays of fish or shellfish are lacking; toxin standards are often unavailable; analytical methods for toxin detection in animal tissue need improvement.

Inadequate mechanisms and knowledge to protect public health fully: Early warnings of known and unknown toxins are required to protect consumers and industry; assay methods need improvement; toxin standards are not always available; sampling programmes are inadequate for bloom detection or characterization; the extent of seafood poisonings is poorly documented; the fate and metabolism of toxins in humans is unknown.

The workshop report, *Marine Biotoxins and Harmful Algae: A National Plan* (Anderson et al., 1993) is now being used by numerous agencies, commercial interests, and individual scientists as a planning document

to guide future activities. This would probably be a useful document for other countries that are attempting to expand and co-ordinate their HAB research and monitoring activities.

Ad hoc Interagency Task Force on Marine Biotoxins and Harmful Algae

The *National Plan* established a framework for progress, but implementation of the plan requires the attention of programme directors within several different government agencies whose responsibilities include marine biotoxins or harmful algal blooms. No single agency can address all of the impediments identifies in the *National Plan*, but most can be covered by the combined efforts and resources of several organizations. An *ad hoc* Interagency Task Force was thus established, with representatives from the Food and Drug Administration, the National Science Foundation, several NOAA agencies or programmes, the Department of Defense, and the National Institute of Environmental Health Sciences. Representatives are being sought from the Environmental Protection Agency and the Centers for Disease Control. The task force has met twice, and will continue to meet in the future to discuss the details of implementing a co-ordinated national programme.

NMFS Saltonstall-Kennedy Funding for HAB Projects

As discussed above, several U.S. agencies provide funding for HAB-related projects. A notable increase in financial support to this field has occurred during the last several years through the efforts of key personnel within the National Marine Fisheries Service (NMFS) who have highlighted HAB issues in the annual solicitation of proposals for funding within the Salton-Kennedy Programme. Funds for this programme come from taxes on imported fisheries products. Working with the list of impediments and recommendations from *National Plan* report, areas targeted as priorities have been identified and projects addressing these areas have been funded. In this manner, the *National Plan* has given the field visibility and recognition that have helped to establish HAB issues as national priorities worthy of enhanced support. The Plan has also helped to guide the specific directions in which funds are allocated.

National Science and Communication Center

Another important step required to foster the development of the U.S. programme and to facilitate international co-ordination on HAB issues was the establishment of an "office" located at Woods Hole Oceanographic Institution and directed by Donald M. Anderson. This can be viewed as a National Science and Communications Center, as described in the report of the First Session of the IOC-FAO Intergovernmental Panel on Harmful Algal Blooms. Support for this office, which comes from the National Science Foundation and the NOAA National Marine Fisheries Service, will allow the U.S. to participate fully in international workshops, panels, working groups, and other HAB activities. The office will also assist in the co-ordination of U.S. HAB activities through the *ad hoc* Interagency Task Force, and will serve as a contact point for scientists, administrators, journalists, and other wishing information on specific aspects of U.S. HAB research or monitoring efforts.

Workshop on the Ecology and Oceanography of Harmful Algal Blooms

One area where special efforts is needed at the national level concerns the ecology and oceanography of HABs. The oceanographic areas to be addressed are many and diverse, as are the organisms involved at all levels of the food chain. The *National Plan* identifies numerous areas where research is needed, but it is simply a framework that must be refined by individual programmes. Implementation of major initiatives funded by NSF, NOAA, and other agencies will only proceed if detailed science plans are formulated, priorities and time scales established, and resource needs identified. The history of past multi-investigator, multi-disciplinary programmes indicates that a science workshop is needed to discuss the most compelling scientific issues facing each of the component scientific disciplines and each of the regions to be represented within an HAB programme. A workshop will therefore be convened, with participation open to the general U.S. scientific community. Details of the proposed workshop on the ecology and oceanography of harmful algal blooms are to be worked out in discussions between the National Science and Communications Center and programme managers at NSF, NOAA and other interested agencies, but the approach will likely resemble those of GLOBEC and other similar programmes.

This HAB workshop faces several challenges which may in fact become major selling points in favor of the programme. One is that the problem is regional in nature -- with at least four large oceanographic and ecological regimes easily identified along the northeast, southeast, northwest and southwest coasts of the U.S.

Other areas can also be identified where planktonic blooms are not a problem, but benthic algal blooms are. On the one hand, this could lead to parochialism and competition between workshop participants. However, these differences can be turned into advantages through the development of a comparative programme that would allow several regional groups to work separately on major field and laboratory efforts designed around their particular harmful algal bloom phenomena, but all co-ordinated and communicating within the context of a national framework as well. Common mechanisms as well as fundamental differences can be identified with this approach, leading to a much deeper understanding of the overall HAB problem. The regional focus will also help broaden the political and funding bases for a programme of this size.

Another challenge to the workshop stems from the diverse nature of the HAB problem and the many subdisciplines involved in its study. Programme managers will be looking to the workshop participants to prioritize their recommendations, but each will have difficulty separating the perspective of their own subdiscipline from the needs of the programme in general. Prioritizing was avoided during the workshop for the *National Plan*, but the ecology and oceanography workshop will need to be more specific in its recommendations and more objective in its prioritizing. The output of the workshop will be a document that tells programme managers not only what specific projects are needed and where, but why the time is right from conceptual and technical standpoints, and what is needed in the way of resources and technique development if the programme is to proceed to a fruitful completion. This workshop obviously poses a major challenge, but it is absolutely necessary if sound ecological and oceanographic programmes are to be attempted.

Marine Toxin Conference Calls

During the intersession between Intergovernmental Panel meetings, an effort was made to increase communication between scientists and regulatory officials in all states affected by HABs. Networking options ranging from electronic mail bulletin boards to faxes were considered, and a conference call format chosen. A series of marine toxins conference telephone calls was thus established, supported by the U.S. Food and Drug Administration. These calls are held once every month, sometimes once every several months, and involve as many as 40 participants at a time. (Canadian workers are also free to participate). An agenda is circulated by fax prior to each call, and a government operator makes the individual calls linked each participant to the common line. The calls lasted 1 1/2 hours. This is an excellent way to communicate the latest results of toxin analyses, as well as to discuss recent research results, forthcoming meetings, and other items of common interest to the national HAB community. The cost of this communication network is significant, however, amounting to approximately $ 2,500 per call, plus the service of a half- or full time co-ordinator. Because of these costs (and an apparent diminution in the severity of the domoic acid problem along the U.S. west coast where the conference calls are co-ordinated), the fate of the programme is uncertain at this time.

Outlook

The climate for research on marine biotoxins and harmful algae has changed significantly over the last several years, in parallel with similar changes that are occurring internationally. The same factors that have motivated IOC, ICES, FAO, SCOR, and other organizations to develop HAB programmes or activities have led the U.S. to expand its research and monitoring activities. Some of this motivation comes from the proliferation of new toxins, new harmful species, and newly impacted resources, but it also comes from a recognition that efficient utilization of scarce funding and personnel resources requires planning, co-ordination, and communication. The U.S. now has a *National Plan* to help guide future actions, as well as an Interagency Task Force and a Science and Communications Office.

Priority must be given to the HAB problems in the U.S., but these actions make it easier for the U.S. to participate in international activities as well.

References

Anderson, D.M., Galloway, B.B., and Joseph, J.D. (1993): *Marine Biotoxins and Harmful Algae: A National Plan.* Woods Hole Oceanographic Institution Tech. Report, WHOI 93-02. Woods Hole, MA, 59pp.

URUGUAY

Toxic outbreaks have increased considerably over the last 3 years in Uruguay.

The National Fisheries Institute (INAPE) has been carrying out a Red tide Monitoring Programme since the first toxic bloom in 1980.

This programme include continue toxic species control and estimation of Diarrhetic Shellfish Poisoning (DSP) and Paralytic Shellfish Poisoning (PSP) by biossay method.

Five stations located along the oceanic coast of Uruguay, are sampled each 10 days and eventually research cruises were carried out.

From 1980 to 1990 no toxic outbreaks were registered but the monitoring continued. Since 1991, until now, there had been 6 outbreaks affecting all the natural mussel beds in our coast. When the toxicity reach the limit of 80 μg STX eq. per 100 gr. of shellfish meat, INAPE recommend the authorities to impose temporary bans on the harvesting and marketing of shellfish.

Public communications and seminars with fishermen, Prefectures, local governments and public health Ministry are also conducted during toxic periods. A permanent experts group on harmful algal blooms was established in 1992 between Argentina and Uruguay at the binational commission CTMFM (Comision Técnica Mixta del Frente Maritimo).

The species associated with the toxic periods in Uruguay were Alexandrium tamarense, Gymnodinium catenatum and Dinophysis acuminata.

In our country there is not experts or professors in this topics, therefore it is important to participate in training courses and receive expertise assistance. For this reason we are very interested in continued participation in the IOC-HAB programme activities.

Uruguay applied for the IOC-HABP financial support to organize in 1994 a south american meeting on HAB, in order to know which are the phytoplankton problems in each country and plan future activities.

ANNEX IX

INTERACTION WITH OTHER ORGANIZATIONS

COOPERATION BETWEEN THE HAB PROGRAMME THE EEC

Dr. H. Barth, the Directorate General for Science, Research and Development, Commission of the European Communities (CEC), intended to participate in the Second Session of the HAB Panel but was finally unable to attend.

Since 1990 the CEC Community Bureau of Reference (BCR) has organized an intercomparison of analysis of PSP- and DSP-toxins in Europe. These intercomparisons were organized by Dr. X. Goenaga, BCR, Dr. L.G.M. Th. Tuinstra, RIKILT, The Netherlands (DSP), and Dr. H.P. van Egmond, Rijksinstituut voor Volksgezondheid en Milieuhygiene, The Netherlands (PSP). The two Intercomparisons were arranged as meetings in Brussels, Belgium, followed by "home-work" at the individual laboratories. The results were compiled by Dr. Tuinstra and Dr. Van Egmond, and the final reports and publications have been prepared. About 20 different European laboratories participated in the exercise.

The BCR has expressed interest in establishing collaboration between the BCR and IOC. Dr. Goenaga is now working in another CEC programme, the Air Programme, and has been replaced by Dr. Boenke at BCR.

COOPERATION BETWEEN THE HAB PROGRAMME THE IST

The International Society on Toxinology (IST), has expressed a direct interest in the HAB Programme. The President of IST, Prof. Dr. G. Habermehl, School of Veterinary Medicine, Hannover, Germany, was unfortunately not able to participate in the Second Session of the HAB Panel.

INTERNATIONAL PROGRAMME ON CHEMICAL SAFETY (IPCS)/WORLD HEALTH ORGANIZATION
ACTIVITY IN HUMAN HEALTH RISK EVALUATION OF PHYCOTOXINS

Intense international concern about the dangers of chemicals for human health and the environment, expressed at the United Nations Conference on the Human Environment, held in Stockholm in 1972 led to the establishment in 1980 of the International Programme on Chemical Safety (IPCS) which is a joint venture of the World Health Organization (WHO), the United Nations Environment Programme (UNEP), and the International Labour Organization (ILO).

The Programme was initially set up specifically to provide assessments of the risks to human health and the environment from exposure to chemicals, whatever their origin, man-made or natural, or wherever they are found. These assessments provide the internationally evaluated scientific basis on which countries may develop their own chemical safety measures. The programme provides guidance to countries on how to use such assessments, and also seeks to strengthen national capabilities to prevent and treat harmful effects of chemicals and to manage emergencies involving chemicals of both man made and of natural origin.

In 1984 the IPCS published an Environmental Health Criteria document on Aquatic (Marine and Freshwater) Biotoxins covering toxicology of several most important biotoxins such as paralytic shellfish poisons (PSP) ciguatera toxins, diarrhoeic shellfish poisoning (DSP), etc. Since the publication of this document much more scientific information on a number of marine and freshwater biotoxins became available. In recent years numerous outbrakes of human acute poisoning due to this class of natural toxins have occurred in many countries. It is therefore felt that an updating and revision of human health risk evaluation of phycotoxins is

timely and very much needed, particularly concerning possible harmful effects of low level exposure. In 1992 IPCS, together with International Life Sciences Institute (ILSI) Europe, formed a Steering Group on Naturally Occurring Toxins which set priorities for evaluation of phycotoxins (Table enclosed). The preparation for the revision and updating of the human health risk evaluation of phycotoxins is underway.

Environmental Health Criteria (EHC) documents are designed for scientific experts responsible for the evaluation of the risk incurred by chemicals to human health and the environment, enabling relevant authorities to establish policies for the safe use of these chemicals. The information conveyed is detailed enough to allow the scientific reader to make his/her own validation

Health and Safety Guides (HSGs) are designed for the wide range of administrators, managers, and decision-makers in various ministries and governmental agencies, as well as in commerce, industry, and trade unions who are involved in various aspects of using chemicals safely and avoiding environmental health hazards. Health and Safety Guides are short documents summarizing toxicity information in simple, non-technical language, and providing practical advice on matters such as safe storage, handling and disposal of the chemical, accident prevention and health protection measures, first aid and medical treatment in cases of over-exposure and clean-up procedures.

INTERNATIONAL UNION FOR PURE AND APPLIED CHEMISTRY

COMMISSION ON FOOD CHEMISTRY

The IUPAC Commission on Food Chemistry is composed of eight working groups whose activities focus on mycotoxins, aquatic biotoxins, elemental analysis, natural toxins (plant), halogenated hydrocarbon environmental contaminants, animal drugs, and effects of food processing. The Terms of Reference for the Aquatic Biotoxins Working Group are attached. The Commission has sponsored nine symposia at various locations worldwide on mycotoxins and/or phycotoxins. The last was held in Mexico City, November 8-11, 1992 and the next will be held in Rome, Italy in 1996.

Previous projects relating to aquatic biotoxins which have resulted in publications include worldwide regulations for phycotoxins, phycotoxins of public health concern, status of methods for the detection of seafood toxins, and interlaboratory study of the immunobead assay for ciguatoxins. Status reports for current projects are listed below:

*** 8th International Symposium and Workshop on Mycotoxins and Phycotoxins: Project 68/91 (Dr. Park, Dr. Pohland)**

The Commission co-sponsored the 8th International IUPAC Symposium and Workshop which was held in Mexico City, Mexico, November 8-11, 1992. Over 200 scientists representing 50 countries attended. Approximately 200 scientific presentations (lectures and posters) were made and publication of the proceedings is currently being arranged.

*** Collaborative study of the immunobead assay for ciguatoxins: Project 69/91 (Dr. Park)**

Results of the limited collaborative study where four laboratories participated demonstrated that the assay was ready for the expanded full collaborative study. The assay is designed to be a rapid procedure for screening in the market place under non-laboratory conditions. Details of the full collaborative include: (a) test portions of naturally incurred toxic and non-toxic fish collected from ciguatera endemic regions of the world (Hawaii, South Pacific and Caribbean) as well as portions where purified toxins (ciguatoxin, okadaic acid, brevetoxin) will be added at varied levels. Approximately 20 laboratories will participate in the study. This report was accepted by AOAC and a full collaborative study recommended. The preparation of

a manuscript reporting the preliminary collaborative study is underway and will be submitted to Food Additives and Contaminants for publication. The full collaborative study will be described in a new project proposal (Project 75/93).

New projects are:

Project 75/93. Collaborative study of the solid-phase immunobead assay for screening of ciguatera-related toxins in fish (follow up of project 69/91).

Precision and accuracy parameters of the method will be terminated through the distribution and analysis of coded test portions of naturally incurred toxic and non-toxic fish and artificially contaminated with known concentrations of ciguatoxin, okadaic acid, and brevetoxin. Several species of fish will be obtained from Pacific and Caribbean regions. Approximately 20 laboratories will participate in the study.

Project 76/93. Collaborative study of the solid-phase immunobead assay for screening DSP toxins in shellfish.
This study is similar to project 75/93 except toxic and non-toxic mussels from Europe will be included in the study and okadaic acid will be used for spiking the test portions.

Project 77/93. Unification of aquatic biotoxins nomenclature.
This project will focus on harmonizing terminology used in the scientific literature to classify and characterize aquatic biotoxins.

Project 78/93. Improved HPLC method for determination of domoic acid in shellfish.
Precision and accuracy parameters of the method will be determined through the distribution and analysis of naturally incurred toxic and non-toxic shellfish and artificially contaminated with purified toxin.

The IUPAC-CFC works closely with AOAC International on the method validation studies. Commission members also coordinate activities with Codex Alimentarius, FAO, and the European Community BCR. IUPAC-CFC is looking forward to future collaborative activities with IOC.

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IUPAC COMMISSION ON FOOD CHEMISTRY
Working Group on Aquatic Biotoxins

Function Statement

Introduction: The Working Group is the unit within the Commission on Food Chemistry charged with the responsibility of coordinating all IUPAC activities associated with contamination of food and water with aquatic biotoxins.

Specific activities: The Working Group shall:

a. Initiate and conduct research on aquatic biotoxins in food and water.

b. Initiate and conduct method performance studies of selected methods of analysis for aquatic biotoxins in food and water.

c. Address the issue of criteria of purity and stability of aquatic biotoxins.

d. Collect and evaluate data relative to incidence, regulations, levels and sources of contamination of food and water with aquatic biotoxins.

e. Collaborate with other international organizations involved in dealing with the consequences of human exposure to aquatic biotoxins.

f. Plan and conduct symposia on aquatic biotoxins.

Membership: All titular members, associate members and national representatives of IUPAC Commissions are eligible membership; membership is achieved by application to and acceptance by the Working Group Chairman. The Chairman may also co-opt experts from outside IUPAC to work on specific Working Group approved projects. In order to ensure good, orderly exchange of information the number of co-opted members should normally be 10 or less. Co-opted members will be invited to serve for a period of two years; active participation is the basis for extension of the period of service.

Meeting attendance: All co-opted members are encouraged to attend and contribute to the annual meeting of the Commission on Food Chemistry. However, it is expected that most of the activities of the Working Group will be conducted via correspondence.

Publications: Members are encouraged to publish in IUPAC-sponsored scientific journals.

ANNEX X

INTERACTION WITH OTHER IOC PROGRAMMES

INTERACTION BETWEEN GIPME AND THE HAB PROGRAMME

The Global Investigation of Pollution in the Marine Environment (GIPME) Programme:

The overall objective of the Global Investigation of Pollution in the Marine Environment (GIPME) Programme is to provide a scientifically sound basis for the assessment and regulation of marine contamination and pollution. The GIPME Programme consists of three groups of experts: GEMSI, GEEP and GESREM.

The Group of Experts on Methods, Standards and Intercalibration (GEMSI)

The work of GEMSI is to provide for scientific and technical basis regional conducting chemical monitoring activities and baseline measurements.

The future work plans of GEMSI include a number of areas of marine research and monitoring which should be brought to the attention of the members of the HAB panel.

An ongoing programme to study riverine inputs of contaminants to the oceans, as part of the GIPME mass balance approach, is now focussing on the input of nutrients. The first workshop on this topic was recently held in the WESTPAC Region.

A new focus will be placed on modern contaminants including herbicides and their impact on the coastal zone. Their effects include e.g. disappearance of seagrass beds and the use of such herbicides in the control of "noxious" algal blooms. Attention will also be given in the future to other recognized sources of contamination specifically the widespread use of pharmaceuticals (antibiotics, growth hormones, etc.) in mariculture and hitherto unanalyzed contaminants in sewage (for example the products of chlorination of raw sewage). A joint GEMSI/GEEP working group will begin to address the issue of Eutrophication and attempt to better define the phenomena from a chemical and biological standpoint.

GEMSI's role in all these new areas will remain to provide advice on methods standards and intercalibration as well as to respond to needs for training in regional programmes.

The Group of Experts on Effects of Pollution (GEEP)

The work of GEEP is to ensure an accurate evaluation of the effects of contaminants (either simply or in complex mixture) upon components of the marine ecosystem (either on the single species level or the ecosystem level). GEEP is evaluating means for assessing tbe biological impact of contamination, and recommending the most effective procedures in regional and global programmes.

GEEP's remit is to address the biological effects of pollution and disturbance of the marine environment. The effects of pollution are rarely isolated from other complex environmental problems and these frequently involve interactions between chemical, physical biological and ecological processes. This inter-dependance needs to be kept in the forefront when considering the development of procedures and methods for measuring biological effects. In fact, many of the techniques developed for chemically-induced effects, and fostered by GEEP are also highly practical for assessing the impact of a range of environmental disturbances on the health of marine organisms, populations and communities.

The problem of the impact of algal toxins on marine organisms has considerable conceptual parallels with GEEP's concern with the biological impact of chemical contaminants. In essence there are four key questions to be addressed that are common to both problems. These are outlined below.

1) What are the fate and effect of algal toxins/toxic contaminants in the marine food web ?
2) How do these chemicals or their metabolites exert their toxicity and cause cell injury leading to pathology and death of fish and other marine animals ?
3) Can molecular, biochemical and cellular pathological indicators or biomarkers be derived from these mechanistic studies, which will provide diagnostic and predictive "early warning distress signals" of damage to the health of marine animals?
4) Are there interactions between the effects of algal toxins and anthropogenic pollutants?

The solution to these problems can be addressed jointly by GEEP and IPHAB by clearly identifying the need for appropriate biological effects indicators. These must be soundly based and would be envisaged as endpoints of mechanistic studies. Cellular and histo-pathology may be particularly useful in identifying biomarkers of toxic damage. This type of approach is probably readily applicable in most of the regions affected by algal toxins. This will also have the added advantage that as immuno-detection methods for specific toxins become more readily available, they can be applied directly to histological tissue sections.

GEEP is now addressing the integration of its methodologies into programmes of management of environmental problems. GEEP's role will be to assess the best ways to create more interaction in areas such as the definition of the problem to be managed and ways of determining its effective resolution. The framework for environmental managerial action developed by GEEP is probably also appropriate to many of the problems being addressed by IPHAB.

The Group of Experts on Standards and Reference Materials (GESREM)

The work of GESREM is to ensure a proper use of certified and working reference materials related to pollution in the marine environment.

The responsibilities of GESREM cover development of instrument calibration solutions and certified reference materials for all analytes of importance to the work of the IOC. These analytes include both inorganic and organic constituents, both natural and anthropogenic. At its Third Session in Brussels on 22-24 September 1992, twelve classes of materials were discussed at length (The report is Document IOC-IAEA-UNEP/GESREM III/3). Of these twelve, perhaps three are of direct interest to IPHAB, viz Inorganic Nutrients in Seawater, Pigments and Algal Cultures and Algal Toxins. The toxins are probably the case of greatest short-term importance. Some solutions of phycotoxins are currently available from the U.S. Food and Drug Administration, and the BCR of the EEC has initiated a program to develop shellfish reference materials for Paralytic Shellfish Poisons (PSPs). A publication describing results of an inter-laboratory comparison of analyses for saxitoxin has been prepared by Dr. Van Egmond of Bilthoven, the Netherlands (in press, "Food Additives and Contaminants"). However, the National Research Council of Canada (NCR) appears to have established a lead currently in the case of ASP, DSP and PSP toxins. Standard solutions of representative compounds of all three classes are now available from NRC, as are shellfish tissue reference materials for the first two.

It is important to distinguish between the meaning of the term "standards" as used by GESREM and similar bodies such as ISO, and the more colloquial meaning. A "certified standard" is a solution whose concentration has been confirmed by more than one independent analytic technique. The NRC marine toxin standards are of this type. On the other hand, one loosely speaks of "standards" which one can use for optimizing chromatographic conditions, training new operators, etc. These latter need not to be so pure (and indeed are probably better if they contain some known impurities in order to evaluate chromatographic performance) and are much cheaper to produce. Both kinds are probably necessary for the purposes of IPHAB.

Unfortunately, NRC is legally obliged to charge for these materials on a cost-recovery basis. It will be important to find a mechanism whereby these expensive materials can be made available to developing countries, in order to fulfill the goals of IPHAB. In addition, participation of NRC scientists in training programs, particularly with respect to quantitative chemical analysis, could be done under the auspices of IPHAB and/or GESREM. A very efficient mechanism for detailed technology transfer has been found to involve visits of a few months at the NRC laboratories in Halifax, by scientists from other institutions. The good offices of IOC (IPHAB and/or GESREM) in arranging and funding such visits would greatly facilitate such arrangements.

ANNEX XI

OVERVIEW OF PRIORITIES AND DECISSIONS WITH REFERENCE TO THE HAB PROGRAMME PLAN

This document is based on the HAB Programme Plan (Document IOC-FAO/IPHAB-I/3). In order to obtain an overview of **Programme Elements and Activities requiring action and identification of resources, ongoing and implemented activities, and priorities and decissions** these have been inserted in the Programme Plan in boxes:

PROGRAMME ELEMENTS AND ACTIVITIES REQUIRING ACTION AND IDENTIFICATION OF RESOURCES *ACTION:*

in shaded boxes

and,

OVERVIEW OF ONGOING AND IMPLEMENTED ACTIVITIES

in non-shaded boxes

PROGRAMME SUPPORT MATTERS

Staff: At present there are two Danish Associate Experts seconded to the HAB Programme. Their present assignment ends on 31 April 1994. Secondment of an experienced person to the IOC Secretariat would be necessary for the continued strong development of the HAB Programme. A description of the potential position can be found in Annex VII, IOC-FAO/IPHAB-I/3. ACTION: **Recommendation IPHAB-II.1 was adopted.**

Referring to Resolution XVII-2 of the Seventeenth IOC Assembly, the need for, and appropriateness of, establishing a Group of Experts on HAB should be analyzed. Document IOC-FAO/IPHAB-II/Inf 1. ACTION: **The Panel adopted Resolution IPHAB-II.1, 2, 3 and 4.**

A brochure on the HAB Programme should be prepared. The brochure should outline the goals of the HAB Programme, the main activities, contact points, etc., and should be addressed to administrators, politicians, funding agencies, and the general public. ACTION: **The Panel endorsed the praparation of a brochure.**

HAB Science and Communication Centres: The establishment of HAB centres has been offered by Denmark and Spain. The Centres should be complementary and coordinated by the IOC Secretariat. Documents: IOC-FAO/IPHAB-II/Inf. 1, IOC-FAO/IPHAB-II/Inf. 2, and IOC-FAO/IPHAB-I/3.

Network: A proposal was prepared for an European Network on Harmful Marine Phytoplankton (Commission of the European Communities, Human Capital and Mobility). IOC is the coordinator. The proposal was rated B (July 93). Re-submission of an adjusted proposal is planned for Nov. 93. For details please see Document IOC-FAO/IPHAB-II/Inf.2.

6.1. EDUCATIONAL PROGRAMME ELEMENTS

6.1.1 Information Network

Goal: To develop, encourage and maintain the flow of information, technology and expertise to scientists, administrators and the general public.

Objectives:

i) Produce a regular newsletter for reporting bloom occurrences, recent publications, meetings, new techniques, requests for assistance and general information.

The IOC newsletter Harmful Algae News is published quaterly and is distributed in 2000 copies. The Editor is Dr. Timothy Wyatt. In 1993 an Editorial Team was identified. Document IOC-FAO/IPHAB-II/Inf 2

ii) Prepare and publish a manual containing standardized methodology for the study of harmful algae (this book could be modelled after the UNESCO Phytoplankton Manual).

A Manual is under preparation and the first draft is expected to be ready end of 1993. The Cheif Editor is Dr. Gustaaf Hallegraeff, University of Tasmania. The outline of the Manual is Document IOC-FAO/IPHAB-II/Inf 2

iii) Prepare identification sheets and reference slides for harmful species, preserved material and video documentation, updated as necessary.

This could be organized through the HAB Centres under establishment. The experience from the preparation of the ICES Identification Sheets should be drawn upon, and the possibilities for supporting the further development and geographical expansion of the ICES Sheets should be considered.
ACTION: **The Panel adopted Resolution IPHAB-II.1.**

iv) Compile lists of experts grouped according to areas of expertise, updated as necessary.

An updated Directory of Experts is under preparation and is expected to be published in the first half of 1994. The Directory is prepared and published in cooperation between IOC and NOAA (USA).

v) Ensure rapid communication of harmful events, new problem species, methodologies and other common information to researchers, administrators and medical personnel.

This could be facilitated by the HAB Centres under establisment.
ACTION: **Endorsed.**

vi) Prepare, distribute and maintain fact sheets on toxin for administrators, the medical community and the general public.

Cooperation and coordination should be sought with WHO (International Programme on Chemical Safety, IPCS)
ACTION: **Endorsed, see Summary Report 7.7.**

vii) Facilitate worldwide distribution of reference books, conference proceedings and equipment.

To the extend possible this will be addressed by the HAB Programme Office and the planned HAB Centres. Discounts on various publications are currently being negotiated with publishers etc.
ACTION: **Endorsed, see Summary Report 7.8.**

viii) Ensure the distribution of material with respect to public safety and education.

6.1.2 Training

Goal: To promote and facilitate the development and implementation of appropriate training programmes in order to distribute the necessary knowledge and expertise on a global basis.

Objectives:

i) Facilitate workshops and training programmes on taxonomy, ecology, toxin extraction and analysis, management strategies, public health and safety and mitigation techniques.

The development and implementation of a HAB Training Programme.
ACTION: **The Panel adopted Recommendation IPHAB-II.2.**

- *IOC-Danida Training Course on the Taxonomy of Harmful Marine Phytoplankton, Copenhagen, 16-28 August, 1993.*

- *IOCARIBE Workshop on Redtides and Mass Mortality of Marine Organisms, Cumana, 16-19 September, 1992.*

ii) Promote access to equipment and the extensive training of selected individuals in regions that lack adequate facilities and properly trained personnel for toxin analysis.

Do i)

6.2 SCIENTIFIC PROGRAMME ELEMENTS

6.2.1 Ecology and Oceanography

Goal: To understand the population dynamics of harmful algae.

Objectives:

i) Develop the necessary understanding of bloom dynamics of harmful algae, which includes the phases of bloom progression (excystment or bloom initiation, exponential growth, aggregation, toxicity, as well as death, grazing, encystment, sinking or dispersal) and the succession of phytoplankton species.

ICES-IOC Study (Working) Group on the Dynamics of Harmful Algal Blooms
Document IOC-FAO/IPHAB-II/Inf.3.

ii) Develop numerical models (and eventually reliable predictions) of toxic blooms based on hydrodynamic, chemical and biological principles as well as the unique hydrography, chemistry and plankton composition determined by regional research programmes.

iii) Determine the role of nutrients (total amounts and ratios) in the dynamics of harmful algal events; investigate the relative importance of natural versus anthropogenic sources.

SCOR-IOC Working Group 97 on the Physiological Ecology of Harmful Algal Blooms
Document IOC-FAO/IPHAB-II/Inf.4.

iv) Elucidate the importance of human activities in the dispersal of certain harmful species (e.g., via ship ballast water; transfer of shellfish stocks).

Possibilities for cooperation with IMO should be investigated in this matter since IMO is already concerned about problems related to transfer of ballast water.
ACTION: **The Panel requested the Chairperson and the HAB Programme Office compile information and report back at the Third session of the Panel.**

v) Derive quantitative relationships among the biological, physical and chemical parameters with respect to the bloom-forming species which can be used in a local management context through predictive models and management strategies.

vi) Determine the ecological role of toxicity in the population dynamics of toxic species and the consequences of toxicity to living resources.

vii) Design appropriate experimental and field studies to develop the required understanding of the hydrography, ecology and oceanographic conditions controlling the population dynamics of harmful species.

viii) Determine the ecophysiological capabilities of causative species (K_s, v_{max}, allelopathic substances, grazer repellant, life-cycle strategies).

SCOR-IOC Working Group 97 on the Physiological Ecology of Harmful Algal Blooms. Document IOC-FAO/IPHAB-II/Inf 4.

ix) Establish long-term trend monitoring stations to document changes in phytoplankton species composition and associated physical and chemical variables over decadal time-scales.

The proposed expansion of the Continuous Plankton Recorder (CPR) route-net to coastal routes (Gulf of Guinea, Argentinean Coast) will increase the value of CPR data in the evaluation of long-term trends in the occurrence and frequency of harmful algal events. The CPR should be developed or complemented to monitor dinoflagellates more effectively, and act in support of process studies of finite duration (IOC/Inf-869)

x) Develop studies on cyst assemblages to document the areal distribution of harmful, cyst-forming species in order to identify risk areas for harmful algal blooms.

xi) Encourage analysis of sediments, especially from anoxic basins, that can provide evidence (cysts, frustules, etc.) for the prior occurrence of harmful species in regions where recent introductions are suspected.

6.2.2 Taxonomy and Genetics

Goal: To establish the taxonomy and genetics of the causative organisms at the appropriate levels.

Objectives:

i) Develop and maintain the capability to recognize, characterize and identify harmful species by morphological criteria, including ultrastructural and phenotypic variability and also by different life stages such as resting cysts.

ii) Establish a group to make taxonomic recommendations and to develop identification standards for preparation of manuals, reference materials and training standards.

This could be initiated by IPHAB if regarded as a priority. The Group could be established and initially work by correspondence.
ACTION: **The Panel adopted Resolution IPHAB-II.1.**

iii) Determine the genetic heterogeneity within species and isolates with respect to mating compatibility and molecular characteristics.

iv) Support existing and establish new regional culture collections specializing in harmful species and create a centralized international culture collection of harmful species.

A first step in this effort could be the preparation of an IOC inventory of harmful algae culture collections worldwide. The World Federation of Culture Collections has been contacted to investigate the possibility for a joint project. The HAB Centres are potential locations for a centralized international culture collection of harmful species.
ACTION: **The Panel noted that an inventory will be included in the IOC Manual on Harmful**

v) Promote the development of new, rapid, automated identification, discrimination and counting techniques such as, image analysis, flow cytometry and immuno-labelling.

vi) Encourage and enable the development of computerized taxonomic data bases of harmful species.

The efforts of the Expert Centre on Taxonomic Identification (ETI), Amsterdam, to develop a computerized taxonomic data bases of harmful species should be actively supported. The data base is in particular developed in cooperation with the Botanical Institute, University of Copenhagen.
ACTION: **The Panel urged the IOC/MRI Representative in the ETI Board to actively support the development of the data base.**

vii) Organize and conduct intercalibration exercises.

This could be organized through the HAB Centres under establishment and the Group mentioned under 6.2.2, ii.
ACTION: **The Panel adopted Resolution IPHAB-II.1.**

6.2.3 Toxicology and Toxin Chemistry

Goal: To determine the physiological and biochemical mechanisms responsible for toxin production and accumulation and to evaluate the effect of phycotoxins on living organisms.

Objectives:

With respect to physiology:

i) Establish the biosynthetic pathways of toxin production in algae including defining the role of endo- or exocellular bacteria and viruses.

ii) Determine the physiological mechanisms underlying variable toxicity among strains of species or within single strains grown under different conditions.

iii) Define the toxin accumulation, chemical conversion and depuration processes in contaminated seafood.

iv) Determine the processes of toxin degradation.

With respect to chemistry:

v) Isolate, identify and/or elucidate the structure of toxins.

vi) Prepare and supply toxin standards and reference materials.

The Expert Groups under GIPME (GESREM, GEEP, GEMSI) should be strongly encouraged to emphasize their relevant activities. Cooperation should be sought with e.g. EEC (BCR), IUPAC, IST, and interested Member States. ACTION: **The Panel adopted Resolution IPHAB-II.2 and Recommendation IPHAB-II.4.**

vii) Develop new chemical analytical methods for toxins, specifically:

1. alternative assay methods to replace such tests as mouse and other bioassay organisms, while improving the sensitivity, specificity and reproductibility of all methods; and

2. simple field assay kits.

The Expert Groups under GIPME (GESREM, GEEP, GEMSI) should be strongly encouraged to emphasize their relevant activities. Cooperation should be sought with e.g. EEC (BCR), IUPAC, IST, and interested Member States.
ACTION: **The Panel adopted Resolution IPHAB-II.2.**

With respect to toxicology:

viii) Define the fate and effects of algal toxins in the marine food web.

ix) Elucidate mechanisms of toxicity to marine animals.

x) Determine the mechanisms responsible for the mass mortalities of fish and other marine organisms caused by toxic substances.

xi) Establish pathological indicators to determine toxins responsible for mortalities and other impacts.

Cooperation and coordination should be sought with GEEP, IPCS (WHO-UNEP-ILO) and FAO.
ACTION:

6.3 OPERATIONAL PROGRAMME ELEMENTS

6.3.1 Resource Protection

Development of the entire Programme Element should be pursued drawing on the expertise and experience of FAO (UNEP).
ACTION:

Goal: To develop and improve methods to minimize the environmental and economic consequences of Harmful Algae.

Objectives:

i) Assist managers in designing, evaluating and improving cost-effective procedures for selecting and protecting aquaculture sites; applying methods for early warning of toxicity and mass mortalities; and developing management strategies.

ii) Assist managers in applying scientific results as quickly and effectively as possible to resolve management, mitigation, public safety, public education and public relations problems.

iii) Assist managers in developing strategies and procedures for protecting the tourist and amenity value of coastal areas.

6.3.2 Monitoring

The entire Programme Element should also be seen as an element of GOOS.
ACTION: **The Panel adopted Resolution IPHAB-II.3. See also Summary Report 7.19 and 7.20.**

Goal: To promote and facilitate the development and implementation of appropriate monitoring programmes.

Objectives:

i) Provide a source of information and guidance on design and implementation of monitoring programmes.

A Chapter in the IOC Manual on Harmful Marine Phytoplankton will address management and monitoring (in general) in relation to harmful algae. A supplement could be an IOC publication where examples of monitoring systems from all over the world are presented in detail. The publication and a follow-up workshop would be a source of inspiration to designers of future and improved monitoring systems. ACTION: **The Panel adopted Resolution IPHAB-II.3.**

ii) **Interact with, and encourage, long-term regional, national and international monitoring plans and programmes to identify trends and cycles in the frequency of harmful algal blooms, their resulting toxicity for marine life, and suspected causes (e.g., climatological, hydrographical, or nutrient changes).**

iii) Ensure the compatibility (e.g., techniques, type of data collected) of plankton and toxin monitoring programmes with basic studies of algal bloom dynamics and ecology.

6.3.3 Public Health and Seafood Safety

WHO should be consulted and cooperated with in the development of the Programme Element.
ACTION: **The Panel adopted Resolution IPHAB-II.2. See also Summary Report 7.21.**

Goal: To protect public health and ensure seafood quality.

Objectives:

i) Facilitate monitoring for toxic species and seafood toxins.

ii) Encourage standardization of methods for toxin detection and levels for market closure.

iii) Facilitate testing of techniques for the mitigation of noxious blooms: (e.g., forced sedimentation, aeration, sea surface scum collection).

iv) Where appropriate, assist with measures to avoid or mitigate harmful events.

v) Develop antidotes against seafood toxins.

ANNEX XII

GLOSSARY OF ACRONYMS AND SPECIAL TERMS

AOAC	Association of Official Analytical Chemists
APEC	Asia Pacific Economic Cooperation
ASEAN	Association of South East Asian Nations
BMTC	Bremen Maritime Training Centre
CEC	Commission of the European Communities
CFC	Commission on Food Chemistry
CIDA	Canadian International Development Agency
CNEVA	Centre National d'Etudes Vétérinaires et Alimentaires (France)
CONICIT	Consejo Nacional de Investigaciones Cientificas y Tecnologicas (Venezuela)
CPR	Continuous Plankton Recorder
DANIDA	Danish International Development Agency
DSP	Diarrhetic Shellfish Poisoning
EEC	European Economic Community
ETI	Expert Centre on Taxonomic Identification
FAO	Food and Agriculture Organization of the United Nations
GEEP	Group of Experts on the Effects of Pollutants
GEF	Global Environment Facility
GEMSI	Group of Experts on Methods, Standards and Intercalibration
GESAMP	Group of Experts on the Scientific Aspects of Marine Pollution
GESREM	Group of Experts on Standards and Reference Materials
GIPME	Global Investigation of Pollution in the Marine Environment
GO	Governmental Organization
GOOS	Global Ocean Observing System
IAEA	International Atomic Energy Agency
ICES	International Council for the Exploration of the Sea
ICSU	International Council of Scientific Unions
IMO	International Maritime Organization
IOC	Intergovernmental Oceanographic Commission
IOCARIBE	IOC Sub-Commission for the Caribbean and Adjacent Regions
IPCS	International Programme on Chemical Safety
IST	International Society of Toxicology
IUPAC	International Union of Pure and Applied Chemistry
JECFA	Joint Expert Committee on Food Additives
JSPS	Japanese Society for Promotion of Science
MAP	Mediterranean Action Plan
MARPOLMON	Marine Pollution Monitoring
MAST	Marine, Science and Technology
MEDPOL	Co-ordinated Mediterranean Pollution Monitoring and Research Programme
NATO	North Atlantic Treaty Organization

NRC	National Research Council (Canada)
NSF	National Science Foundation
OSLR	Ocean Science in Relation to Living Resources
PICES	North Pacific Marine Science Organization
PSP	Paralytic Shellfish Poisoning
SCOR	Scientific Committee on Oceanic Research
TEMA	Training Education and Mutual Assistance in the Marine Sciences
UNCED	United Nations Conference on Environment and Development
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UV	Ultra Violet radiation
VCP	Voluntary Contribution Programme
WESTPAC	IOC Sub-Commission for the Western Pacific
WG	Working Group
WHO	World Health Organization
WMO	World Meteorological Organization