

Intergovernmental Oceanographic Commission

Reports of Governing and Major Subsidiary Bodies



IOC Intergovernmental Panel on Harmful Algal Blooms

Tenth Session

Paris, UNESCO Headquarters
12–14 April 2011

UNESCO

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IOC/IPHAB-X/3
Paris, 8 July 2011
English only

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EXECUTIVE SUMMARY

The Tenth Session of the IOC Intergovernmental Panel on Harmful Algal Blooms (IPHAB) was held at UNESCO Headquarters, Paris, from 12 to 14 April 2011.

The Panel reviewed the actions completed during the intersessional period and noted that continuous progress had been made and that the Recommendations of the Ninth Session had been followed up to large extent. The major achievements reported include: (i) developments within GEOHAB including the launch of the GEOHAB Research Plans for the Core Research Projects in Fjords and Coastal Embayments and the development of a research plan for Benthic HABs; (ii) development of the regional activities within ANCA, FANSA, HANA and WESTPAC-HAB; (iii) the implementation of ten training courses and training-through-research projects; (iv) results from the ICES-IOC WGHABD and ICES-IOC-IMO WGBOSV; (v) the continued development of the integrated IPHAB-IODE Harmful Algae Information System (vi) the continued publication of the IOC Harmful Algae News; (vii) and the IOC co-sponsorship of international HAB conferences.

The Panel decided on seven Resolutions and endorsed two Recommendations. The Resolutions concern (i) Regional HAB Programme Development, (ii) Biotoxin Monitoring, Management and Regulations, (iii) The GEOHAB Research Programme, (iv) Harmful Algae and Desalination of Seawater, (v) reviser terms of reference for the Task Team on Algal Taxonomy, (vi) Harmful Algae and Global Change, and (vii) Harmful Algae and Fish-killing Marine Algae. The Session also adopted a revised strategy for IPHAB, and a focus for activities on the transfer and introduction of HAB species by human activity such as shipping (ballast water).

The Recommendations concern (i) a summary of the Resolutions and planned intersessional activities into a Work Plan and budget for the IOC HAB Programme 2012–2013, and (ii) the continuation of the IPHAB and time of the next Session. Dr R. Magnien (USA) was elected as Chair and Dr Gires Usup (Malaysia) was elected as Vice-Chair.

1. INTRODUCTION

1. The IOC 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 to solve some of the problems caused by harmful algae. 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 are also seen as IOC follow-ups to the United Nations Conference on Environment and Development (UNCED).
2. The Tenth Session of the Panel was held at IOC UNESCO Headquarters in Paris from 12-14 April 2011. The Session was opened by the Executive Secretary IOC, Dr Wendy Watson-Wright. The Executive Secretary noted that HABs are a permanent part of coexistence with the marine environment and a part that pose constant challenges to many aspects of human activity. These challenges will continue to request knowledge and solutions for mitigation from the research community. We have seen over the past decade that irrespective of whether there is an increased occurrence of HABs or not, there is a constant or an increasing number of harmful algal events because human activity in coastal seas continues to intensify.
3. The Executive Secretary reminded the Panel that one of the reasons it was established is to address the concerns of governments as opposed to scientific areas of interests. IOC priorities should be those where science can assist society to address issues of concern. She also noted that the Panel has a core of dedicated members who have been the basis for sustaining the activities of the Programme. This is the kind of commitment that allows the IOC to make a difference.
4. The Executive Secretary noted that the IOC HAB Programme has a broad variety of activities compared to its relative share of the IOC budget and that this is only possible because of cash and in-kind contributions from Member States. She acknowledged that one of the strengths of the IOC HAB Programme is that it encompasses activities targeting both state-of-the-art research and enhancement of basic capacity to manage HABs in Member States with very different situations and different financial and institutional contexts. The Executive Secretary commended the Panel for its longstanding efforts and results in capacity enhancement, the many cooperative efforts with other organizations in this respect, and considered this is an important element in the overall capacity development strategy of the IOC. She strongly encouraged that IPHAB continue this balanced approach to address diverse needs among IOC Member States. She also noted that resources for the HAB Programme to a significant degree are coming from research pools of funds via engaged institutions and IPHAB members and stressed the need to expand the funding basis, and that this task is part of establishing the role of IPHAB as an intergovernmental mechanism.
5. The Executive Secretary informed that the Secretariat is working on a funding strategy and it will be working actively with IPHAB members on securing financial support to implementation of the Programme.
6. The Executive Secretary informed the Panel that after 19 years the challenge of extra-budgetary funding for staff was finally solved in early 2010 with the transfer of the Programme Manager/Technical Secretary IPHAB to a staff position under the UNESCO regular programme and budget.
7. Finally the Executive Secretary reminded the Panel of the value of members of subsidiary bodies like IPHAB having good contact and communication with their national IOC committees and delegates to the IOC Executive Council and Assembly and that this contact is very important for a well functioning organisation.

8. She concluded by introducing the new Deputy Executive Secretary of the IOC, Dr Mitrasen Bhikajee.
9. The Ambassador of Spain to UNESCO, Mr. Ion de la Riva welcomed IPHAB Members to the Tenth Session of the Panel. He expressed the interest of Spain in promoting the international cooperation and supporting organizations such as IOC of UNESCO, ICES, CIESM, etc., and noted that Spain has supported IOC since its establishment, following its marine tradition and its scientific interests. This is the reason why Spain received with enthusiasm the request of the Panel to host a HAB Centre. The importance of fisheries and aquaculture and socio-economic impact of harmful algal events has triggered the development of research projects and monitoring centres focused on Galicia, one of the most productive fishing and aquaculture areas in the world. Several institutions are involved spanning from the Spanish Institute of Oceanography (IEO in Vigo and Coruña), the Galician Government (CIMA and INTECMAR), the Higher Council for Scientific Research (IIM-CSIC), the Universities of Vigo and Santiago de Compostela and the European Union Reference Laboratory for Marine Biotoxins. All these stakeholders and activities provide the favourable atmosphere for the establishment of a HAB centre in the region, drawing from the expertise of all institutions.
10. The Ambassador emphasized that during the 25th session of the IOC Assembly (UNESCO, Paris, 2009) Spain informed the Assembly that its commitment to fund the Science and Communication Centre in Vigo will be extended beyond the present commitment of 2011, strengthening once again the support of Spain to the IOC. He thanked again the IEO for establishing and maintaining the HAB Centre in Vigo and wished an excellent meeting to IPHAB participants.
11. The Session was attended by representatives from: Barbados, Brazil, Canada, Chile, Croatia, Denmark, France, Germany, Greece, India, Italy, Malaysia, Mexico, Morocco, Oman, Saudi Arabia, Slovenia, Spain, Sudan, Sweden, Thailand, Tunisia, United Kingdom, United States of America, Uruguay, PICES, IOC-SCOR GEOHAB, IOC/WESTPAC-HAB, IOC/WESTPAC-TMO, IOC HANA, and the International Society for the Study of Harmful Algae (ISSHA) (Fig. 1). The List of Participants is attached as [Annex V](#) hereto.
12. The Chair, Leonardo Guzman (Chile) recalled the Terms of Reference for the Panel, as set out in IOC Resolution XVI.4 of the Twenty-fifth Session of the IOC Assembly, March 1991 ([Annex VI](#) hereto) and the objectives in the IOC HAB Programme Plan ([Annex VII](#) hereto).

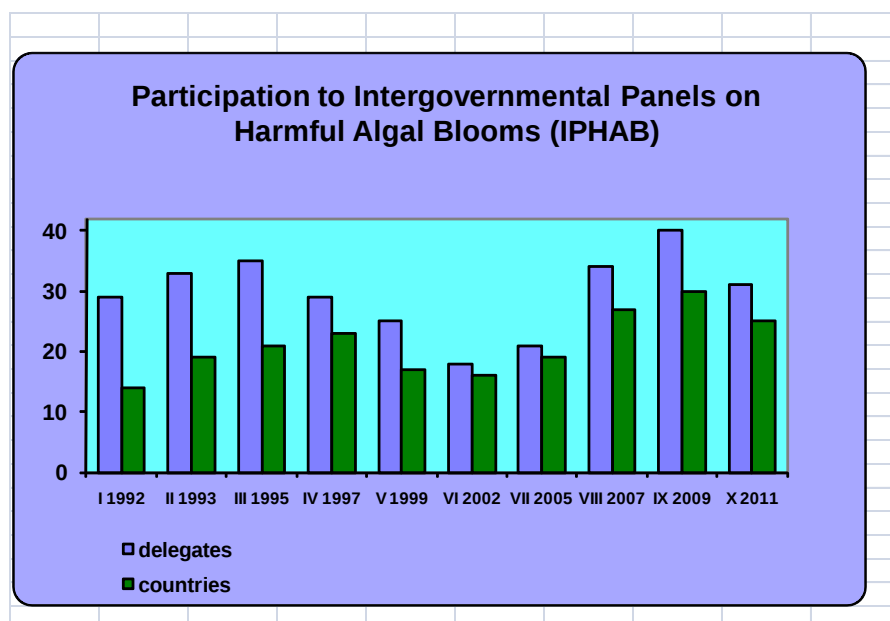


Figure 1. Attendance to IPHAB 1992–2011

13. **The Panel noted** that the Twenty-fifth Session of the IOC Assembly, Paris, 2009 had endorsed the Recommendations of the Ninth Session of the Panel. The Resolution of the Twenty-fifth Session of the Assembly was introduced.

2. ADMINISTRATIVE ARRANGEMENTS

14. The Agenda for the Session was introduced by the Chair ([Annex I](#) hereto) and adopted. Dr P. Hess (France) was designated as Rapporteur.

3. HABP DEVELOPMENTS IN THE INTERSESSIONAL PERIOD

15. During its Tenth Session, **the Panel reviewed** the actions completed during the intersessional period. The detailed report on HAB Programme developments in the intersessional period is included as [Annex VIII](#) hereto.
16. **The Panel noted with satisfaction** that considerable progress had been made and that good progress had been made in implementing the Recommendations of the Ninth Session of the Panel.

4. THE IPHAB STRATEGY

17. Through Resolution IPHAB-VIII.1 the Panel decided to formulate a strategy for IPHAB and the HAB Programme. The Eight Session the Panel reviewed and adopted the draft strategy as a working draft to be further developed and refined prior to IPHAB-X.
18. The Secretariat introduced the revised Strategy which had been prepared based on comments and advice from IPHAB Members. The adopted strategy is included as [Annex IX](#) hereto.

5. MAJOR ISSUES REQUIRING INTERGOVERNMENTAL COOPERATION

19. The Session was organized into eight panel discussions: Panel 1 on formulation/endorsement of specific objectives for Regional HAB Working Groups was chaired by Leonardo Guzman (Chile); Panel 2 on capacity building was chaired by Beatriz Reguera (Spain); Panel 3 on the GEOHAB Research Programme was chaired by Raphael Kudela (GEOHAB SSC); Panel 4 on harmful algae and desalination of seawater was chaired by Donald M. Anderson (USA); Panel 5 on HAB observations and their inclusion in GOOS Regional Alliances was chaired by B. Karlson (Sweden), Panel 6 on harmful algal events, coastal zone management and linkages with coastal eutrophication was chaired by Robert Magnien (USA); Panel 7 on harmful algae and global change was chaired by Richard Gowen (UK); and Panel 8 on fish-killing marine algae was chaired by Mark Wells (PICES).
20. The objectives in the HAB Programme Plan ([Annex VII](#) hereto) were affirmed, priorities were set, actions to be taken discussed and decided upon, and resources were sought, identified and committed as far as was possible.
21. **The Panel endorsed** a number of intersessional activities to be implemented by Member States and the IOC Secretariat. These activities are summarized in the Work Plan for the IOC HAB Programme 2012–2013, which is included in [annex to Recommendation IPHAB-X.1](#) hereto.
22. A summary of the deliberations made and the decisions taken is given below.

5.1 OBJECTIVES FOR REGIONAL IOC HAB GROUPS

23. **The Panel took note** of the results and reports under the regional components of the HAB Programme, IOC/FANSA (South America), and IOCARIBE/ANCA (Caribbean), HANA (North Africa) and IOC/WESTPAC-HAB (Western Pacific). See [Annex X](#) hereto.
24. **The Panel recalled** an identified wish from a group of Gulf States for a regional working group or network on HAB. It was proposed that such an initiative should include Pakistan and India and a Centre for a regional HAB group in Oman was proposed.
25. Concerning ANCA **the Panel noted** that a process of a rejuvenation of the membership has been initiated in order to achieve renewed rooting in national institutions and commitment to regional cooperation on HAB.
26. India expressed its strong interest in taking part in a regional HAB group or network, and noted that India with 12-15 institutions carrying out HAB research, recurrent blooms etc. needed to strengthen its research focus on HABs.
27. **The Panel considered** how regional groups could connect on issues of common concern. The compilation of annual national HAB events reports which are merged into HEADT was mentioned as an example of a coordinated effort that contributes to a common high-value product.
28. **The Panel recognized** the importance of IPHAB to pick-up themes from regional groups and formulate these into new global initiatives when relevant. This was seen as a way also to formalize more the linkage of regional groups to IPHAB.
29. **The Panel considered** what the core elements of the terms of reference should be for regional HAB groups.
30. **The Panel concluded** that its role should be to assist regional groups to focus on 3-4 outputs to be presented to IPHAB. IPHAB can then help implement some of them through global activities.
31. **The Panel concluded** that such core outputs/terms of reference include compilation of national harmful algal event data for HAEDAT, identification of regional research priorities, management needs, regional overview of regulatory issues for HABs and phycotoxins, and capacity development needs, with the view to get more systematized and coherent input from each regional group for each session of IPHAB. At the same time each regional group can have other terms of reference specific to that region.
32. **The Panel noted** that one way for funding for regional groups is to develop as a regional project to undertake e.g. inter-calibration, training etc. This has been done with success in the past.
33. **The Panel also noted** that some regional groups with success had developed through having a host country which provides a mechanism for funding of activities.
34. **The Panel noted** an interest for an EU regional group and it was discussed how and in which context such a regional group would be most effective. It was also debated how a European group would best interact with HANA in order to cover all of the Mediterranean Sea, and how in general to strengthen the link between North African and European scientist and institution concerned with HAB.
35. **The Panel requested** the Secretariat in close cooperation with concerned IPHAB delegates to actively seek to establish new regional HAB regional groups under the IPHAB umbrella.

36. **The Panel endorsed** the proposed regional activities of ANCA, FANSA, and HANA for 2010–2011 and integrated them into the Work Plan (see Recommendation IPHAB-IX.3 and its Annex 1). The priorities of WESTPAC/HAB will be included in the work plan according to availability of resources

37. **The Panel adopted** [Resolution IPHAB-X.1](#).

5.2 CAPACITY BUILDING

38. **The Panel recalled** the adoption by the IPHAB-VI of a revised IOC HAB Training and Capacity Enhancement Programme, and the set of basic principles for capacity enhancement in research and management of harmful algal events adopted by IPHAB-IX. The Panel noted with satisfaction the number of training courses and workshops on harmful algae that have been successfully implemented, regionally and globally in 2009–2011 (listed in [Annex XII](#)).

39. **The Panel expressed its appreciation** of the significant support provided by Denmark and Spain, and strongly encouraged Member States to continue to support IOC capacity enhancing activities.

40. **The Panel reiterated** the importance of systematically compiling feed-back from trainees as a means to continuously adapt and improve training activities.

41. **The Panel welcomed** the introduction of qualification by examination and encouraged the concept of proficiency testing, intercalibration and quality assurance as part of CD activities. In this context the planned cooperation with BEQUALM was welcomed.

42. **The Panel acknowledged** the value of materials for training courses provided to trainees and available via the IOC web site and welcomed the initiative by IOC/WESTPAC-HAB to produce other language versions for teaching by trainees, e.g. handouts, posters, etc, etc.

43. **The Panel recalled** the endorsement by IPHAB-IX to conduct the longstanding series of international advanced phytoplankton courses to be conducted under the auspices of the IOC and HAB Programme. This would imply assistance with advertisements for courses, training materials and financial support to the extent feasible within the available resources.

44. **The Panel welcomed** that this has now been arranged in cooperation with University of Copenhagen and that the first course (APC10) will be held in 2012.

45. **The Panel made** a thorough reassessment of the capacity enhancing activities implemented or fostered by the IOC and partners, and revisited regional priorities.

46. **The Panel endorsed** the implementation of a number of proposed capacity building activities 2012–2013 listed in [Annex II](#) hereto ([annex](#) to [Recommendation IPHAB-X.1](#)).

5.3 BIOTOXIN REGULATIONS AND HUMAN HEALTH

47. **The Panel recalled** its Resolution IPHAB-VI.2 where the Panel established a Task Team to address incompatibilities among biotoxin regulations in major markets and the subsequent updates of the Terms of Reference by IPHAB.

48. **The Panel took note** of the withdrawal of the Chairman of the Task Team P. Busby (New Zealand) from IPHAB.

49. To continue to address the issue of biotoxins and human health systematically and to identify it as a key issue for IPHAB, to communicate to FAO and WHO, and for IPHAB to stay

informed and provide overview, **the Panel decided** on revised Terms of Reference for the Task Team. **The Panel adopted** [Resolution IPHAB-X.2](#).

5.4 THE GEOHAB RESEARCH PROGRAMME

50. At its Fourth Session, the Panel, through Recommendation IPHAB-IV.2, endorsed the establishment of an international research programme on the global ecology and oceanography of harmful algal blooms, GEOHAB. GEOHAB was established jointly with SCOR and has the overall goal of developing the scientific knowledge needed to increase capability to mitigate the impacts of HABs. This will be addressed through improving capabilities for modelling the population dynamics in a number of geographical regions identified as particularly suited for international research cooperation. Furthermore, GEOHAB is intended to help Member States in setting national priorities and in particular to promote the establishment of national, regional and international research projects. GEOHAB has its web site at www.geohab.info.
51. The GEOHAB IPO functions are shared between the SCOR Secretariat and the IOC Science and Communication Centre on Harmful Algae at the University of Copenhagen, and funded with resources earmarked for GEOHAB and resources available in general to SCOR and the IOC Centre.
52. The Chair of the IOC-SCOR Scientific Steering Committee (SSC) for GEOHAB, R. Kudela (USA), gave a summary of GEOHAB and reported on GEOHAB developments 2009–2010. The Terms of Reference for the GEOHAB SSC, the List of SSC Members, and the summary of GEOHAB activities and achievements are included in [Annex XIII](#) hereto.
53. In his report the Chair of the SSC addressed the strengths/weaknesses and major challenges of GEOHAB. A major achievement of GEOHAB has been the production of the series of five GEOHAB reports, which include the Science and Implementation Plans and the CRP reports. These reports lay a very strong foundation for the organization and framework of future HAB research as well as list key questions which need to be addressed.
54. **The Panel gratefully acknowledged** the U.S. extra budgetary support provided via IOC and SCOR for GEOHAB activities.
55. **The Panel expressed its appreciation** of the work of the GEOHAB SSC and in particular the advanced in developing the GEOHAB Core Research Projects.
56. **The Panel welcomed** the activities targeted at developing regional GEOHAB initiatives, and noted that linkages between projects within regions through GEOHAB endorsements had not been as successful as originally hoped, but that there have been significant improvements facilitating this.
57. **The Panel recalled** that IPHAB-IX had requested the GEOHAB SSC to present to IPHAB-X a plan for the period 2011–2013 and an assessment of activities with potential to continue beyond 2013.
58. **The Panel noted** that GEOHAB makes use of *Harmful Algae News* (HAN) as its bulletin. However, the Panel noted that there is a lack of coordination and sharing of data. The Panel recommended that GEOHAB endorsed projects should be obliged to submit at least one article to HAN.
59. **The Panel** had a thorough discussion and **noted** that GEOHAB should remain a research initiative not a coordinating body. It was further noted that GEOHAB should benefit Member States via the research community; if Member States will not support it then there is no benefit. Also research priorities from regional groups must be synthesised into the new focus for GEOHAB. It was recalled that what is unique about GEOHAB is that it focusses on

causes not on management or effects and that it is a long process to reach this. Most management agencies do not have this longer perspective and therefore GEOHAB is needed in order to make fundamental progress.

60. **The Panel recommended** that as part of the foreseen synthesis process leading up to 2013, GEOHAB should look critically at all related publications to see how well they answer the Science Plan questions.
61. **The Panel noted** that GEOHAB have not had large scale funding, but that it has been successful in initiating large scale research projects funded by e.g. the European Commission and U.S. NSF. These projects have responded to GEOHAB questions. **The Panel recommended** that the Core Research Project concept should not be discontinued. It has proved useful to produce good science based on which other entities can deliver management solutions. Regional groups may play an important role in this application of new knowledge.
62. **The Panel debated** how to show the continued value and relevance of a GEOHAB framework for HAB research.
63. **The Panel concluded** that efforts must be made to link it conceptually to the High Level Objectives of the IOC, the foci of the IOC Ocean Science Programme, regional research priorities, as well as to the programmes and priorities of other organisations, and that these links are to be made and strengthened before 2013 to make a stronger case.
64. **The Panel further concluded** that it supports a continued process to develop a plan for GEOHAB beyond 2013, and **took note** that there is interest in reformulating goals to better address impacts of HABs on ecosystems in order to make GEOHAB more likely of receiving support also from managers who eventually will make use of the generated knowledge.
65. **The Panel endorsed** the proposed Scientific Steering Committee composition.
66. **The Panel adopted** [Resolution IPHAB-X.3](#).

5.5 HARMFUL ALGAE AND DESALINATION OF SEAWATER

67. Dr Donald M. Anderson (USA) introduced the issue of HABs and desalination of sea water. The issue has received increased attention in relation to drinking water supply from surface water and from desalination of sea water. The long-term effects of exposure to low levels of biotoxins are poorly understood. A related concern of desalination plants is algal biomass that clogs filters and fouls membranes.
68. **The Panel assessed** the need for and possible action of IPHAB regarding HABs and desalination. It was considered that an activity should address all biological problems to desalination such as jellyfishes, seaweeds and HABs in particular and it should be systematically investigated with which expert groups partnership could be made.
69. **The Panel adopted** [Resolution IPHAB-X.4](#).

5.6 HAB OBSERVATIONS AND THEIR INCLUSION IN THE GOOS REGIONAL ALLIANCES

70. **The Panel recalled previous** recommendations and resolutions in relation to operational observation of HABs as a constituent of the Coastal Ocean Observations Modules of The Global Ocean Observing System (GOOS) (IPHAB-V.3, IPHAB-VI.3, IPHAB-VII.3, IPHAB-VIII.2, and IPHAB-X.4), and how, in December 2006, the Scientific Steering Committee for GEOHAB opened a dialogue with the GOOS Regional Alliances to address

the inclusion of, and approach to, observation systems for HABs and the occurrence of HAB species in the regional components of GOOS.

71. The agenda item was introduced by a presentation by B. Karlsson (Sweden) on the work of the IPHAB Task Team on Implementation of HAB Monitoring within the Global Ocean Observing System (Resolution IPHAB-IX.4).

72. **The Panel took note** that the Task Team had completed its Terms of reference **and decided** to suspend the Task Team.

73. **The Panel invited** the former Chair and the Secretariat to remain in dialogue with GOOS and to identify what level of interaction would be meaning full onwards.

5.7 HARMFUL ALGAL EVENTS, COASTAL ZONE MANAGEMENT AND LINKAGES WITH COASTAL EUTROPHICATION

74. R. Magnien (USA) introduced the subject. The IOC has activities on coastal zone management and ecological modelling of coastal ecosystems in relation to nutrient loading. HAB management and prevention is closely related to these broader areas of concern. IPHAB will review progress on development of the NEWS2USE Programme and alternative models and technical tools as recommended by IPHAB-IX, and discussed how it could promote the further implementation.

75. **The Panel took note** of the developments within the NEWS2USE programme and the associated development of a joint UNEP-IOC Global Environment Facility funded Project entitled "Global Foundations for Reducing Nutrient Enrichment and Oxygen Depletion from Land-based Pollution in Support of Global Nutrient Cycle".

76. **The Panel recalled** Recommendation IPHAB-IX.1 and **decided** to remain engaged in the development of an IOC Integrated Research Strategy.

5.8 THE HARMFUL ALGAE INFORMATION SYSTEM

77. This topic was introduced by a presentation by the Secretariat (H. Enevoldsen), on the progress of development of an integrated Harmful Algae Information System (HAIS). It is envisaged that when fully established, the information system will consist of access to information on harmful algal events, harmful algae monitoring and management programmes worldwide, currently used taxonomic names of harmful algae, and in cooperation with ISSHA, information on the biogeography of harmful algal species. Supplementary components will be an expert directory and a bibliography.

78. **The Panel welcomed** the reported progress, **but noted with concern** the lack of funds to develop in particular HAEDAT and HABMAP components.

79. **The Panel reiterated** the request by IPHAB-IX for the Chairs of regional HAB groups to pursue the sharing of data in the Harmful Algal Event Data Base (HAEDAT).

80. The taxonomic backbone of HAIS is the IOC Taxonomic Reference List of Toxic Microalgae which is an element of the World Register of Marine Organisms (WoRMS) as decided by IPHAB-VIII. The Reference List is maintained and developed by The IPHAB Task Team on Algal Taxonomy (resolution IPHAB-IX.3).

81. **The Panel urged** editors to update the reference list as it is widely used, for example by monitoring agencies, making it very important that it is updated.

82. **The Panel recommended** a revised introductory text with summary information about how many producers there are of each toxin, etc., and that it be done jointly with the Task Team on Biotoxins.

83. Dr Fukuyo informed the Panel that the web-based HAB list he maintains for WESTPAC-HAB will close for two years, and asked if the list including photo material could be transferred to the Reference List. The Chair of the Task Team Dr Ø. Moestrup welcomed the suggestion.

84. **The Panel reaffirmed** the strong need in the international research and management community for a reference list on potentially harmful algae, and **decided** to continue the Task Team with revised Terms of Reference.

85. **The Panel adopted** [Resolution IPHAB-X.5](#).

5.9 HARMFUL ALGAE AND GLOBAL CHANGE

86. R. Gowen (UK) introduced the topic. The scientific focus on effects of climate and global change on HAB occurrence and impact has so far been limited. However, a recent review (Hallegraeff 2010)¹ has stressed the need for time series analysis to better understand and track relationships between global change and the frequency and geographical distribution of HAB species.

87. **The Panel discussed** the need for an internationally driven initiative to focus science.

88. **The Panel adopted** [Resolution IPHAB-X.6](#).

5.10 FISH KILLING MARINE ALGAE

89. Mark Wells (PICES) introduced the topic. Marine algae are thought to cause health problems for fish world-wide, and there are areas that no longer have fish farming, in part due to the presumed effects of harmful algae. Little is known about which algae or algal toxins might be involved, the potential for accumulation of algal toxins in farmed fish, or possible monitoring and mitigation strategies. An IOC sponsored 'International Workshop on Fish-killing Marine Algae', which was held 10–11 April 2011 at the Norwegian Veterinary Institute, Oslo, Norway, aimed to bring together researchers working on ichthyotoxic algae to identify research that will bring better understanding of, and, in turn, improved mitigation options for managing, ichthyotoxic algal problems.

90. **The Panel discussed** the need for an internationally driven initiative to focus science.

91. **The Panel adopted** [Resolution IPHAB-X.7](#).

6. HAB PROGRAMME WORKPLAN 2012–2013

6.1. STAFFING AND BUDGET OF THE HAB PROGRAMME

92. **The Panel noted with satisfaction** that staffing of the programme no longer depend on extra-budgetary funding alone, and the confirmation of continued staffing at the Vigo Centre.

¹ Hallegraeff, G. M. (2010), Ocean Climate Change, Phytoplankton Community Responses, and Harmful Algal Blooms: a formidable predictive challenge. *Journal of phycology*, 46: 220–235. doi: 10.1111/j.1529-8817.2010.00815.x

93. **The Panel strongly reiterated its encouragement** to all Member States to consider financial support for staff to the HAB Programme, and **urged** the IOC Executive Secretary to ensure continued staffing of the HAB Programme.

6.2. IOC SCIENCE AND COMMUNICATION CENTRES ON HARMFUL ALGAE

94. **The Panel recalled** how the IOC Science and Communication Centres on Harmful Algae established in Copenhagen (Denmark) and Vigo (Spain) were established as a decentralised programme office to provide assistance to Member States, and developing countries in particular (Document SC/MD/101, para.80). Through Recommendation IPHAB-VI.7, the Panel sought expansion of the IOC Science and Communication Centres to provide a broader and longer-term platform for the implementation of capacity-building activities including courses, workshops, training through research, and individual training. **The Panel also recalled** IOC Resolution XX-3 through which the IOC Assembly endorsed the continuation of the Centres and urged Member States to continue to provide support.

95. As at its previous sessions, **the Panel acknowledged the importance** of the long-standing support of Denmark and Spain for the IOC Science and Communication Centres.

96. **The Panel noted with appreciation** the commitment of Spain for a new 5-year period.

97. **The Panel recognized** the importance of the additional resources made available by having a decentralized Programme Office, and that the decentralized programme office is essential for the Commission to implement the HAB Programme.

6.3 WORKPLAN 2012–2013

98. **The Panel summarized** the priorities and needs for the next intersessional period and recommended a workplan for the period 2012–2013 in [annex](#) to [Recommendation IPHAB-X.1](#) **the Panel adopted.**

7. OPERATION OF THE IOC INTERGOVERNMENTAL PANEL ON HAB

99. **The Panel decided** to continue its intersessional activities under the co-ordination of the Chair. R. Magnien (USA) was elected Chair, and G. Usup (Malaysia) was elected Vice-Chair.

100. **The Panel and the Secretariat expressed their gratitude** to the outgoing Chair and Vice-Chair L. Guzman (Chile) and P. Busby (New Zealand) for their service to the Panel.

101. **The Panel adopted** [Recommendation IPHAB-X.2](#). **The Panel requested** the Chair to present an Executive Summary, Resolutions and Recommendations to the IOC Assembly at its Twenty-sixth Session in June 2011.

ANNEX I

ANNOTATED AGENDA

1. OPENING

OBJECTIVES OF THE INTERGOVERNMENTAL PANEL ON HARMFUL ALGAL BLOOMS.
DECISIONS TAKEN BY THE IOC ASSEMBLY

2. ADMINISTRATIVE ARRANGEMENTS

ADOPTION OF THE AGENDA
DESIGNATION OF RAPPORTEUR

**3. SUMMARY DESCRIPTION OF THE IOC
HARMFUL ALGAL BLOOM PROGRAMME**

4. HABP DEVELOPMENTS IN THE INTERSESSIONAL PERIOD:

- 4.1 CHAIR IPHAB AND TECHNICAL SECRETARY'S SUMMARY REPORT on activities and implementation of IPHAB-IX decisions
- 4.2 High-level summary of major IPHAB accomplishments
- 4.3 The IPHAB Strategy

5. MAJOR ISSUES REQUIRING INTERGOVERNMENTAL COOPERATION (INCLUDING INTERACTION WITH OTHER PROGRAMMES AND ORGANIZATIONS)

This agenda item will be organized as a series of Panels:

1. Formulation/endorsement of specific objectives for Regional HAB Working Groups, Chaired by Leonardo Guzman (Chile): IPHAB's Regional HAB Working Groups are a critical link to member states and can serve to highlight international priorities for research, capacity building, data, communications, and other technical support required to prevent, control or mitigate HABs. Each Regional HAB Working Group will report on the priorities for its region and IPHAB will seek to strengthen regional HAB Programme components through formulation and endorsement of specific objectives for regional activities based upon this input from Regional HAB Working Groups.

2. Capacity building, Chaired by Beatriz Reguera (Spain): The aim of IPHAB capacity building activities is to strengthen the capacity of governments and agencies to monitor and manage harmful algal events and to enhance the research capacity to deliver better forecasting tools and mitigation techniques. Based on the strategic plan for capacity building adopted by the Sixth Session of the Panel, and input from the Regional HAB Working Groups, the IPHAB will assess progress and identify actions to be taken.

3. The GEOHAB Research Programme, Chaired by Raphael Kudela (GEOHAB SSC): GEOHAB is established as an international research framework to facilitate and coordinate research that will deliver enhanced basic understanding of harmful algal ecology and thereby better and more operational modelling and forecasting tools. The IPHAB will assess advances in GEOHAB implementation, assess research needs of member states primarily through the Regional HAB Working Groups and identify IPHAB assistance required. With an anticipated sunset of GEOHAB in 2013 the Panel will assess the need for and focus of international led research beyond the current GEOHAB.

4. Harmful Algae and desalination of seawater, Chaired by Donald M. Anderson (USA): Long-term effects of exposure to low levels of biotoxins are poorly understood. The issue has

received increased attention in relation to drinking water supply from surface water and from desalination of sea water. A related concern of desalination plants is algal biomass that clogs filters and fouls membranes. The Panel will assess the need for and possible action of IPHAB regarding HABs and desalination.

5. HAB observations and their inclusion in GOOS Regional Alliances, Chaired by Bengt Karlson (Sweden): IPHAB has a Task Team to act as the focal and coordination point of the IPHAB regarding interaction with the Global Ocean Observing System (GOOS), the Joint WMO-IOC Technical Commission for Oceanography and Marine Meteorology (JCOMM), and the IOC Ocean Related Hazards Early Warning System with respect to HAB observations, forecasting and warning systems. IPHAB will assess progress and actions to be taken based on the input of member states and Regional HAB Working Groups.

6. Harmful algal events, coastal zone management and linkages with coastal eutrophication, Chaired by Robert Magnien (USA): IOC has activities on coastal zone management and ecological modelling of coastal ecosystems in relation to nutrient loading. HAB management and prevention is closely related to these broader areas of concern. IPHAB will review progress on development of NEWS2USE and alternative models and technical tools as recommended by IPHAB-IX, and discuss how it can promote the further implementation.

7. Harmful Algae and Global Change, Chaired by Richard Gowen (UK)): The scientific focus on effects of climate and global change on HAB occurrence and impact has so far been limited. However, a recent review (Hallegraeff 2010) has stressed the need for time series analysis to better understand and track relationships between global change and the frequency and geographical distribution of HAB species. IPHAB will discuss the need for an internationally driven initiative to focus science and seek to identify possible modalities for such work if deemed necessary.

8. Fish-killing Marine Algae, Chaired by Mark Wells/Charlie Trick (PICES). Marine algae are thought to cause health problems for fish world-wide, and there are areas that no longer have fish farming, in part due to the presumed effects of harmful algae. Little is known about which algae or algal toxins might be involved, the potential for accumulation of algal toxins in farmed fish, or possible monitoring and mitigation strategies. An IOC sponsored workshop in April 2011 aims to bring together researchers working on ichthyotoxic algae to identify research that will bring better understanding of, and, in turn, improved mitigation options for managing, ichthyotoxic algal problems. IPHAB will discuss the need for an internationally driven initiative to focus science.

6. OTHER RELEVANT ITEMS

The Panel will discuss any other proposal for activities.

7. RECOMMENDATIONS OF THE IPHAB, OVERVIEW OF RESOURCES AND NEEDS - WORKPLAN 2012–2013

8. OPERATION OF THE IPHAB

9. ELECTION OF CHAIR AND VICE-CHAIRPERSONS

10. ANY OTHER BUSINESS

11. ADOPTION OF EXECUTIVE SUMMARY AND RESOLUTIONS/RECOMMENDATIONS

12. CLOSURE

ANNEX II

ADOPTED RESOLUTIONS AND RECOMMENDATIONS

<u>Code</u>	<u>Title</u>
Resolutions	
Resolution IPHAB-X.1	Regional HAB Programme Development
Resolution IPHAB-X.2	Task Team on Biotoxin Monitoring, Management and Regulations
Resolution IPHAB-X.3	The GEOHAB Research Programme
Resolution IPHAB-X.4	Harmful Algae and Desalination of Seawater
Resolution IPHAB-X.5	Task Team on Algal Taxonomy
Resolution IPHAB-X.6	Harmful Algae and Global Change
Resolution IPHAB-X.7	Harmful Algae and Fish-killing Marine Algae
Recommendations	
Recommendation IPHAB-X.1	HABP Work Plan 2012–2013
Recommendation IPHAB-X.2	Operation of the IOC Intergovernmental Panel on Harmful Algal Blooms

Resolution IPHAB-X.1

REGIONAL HAB PROGRAMME DEVELOPMENT

The IOC Intergovernmental Panel on Harmful Algal Blooms,

Recalling the priority of implementing and maintaining IOC programmes at the regional level,

Noting with appreciation the reports of the regional activities within ANCA, FANSA, HANA and IOC/WESTPAC-HAB,

Acknowledging that regional working groups enhance collaboration on scientific and technical matters in support of Member State management and mitigation of harmful algal blooms,

Notes with appreciation the revised Terms of References for IOC/WESTPAC-HAB and the process to revitalize the membership of ANCA;

Decides that the terms of reference of regional IOC HAB groups shall include:

- (i) collating data on regional HAB events for inclusion into HAEDAT
- (ii) prioritizing HAB research, management issues and capacity development to be addressed regionally
- (iii) the practice of open invitation to IOC Member States to participate in IOC/HAB regional groups and for each group to elect a chair at two-year intervals
- (iv) reporting of (i)-(iii) to IPHAB every second year;

Notes that for WESTPAC-HAB these standard ToRs for regional HAB groups are subject to IOC/WESTPAC agreement;

Endorses the proposed work plans of ANCA, FANSA, HANA and WESTPAC-HAB for 2012–2013 subject to availability of funding;

Supports the establishment of new regional HAB groups or networks where there is a request for this;

Recalling Resolutions IPHAB-VIII.4 and Resolution IPHAB-IX.5 on Regional HABP development, in particular the needs identified for regional HAB activities in the Red Sea-Gulf-Arabian Sea-Northern Indian Ocean region; Southern Africa; Pacific Islands Countries and Territories (PICT),

Encourages northern Mediterranean counties to participate in HANA meetings;

Decides to assess the feasibility and potential for cooperation with the relevant regional organizations, in the establishment of regional HAB networks in: the Red Sea-Gulf-Arabian Sea-Northern Indian Ocean region; Southern Africa; Pacific Islands Countries and Territories (PICT) with the view to:

- (i) Improve scientific knowledge of the physical, biogeochemical and physiological factors governing the occurrence of HABs in each region
- (ii) Establish a data-base on HABs and associated events in the region as a contribution to HAE-DAT

- (iii) Establish a directory of personnel involved in HABs, their area of specialization and their level of expertise as a contribution to IOC/IODE OceanExpert data-base
- (iv) Compile an inventory of regional publications relevant to HABs
- (v) Promote the exchange of information through regular working groups, workshops and correspondence
- (vi) Promote capacity building for scientists and managers involved in the management and mitigation of HABs and their effects

Request that the regional Chairs maintain contact with Chair and Vice-Chair IPHAB and coordinate activities;

Urge Member State institutions to contribute resources to help implement the work plan of the regional networks and groups.

Resolution IPHAB-X.2

TASK TEAM ON BIOTOXIN MONITORING, MANAGEMENT AND REGULATIONS

The IOC Intergovernmental Panel on Harmful Algal Blooms,

Recalling Resolution IPHAB-IX.1 on the IPHAB Task Team on Biotoxin Monitoring, Management and Regulations,

Acknowledging that biotoxins from harmful algae pose a serious threat to human health, the seafood industry and the socio-economic wellbeing of coastal communities,

Acknowledging the work of various groups which address the scientific aspects of methodologies and legislations with regards to the contamination of seafood with HAB-derived toxins, and that each group generates valuable scientific information that may be used to recommend regional or national policies. Some of the working groups have operated on an ad hoc basis [FAO/IOC/WHO expert consultation 2004/5; ECVAM/DG Sanco workshop 2005; EFSA risk evaluations 2006 – 2010] while others are standing working groups, in particular those for methodological development or policies [e.g. Asia Pacific Economic Cooperation (APEC), US-ISSC, EU National Reference Laboratories, CEN, AOAC, FAO-WHO Codex Committee on Fish and Fisheries Products],

Noting that there is potential to improve the coordination and exchange of information among these groups,

Noting that new biotoxins from harmful algae and routes of exposure are being discovered, bringing to light heretofore unknown risks,

Noting that new and improved methodologies for detecting and monitoring the occurrence of HAB toxins in phycotoxins in seawater and seafood tissue are being developed,

Recalling that many aspects of IPHAB contribute to minimising the effect of HABs on human health, international trade in seafood and economic wellbeing,

Decides to continue with the Task Team on Biotoxin Monitoring Management and Regulation with the following Terms of Reference;

- (i) Review and update the IOC/HAB Programme Plan elements that address HAB-derived biotoxins to ensure that they contain current scientific information and regulatory frameworks
- (ii) Establish and maintain regular contact with FAO, WHO and other regulatory bodies
- (iii) Establish and maintain regular contact with leading scientists and scientific organizations to ensure that the latest and most robust science is available to the Task Team in discharging its responsibilities;
- (iv) Coordinate with and advise the Task Team on the Harmful Algal Information System regarding the use of toxin names and the inclusion of background data on toxins
- (v) Report to IPHAB-XI on international activities in marine biotoxin monitoring management and regulation during the inter-sessional period
- (vi) Approach WHO to co-sponsor a meeting on “Impacts and management of toxic and harmful algal blooms (HABs) at desalination plants and related seawater facilities”
- (vii) Recommend to IPHAB-XI on revised priorities for research, capacity development and engagement with regulatory bodies to address the most pressing issues and threats posed by HAB toxins in the marine environment

Encourages relevant organizations to invite the IPHAB Task Team to participate as observer at the principal meetings of their respective groups to facilitate international compatibility of applied methodology and legislation with respect to HAB toxins;

Decides that the Task Team will be chaired by P. Hess (France) and members selected by the Chair of IPHAB and the Secretariat;

Invites FAO and WHO to be members of the Task Team;

Notes that the Task Team is established until otherwise decided by the Panel and that it will work by correspondence and/or meets on an opportunistic basis, and provide a progress reports for the inter-sessional period to the Chair IPHAB prior to IPHAB-XI.

Resolution IPHAB-X.3

GLOBAL ECOLOGY AND OCEANOGRAPHY OF HARMFUL ALGAL BLOOMS

The IOC Intergovernmental Panel on Harmful Algal Blooms,

Referring to the joint SCOR-IOC international science programme on the Global Ecology and Oceanography of Harmful Algal Blooms (GEOHAB) as established through IOC Resolution EC-XXXI.1, and the associated GEOHAB Science Plan and associated Implementation Plans,

Noting that GEOHAB provides a unique ability to address underlying scientific questions and concerns related to harmful algae and their science based management,

Noting the achievements and ongoing activities of GEOHAB detailed in the GEOHAB report series and the contributions made to the scientific literature,

Noting that GEOHAB provides an interface between IOC and other international coordinating organizations for science such as SCOR, IOCCG, ICES, and PICES,

Noting that within the joint framework of IOC and SCOR, GEOHAB is expected to conclude its activities by the end of 2013,

Recognizing that to fully realise the benefits of the accumulated investments in GEOHAB and to address any new priorities identified by the IOC in collaboration with SCOR, it would be desirable to extend specific CRPs and framework activities within the GEOHAB Terms of Reference beyond the end 2013,

Recognizing that GEOHAB cannot continue to be implemented without the strong endorsement of the funding agencies of IOC Member States,

Decides, that the GEOHAB SSC should:

- (i) summarize GEOHAB contributions, successes, and yet to be achieved objectives as part of a 10-year synthesis
- (ii) evaluate the need for new scientific foci (as framework activities or new CRPs) in consultation with SCOR
- (iii) gather input from the international community by utilizing meetings such as ICHA 2012, ASLO 2012, and the planned Open Science Meeting in 2013
- (iv) interface with the IPHAB Task Teams, Working Groups, and Regional Networks to remain responsive to IOC/IPHAB priorities
- (v) present to IPHAB-XI a revised Science Plan and outline of an implementation plan for GEOHAB beyond 2013

Anticipates that IPHAB, pending a satisfactory revised Science Plan and outline of an Implementation Plan, will recommend to the Twenty-seventh Session of the IOC Assembly that GEOHAB continue beyond 2013 and that SCOR should be invited to continue as co-sponsor;

Urges Member State institutions to contribute advice and resources to help implement GEOHAB objectives.

Resolution IPHAB-X.4

HARMFUL ALGAE AND DESALINATION OF SEAWATER

The IOC Intergovernmental Panel on Harmful Algal Blooms,

Noting that more than 150 countries worldwide operate desalination plants to produce drinking water from seawater and that many of these countries are IOC member states,

Recognizing that desalination capacity is forecast to grow rapidly in the coming years as demand for fresh water grows,

Noting that in recent years, HABs have caused serious impacts at desalination plants [e.g. the cessation of operations due to clogging of filters, fouling of surfaces, damage to reverse osmosis membranes, taste and odour problems] and the concern that HAB-derived toxins could be present in the freshwater produced,

Noting that there is recent research evidence that if there are dense blooms of toxin producing HAB species in the vicinity of desalination plants it is conceivable that levels of HAB-derived toxins in the treated water could approach the levels of toxins that have been of concern in shellfish,

Noting that research on this topic is limited and that the detailed guidance being requested by stakeholders in Member States is difficult to provide,

Recognizing that there is a growing risk to public health and plant operations and, therefore considerable value in assembling information on gaps in scientific understanding and engineering challenges and in seeking a consensus on methodologies to reduce risks,

Decides to organize a meeting on “Impacts and management of toxic and harmful algal blooms (HABs) at desalination plants and related seawater facilities” before the end of 2012 (if possible) to:

- (i) Review the state of knowledge on the impact of HABs on desalination plants and other facilities that utilise large volumes of seawater in commercial or industrial applications
- (ii) Explore the engineering and operational strategies that are used, or could be used to mitigate the impacts of HABs and other planktonic threats to these types of facilities
- (iii) Produce a series of recommendations on plant operations when impacted by HABs, on research priorities to fill knowledge gaps and to inform policy decisions in this subject area
- (iv) Produce a report summarizing the conference and its findings and recommendations

Invites WHO and ROPME to be members of the Organizing Committee;

Decides also that the Organizing Committee will be chaired by D. Anderson (USA), with assistance from A. Al-Thukair (Saudi Arabia). H. Gheilani (Oman), P. Hess (France), M. Wells (USA), and R. Kudela (USA), with other members to be invited in consultation with the Chair IPHAB and the Secretariat;

Notes that the Organizing Committee is established until the event has been completed and a report published; that it will work by correspondence and/or meet on an opportunistic basis, and provide a report to the Chair IPHAB prior to IPHAB-XI.

Resolution IPHAB-X.5

TASK TEAM ON ALGAL TAXONOMY

The IOC Intergovernmental Panel on Harmful Algal Blooms,

Recognizing the pivotal role of taxonomy in scientific research, monitoring and management activities in the HAB programme,

Acknowledging that there are publications available on the taxonomy and identification of harmful algae, including those published by UNESCO/IOC,

Acknowledging the progress made by the Task Team in publishing and updating the IOC Taxonomic Reference List of Harmful Marine Microalgae as an integrated element of the World Register of Marine Organisms and the IOC/IODE Harmful Algal Information System (HAIS),

Recalling the frequent change of taxonomic status of many harmful algae and the identification of new harmful species require continuous updating of the Reference List,

Noting that frequent taxonomic changes must be considered and incorporated into the work of ecologists, toxicologists, and those undertaking regulatory monitoring,

Recalling the decisions of the previous sessions of the Panel regarding the Task Team on Algal Taxonomy,

Decides, with reference to the HAB Programme Plan, objective 6.2.2, ii (Annex V), to continue the Task Team on Algal Taxonomy with the following terms of reference:

- i) verify the Reference List and suggest modifications to it
- ii) cooperate with the Task Team on Biotoxins to prepare a summary of data [e.g. number of species known to produce each toxin, current taxonomic problems]
- iii) interact in the development of the Harmful Algal Information System
- iv) identify editors within or outside the task team who will be responsible for maintaining, completing and updating the Reference List, including illustrations showing diagnostic features of each species, and reference or links to such illustrations

Decides that the Task Team will comprise Ø. Moestrup (Denmark) Chair, R. Akselman (Argentina), N. Lundholm (Denmark), Y. Halim (Egypt), M. Elbraechter (Germany), M. Hoppenrath (Germany), A. Zingone (Italy), S. Fraga (Spain), L.N Nguyen (Vietnam). The Task Team may be expanded as required to fulfil the Terms of Reference;

Notes that the Task Team will continue its work until otherwise decided by the Panel, and that it will work by correspondence and/or meet on an opportunistic basis, and provide a progress report including a work plan for the intersessional period to the Chair IPHAB prior to IPHAB-XI.

Resolution IPHAB-X.6

HARMFUL ALGAE AND GLOBAL CHANGE

The IOC Intergovernmental Panel on Harmful Algal Blooms,

Recalling High Level Objective 2 of the IOC Medium Term Strategy for 2008–2013, Mitigation of the impacts and adaptation to climate change and variability and, in particular, the decision therein to increase the understanding of the impacts of climate change and variability on marine ecosystems and their living resources,

Recalling the IPCC 2007 report that identified the likely intensification of problems associated with eutrophication and stress on coastal marine ecosystems,

Noting the influence of short-term decadal scale climate variation on the occurrence of HABs and related events,

Noting that warming of surface layers of the ocean may lead to the geographical spreading of HAB species and an increase in the seasonal occurrence of some HAB species,

Noting that climate change also may have effects on ocean circulation, stratification; carbonate system and nutrient delivery modes,

Recognizing that the effects of global warming on the occurrences of HABs in coastal waters are complex because of the influence of human pressures such nutrient enrichment,

Recognizing the importance of assembling and analyzing time-series of HABs and related events identifying gaps in scientific understanding that constrains how projected climate change may influence HAB events;

Recognizing that understanding the role of decadal variability and climate change on HABs is a priority identified within the GEOHAB core research programmes and framework activities,

Endorses the terms of reference proposed by the ICES-IOC Working Group on Harmful Algal Bloom Dynamics to:

- (i) Develop an improved understanding of long-term changes in HABs driven by climate and other factors by assembling and analysing time-series of HABs and related events in the ICES area and progress to publication as an ICES Cooperative Research Report on HAB time-series
- (ii) Identify central unresolved issues that limit advances in understanding how projected climate change may influence HAB events by convening an ICES/IOC/PICES workshop of HAB experts.

Resolution IPHAB-X.7

FISH KILLING MARINE ALGAE

The IOC Intergovernmental Panel on Harmful Algal Blooms,

Recalling the IOC co-sponsored 'International Workshop on Fish-killing Marine Algae' held in Oslo, Norway, April 2011,

Noting:

- that many, perhaps most, ichthyotoxic algae, are known and can be identified
- that there is increasing concern about the impact of these blooms on society, economic interests, sustainability of food supplies and aquaculture in particular
- the likelihood that toxicity is not the sole reason for fish kills, but that there may also be other less specific mechanisms
- the limited utility and lack of standardization of bioassay methods for assessing toxicity
- that while these events are categorized as "Fish-Killing" there are impacts on other components of coastal marine ecosystems
- that the broader issue comprises three components: a) the ecology and oceanography of fish killing algae, b) the ethiology and specific mechanisms of fish mortality, and c) the management and mitigation of fish killing algal events

Recognizing that there has been little discussion of fish-killing algae outside the aquaculture industry sector and little awareness of this issue within the scientific community,

Encourages a session on fish killing algae at the 15th International Conference of Harmful Algae, Korea 2012;

Decides, with reference to the HAB Programme Plan, objective 6.3.1, ii, to establish a Task Team on Harmful Algae and Fish Kills with the following terms of reference:

- (i) develop a Term of Reference on fish killing algae for 2012 for the ICES-IOC Working Group on Harmful Algal Bloom Dynamics before 1 August 2011
- (ii) prepare an overview of the scale of the issue and priorities and report to IPHAB-XI with view to develop a community scale project
- (iii) support the organization of a joint ICES/IOC/PICES meeting to better define global understanding of the broad issues listed in item i)

Decides also that the Task Team will be composed by A. Cembella (Germany) (Co-chair), R. Gowen (United Kingdom) (Co-chair), P. Hess (France), and M. Wells (PICES). The Task Team may be expanded as required to fulfil the Terms of Reference;

Notes that the Task Team will continue its work until otherwise decided by the Panel, and that it will work by correspondence and/or meet on an opportunistic basis, and provide a progress report including a work plan for the intersessional period to the Chair IPHAB prior to IPHAB-XI.

Recommendation IPHAB-X.1

HABP WORKPLAN 2012–2013

The IOC Intergovernmental Panel on Harmful Algal Blooms,

Referring to the deliberations of its Tenth Session and the priorities identified prior to the session by ANCA, FANSA, and HANA,

Endorses the implementation of the Work Plan for the IOC Harmful Algal Bloom Programme as presented in [Annex 1](#) to this Recommendation within the resources available;

Urges Members of the Panel and the IOC Secretariat to help identify the required resources.

Recommendation IPHAB-X.2

OPERATION OF THE IOC INTERGOVERNMENTAL PANEL ON HARMFUL ALGAL BLOOMS

The IOC Intergovernmental Panel on Harmful Algal Blooms,

Recommends that the IOC Intergovernmental Panel on Harmful Algal Blooms continue until otherwise decided by the IOC. The Terms of Reference should remain unchanged.

Annex 1 to Recommendation IPHAB-IX.1

IOC HAB PROGRAMME WORKPLAN 2012–2013
(Main activities and funding identified as of 1 May 2011 only)

SCC HA = IOC Science and Communication Centres on Harmful Algae; HQ = IOC-UNESCO Headquarters Paris

ACTIVITY:	ORGANIZER/ RESPONSIBLE	TARGET GROUP/ Region:	WHERE:	WHEN:	FUNDING IDENTIFIED: In USD 1000		FUNDING REQUIRED TOTAL: In USD 1000	AUTHORIT Y & REMARKS
					IOC	Ex Bud		
OPERATION & SERVICES								
IOC SCC HA & HAB Programme Office <i>Incl. the activities and services in this workplan implemented by the Centre and required to justify a decentralised PO.</i>	IOC/H.Enevoldsen	Global	Copenhag en	2012- 2013	0	Denmark in kind and individual projects	2 x 50 and in kind by host	IPHAB-X
IOC SCC HA	IOC/M. Lion	Latin America & North Africa	Vigo	2012- 2013	0	2 x 40 Spain and in kind	2 x 40 and in kind by host	IPHAB-X
PUBLICATIONS								
HAB Programme Strategic document	IOC	Global	HQ / SCC HA	2009	0	0	5	IPHAB-VIII
Harmful Algae News	T. Wyatt (Spain), Editor	Global	HQ / SCC HA	2012- 2013	4	4	9	IPHAB-X
GEOHAB CRP Plan: Benthic HABs	P. Bienfang (USA)	Global	HQ with SCOR	2011/12	0	4	4	IPHAB-IX

IPHAB-XI Report	IOC	Global		2013	2	0	2	IPHAB-XI
COSPONSORSHIP OF CONFERENCES								
XVth ICHA	ISSHA	Develop. Country.	R. Korea	2012	0	0	5	IPHAB-X
TRAVEL								
IOC Staff	H. Enevoldsen	-		Yearly	2 x 3K	2 x 5	2 x 10	IPHAB-X
Chair IPHAB Travel	R. Magnien (USA)	-		Yearly	2 x 2K	0	2 x 2	IPHAB-X
SCIENTIFIC ELEMENTS								
GEOHAB SSC	IOC/SCOR	Global	-	-	2 x 20K (incl publication)	2 x 50 via SCOR	2 x 100	Agreement with SCOR
ICES-IOC WGHABD	B. Karlson (Sweden)	Develop. Country	Oban, Scotland (2012)	Yearly	0	0	4	IPHAB-X
ICES/IOC/IMO WGBOSV	T. McCollin (Ireland)	Global		Yearly	0	0	4	IPHAB-X
ICES-IOC-PICES Science Workshop on HABs and Global Change	B. Karlson-R.Gowen - M. Wells	Global	Oban or Copenhagen	2013	0	Sought	35	IPHAB-X
Harmful Algal Information System development	HABP-IODE	Global	-	2012-2013	5	0	100	IPHAB-IX and IODE-XX
International Workshop on HABs and desalination	D. Anderson	Global	To be decided	2012	2	0	30	IPHAB-X
REGIONAL GROUPS								
Regional Working Group on Harmful Algal Blooms in South America (IOC FANSA)	L. Proenca (Brazil)	S-America	Brazil	2012	0	7	10	IPHAB-X

Regional Working Group on Harmful Algal Blooms in the Caribbean (IOC ANCA)	To be decided	To be decided	To be decided	2012	0	5	10	IOCARIBE and IPHAB-IX
Regional Group on Harmful Algal Blooms in the Western Pacific: WESTPAC-HAB	To be decided	WESTPAC	To be decided	To be decided	0	0 (?)	10	IPHAB-X and WESTPAC-9
Regional Working Group on Harmful Algal Blooms in North Africa (IOC HANA)	Y. Halim (Egypt)	North Africa	To be decided	2013	0	7	10	IPHAB-X
New regional initiatives	IPHAB members	-	To be decided	To be decided	5	0	20-30	IPHAB-X
CAPACITY ENHANCEMENT								
IOC Training Course on Identification and Qualification in Harmful Marine Microalgae	IOC SCC HA CPH	Global, Develop. Country	University of Copenhagen, Denmark	2012 and 2013	0	Danish partners and cost recovery. Grants sought	2 x 10 If grants are to be provided	IPHAB-X
IOC-IEO-AECI Training Courses	IOC SCC HA Vigo	Latin America, and North Africa Develop. Country	Instituto Español de Oceanografía, Vigo, Spain	2012 and 2013	0	2 x 20 /Spain 2 x 10 IEO	2 x 36	IPHAB-X
IOC Training Course on Qualitative and Quantitative Determination of Algal Toxins	A. Cembella - B. Krock (Germany)	Global	AWI, Germany	2012 and 2013	0	German partners and cost recovery. Grants sought	10 If grants are to be provided	IPHAB-X
10 th Advanced	Ø. Moestrup – A.	Global	Hillerød,	2012	0	Cost	20	IPHAB-X

Phytoplankton Course	Zingone		Denmark			recovery. Grants sought	If grants are to be provided	
Regional Training Course on Taxonomy and Ecology of Harmful Marine Microalgae (E- learning)	To decided	HANA	To decided	2012/13	0	0	15	IPHAB-X
Regional Training Course on HAB species identification	To decided	FANSA	To decided	2012/13	0	0	15	IPHAB-X
Regional Training Course on HAB Monitoring	To decided	ANCA	To decided	2012/13	0	0	15	IPHAB-X
Reestablishment of the ANCA-FANSA portal Algas Nocivas	Portal Editors	ANCA/FA NSA	IOC Server	2011- 2012	2	0	5	IPHAB-IX and X
Intercalibration exercise of DSP and other lipophilic toxin determination between EU-CRL and the NRLs of the Region which have already implemented ISO norm 17025	Public Health Institute of Chile	FANSA	-	2012/13	0	0	3	IPHAB-X

Requested funding (2012-2013): US\$ 70,000 from IOC Regular Programme (draft
C36/C5)

Identified funding (2012-2013): US\$ 80,000 from expected extra-budgetary resources
US\$ ~500,000 to be identified from extra-budgetary resources for full implementation.

ANNEX III

NATIONAL STATEMENTS

A. Barbados

Introduction:

The Barbados Government (i.e. Coastal Zone Management Unit (CZMU) and the Environmental Protection Department (EPD)) has been monitoring the occurrences of *Trichodesmium* sp. (i.e. sea sawdust), a colonial filamentous blue-green algae/cyano-bacterium in Barbados's coastal waters since 1998. Relatively large "non-harmful" blooms of *Trichodesmium* sp. have been reported and observed on the following dates:

- March 11, 1998
- March 25, 2003
- March 23, 2005
- March 26, 2007
- March 05, 2009
- March 04, 2011

Therefore, some seasonality (i.e. March) could be assigned to the occurrence of this species in Barbados's waters. *Trichodesmium* sp. should be of particular interest to Barbados and the region since it has the potential to negatively impact the marine and coastal environment and its users. This organism is known to produce a "red tide" that discolours coastal waters and beaches. Such an event can have severe negative economic impacts on Barbados's tourism industry, which is characteristically "coastal tourism" in nature, and can also result in negative impacts to coastal recreational activity by locals. In 2004, Brasil experienced the effects of a *Trichodesmium* sp caused "red tide" (Figure 1), where their tourism industry suffered that year as a consequence.



Furthermore, *Trichodesmium* sp. is also reported in the literature to be associated (i.e. via the provision of nutrients) with *Karenia brevis*, an organism (i.e. dinoflagellate) that produces toxic aerosols that can lead to respiratory asthma-like symptoms in humans. Such threats to the health of Barbados's coastal users, physical environment and economy, posed by *Trichodesmium* and other HAB species, and the occasional uncharacterized fish kill events, warrant Barbados's commitment to becoming proactively (i.e. precautionary approach) prepared for HAB events and its involvement with the IPHAB. Such proactivity is further sanctioned by the global expansion in the occurrence of

HAB. The Caribbean Sea has become surrounded by HAB hotspots during the period 1970 to 2009. Such a commitment is consistent with the following:

Figure 1. *Trichodesmium* bloom in Brasil, 2004
(ANCA Workshop, San Andreas, Columbia)

1. Barbados Sustainable Development Policy - which specifies that Government and civil society should take initiatives in accordance with

their respective roles, to develop their maximum potential and enrich the process of

decision-making for sustainable development. Furthermore, the policy recognizes the importance of preparing as far as possible for and mitigating against the adverse repercussions of man-made and natural disasters.

- 2. National Sustainable Development Action Plan and Integrated Coastal Management Plan** – which seek to ensure the sustainable management of coastal and marine resources in order to retain their vital and pivotal role in the economic, social and physical development of Barbados. This objective is expected to be achieved by ensuring that management decisions account for the dynamic nature of the coastline, conservation of coastal ecology, application of standards and procedures and seeking compatibility between socio-economic and environmental interests.

Trichodesmium sp is presently being researched routinely during American research-cruises being conducted in the waters of Barbados and the wider Caribbean region. Barbados has initiated discussions with such researchers to gain insight into the ecology of this organism in the Caribbean Sea/Atlantic Ocean and any evolving implications regarding the potential for HABs. In this regard, via the cooperation of the researchers and in keeping with the requirements of the United Nations Convention on the Law of the Sea (UNCLOS), Barbados is anticipating receipt of reports of the research findings from the scientists.

National Priorities for HABs:

Barbados's national priorities are as follows:

1. Recognizing that the *Trichodesmium sp.* is but one of numerous species of phytoplankton that can impact Barbados, there is a need to educate / sensitize national stakeholders regarding the possibility that climate and environmental factors can change to favour the occurrence of HABs, which can impact human health, ecosystems and the national economy.
2. Catalyze capacity building for Government and other relevant agencies to monitor and manage HAB events.
3. Identify and/or acquire the necessary expertise that could offer support to educational/sensitization efforts, research needs, HAB forecasting/monitoring programmes and HAB incident response.
4. Work towards technical cooperation with the regional HAB working group (i.e. ANCA) and to contribute towards regional efforts on HAB management and science.
5. Develop a national HAB Response Plan.

References:

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B. Croatia

Ivona Marasović, Institute of Oceanography and Fisheries

“National monitoring program of the shellfish toxicity on the Croatian breeding areas” includes the biggest part of the HAB research activities in Croatia. The program is performed in compliance with the EU shellfish hygiene directive 91/492/EEC and funded by the Croatian Ministry of Agriculture, Fisheries and Rural Development. In the frame of this program an environmental monitoring has been performed (including phytoplankton composition, toxic

species, chlorophyll a, transparency, temperature, oxygen, pH and sanitary bacteriology) together with monitoring of phycotoxins in shellfish (PSP, DSP and ASP). Mouse bioassay is used for determination of PSP and DSP shellfish toxicity, whereas HPLC method is used to determine ASP toxicity. The majority of toxicity examinations are performed on mussels (*Mytilus galloprovincialis*) and minor part on *Pecten jacobaeus*. Sampling of sea water and shellfish are performed weekly or, in case of positive results, every 48 hours. The National Reference Laboratory for investigation of marine biotoxins and identification and enumeration of toxic algal species is the Laboratory of Plankton and Shellfish Toxicity, at the Institute for Oceanography and Fisheries, Split, Croatia (accreditation in compliance with 91/492/EC under ISO 17025).

The biggest problem in the Croatian farms is DSP toxicity, which in previous years was seen mainly in the farms in the northern Adriatic Sea, while in 2010 and 2011, was often recorded in the farms of central and southern Adriatic. For example, in 2009 out of 989 analyzed samples, on the DSP toxicity were 9.1% positive samples, while in 2010 out of 1290 samples were positive even 15.3% of samples, and during the first 3 months of 2011 due to the DSP toxicity many farms were closed, predominantly those in the southern Adriatic. LC/MS /MS analysis showed that in the Croatian farms the largest part of DSP toxicity is attributable to yessotoxin, while the presence of ocadaic acid and DTX toxins in shellfish samples is considerably rarer. Analyses of seawater samples showed that in this area as a cause of DSP toxicity can usually be identified the species of *Dinophysis fortiri*, *D. caudata*, *D. sacculus* and *D. rotundata*, but in 2010 was more often recorded the presence of species *D. acuta* and *D. tripos*.

The first appearance of PSP toxicity in the Croatian farms was recorded at the beginning of 2009, and toxicity was maintained until the end of March in 2009, where the concentration of toxins repeatedly exceeded maximum level allowed for SXT in shellfish. The similar situation was repeated in December 2009 and 2010, but during all these episodes of toxicity, it was very difficult in phytoplankton community to identify the causal species. Namely, in the period preceding the appearance of PSP toxicity, as well as during the PSP toxicity in samples of seawater were identified species *Alexandrium tamarense*, *A. minutum* and *A. concavum*, but in very low abundance. LC/ MS/MS analysis showed that the PSP toxicity in the Croatian farms could mostly be associated with STX, while low concentrations of dcSTX and GTX2, 3 were present. The PSP toxicity was present only in shellfish farms in the northern Adriatic (Istria), in shellfish and tunicate *Microcosmus sulcatus*.

Although in the Croatian farms has never been recorded ASP toxicity, though in some periods in bivalves were reported increased concentrations of domoic acid (6.5 mg), but still significantly below the maximum level allowed for DA in shellfish (20 mg).

The problem of HAB is also addressed in the frame of international collaboration with other countries, particularly with Adriatic countries in the frame of the IPA ADRIATIC CROSS-BORDER COOPERATION PROGRAMME. Currently is in preparation a joint proposal program for the identification of HAB organisms in the Adriatic ports sea water and imported ballast water, which will be submitted to the upcoming IPA ADRIATIC CBC call for proposals . Through this program, real time observing system would be established and between the Adriatic ports would be conducted a continuous exchange of data information about the presence of HAB organisms (Adriatic network).

Research activities focusing on harmful algal blooms problem in Croatia include a basic research in the factors that control HAB events (hydrography, nutrients availability, temperature, pH, precipitation), research on bloom dynamics and research the impact of climate changes to the frequency of HAB events. In the research of HAB problem in Croatia a special attention is paid to taxonomic study of HAB species. During the last five years, a large number of scientific reports and scientific papers related to problem of HAB species and biotoxins have been published.

Croatia develops observing system and data management system (oceanographic buoys and permanent monitoring), whose main goals are the following:

- to characterize the status of the Adriatic Sea in terms of its health (HABs, hypoxia, mucilage) and living marine resources (fisheries);

- to detect the role of ballast waters from ships in the introduction of invasive species, including harmful algae and toxic cysts, and to prevent the new invasions and mitigate the harmful influence of the established invaders;
- to forecast and mitigate the effects of extreme meteorological events and climate change on the Adriatic Sea and its bays
- to detect and predict changes in status as the means to protect and restore healthy coastal ecosystems and sustain the living resources and the economic activities they support;
- to ensure public health and safety.

As the priority actions to be taken within the IOC-IPHAB activities Croatia proposes the following:

- Education of new experts through organization of training courses for identification of shellfish toxins and toxic species
- Organization of regional (international) inter-calibration of shellfish toxins identification
- Organization of regional (international) inter-calibration of identification of toxic species
- Exchange of information on shellfish toxicity with the neighboring countries
- Research on toxic bloom dynamics and on the response of HAB species to environmental factors
- Establishment of regional HAB group in Adriatic region (ADRIAHAB)

C. Greece

HABS EVENTS

As has been previously reported, the major persistent impacts of HAB events in Greece, have been associated to proliferation of *Dinophysis* species. The most serious diarrhetic shellfish poisoning (DSP) outbreak, associated with a *Dinophysis cf. acuminata* bloom (maximum abundance: 8×10^4 cells l^{-1}) was firstly observed in January 2000 in Thermaikos Gulf, a major shellfish cultivation area in Greece (90% of total shellfish production). The outbreak lasted several months, until early May 2000, resulting in great economical losses in the shellfish industry due to closing of bivalve mussel production zones. Since then, *Dinophysis cf. acuminata* constantly appears during the winter-spring period and its maximum abundance (6.1×10^5 cells l^{-1}) was recorded in February 2004. *Noctiluca scintillans* blooms often coincide or follows *Dinophysis* blooms, as well as, the diatom *Pseudo-nitzschia* does in Thermaikos Gulf. Occurrences of such events were recorded in 2010 and spring 2011, as well.

However, *Dinophysis* and *Pseudonitzschia* increased abundances have reported also from other Greek gulfs, as are Elefsis Bay in Northern Saronikos during summer 2010 (up to 1.8×10^3 cells l^{-1} and 1.4×10^5 cells l^{-1} , respectively) and in Maliakos gulf in Central Aegean. In Maliakos Gulf the most serious event recorded during March-May 2009, caused by the fish-killing raphidophyte *Chattonella sp.* A serious economic problem arose from massive mortalities of cultured and wild fish in the estuary of Sperchios river, after an episodic rainfall event during the fertilizer application period (January-February). Raphidophytes are blooming also in Thermaikos Gulf, including *Chattonella sp* and *Heterosigma akaswiwo*, the latest being recorded in high abundances up to 1×10^8 cell l^{-1} in late spring 2010. Fish killing events were also reported by fishermen from other coastal areas of Northern Aegean near river mouths, during spring-summer 2009 and 2010 and were related to coloured sea water.

Alexandrium ostenfeldii densities above 1×10^3 cells l^{-1} in Saronikos gulf during December 2010 – January 2011 were in agreement with mouse bioassays positive for PSP toxins.

The last years researchers have reported predominance of toxin producing cyanobacteria as *Microcystis aeruginosa* in several lakes of Northern Greece causing HABs events. It must be noticed that water from these lakes is used for irrigation, etc.

Research projects

Research activities focusing on harmful algal blooms problem are conducted at research centers and universities through monitoring projects, mainly funded by national

sources and through research projects as well. Research includes HAB species taxonomy, physiology, life stages, relation to eutrophication and nutrient inputs, ecology and toxins' methods to detect marine biotoxins using biosensors for early warning. Targeted investigations, related to toxic phytoplankton species and shellfish toxicity events are carried in the frame of harmful algae national monitoring programs conducted in a wide network of fixed points at the main fishing and shellfish growing areas of Greece, as well as ecological protection areas, recreation resorts and HABs frequently occurrence areas. Most projects have combined field and laboratory experimental studies in a coordinated effort in order to characterize the physical, chemical and biological processes governing the growth of HAB species, the production of their toxins and their transport into the pelagic and benthic food web.

At the period 2010-11, some of the research programmes for environmental monitoring of phytoplankton (which included HABs monitoring) of the Institute of Oceanography, Hellenic Centre for Marine Research are the following:

Study of the Inner Saronikos ecosystem, under the influence of Psittalia sewage treatment plant. (Funding: Company of water supply and sewerage)

Monitoring program for the evaluation of the quality of Messiniakos Gulf and the western coast of Messinia during 2006-2010. (Funding: Prefecture of Messinia)

Study of short- and mid-term effects of the pollution caused from the accident of the ship "SEA DIAMOND" in Santorini Bay. (Funding: Ministry of Mercantile Marine).

2011-2014: Mediterranean Sea Acidification under changing climate (MedSeA), FP7/EC. In the frame of this project as a contribution to the "Quantification of the impacts of ocean acidification and warming on ecologically and socio economically important species" the ecological response of the harmful algal bloom (HAB) species *Alexandrium minutum* to ocean acidification and warming in the Eastern Mediterranean will be assessed using laboratory experiments.

2011-2012: Dynamics of Harmful Algal Blooms (HABs) in three eutrophicated bays in Greece and Turkey. Resting cysts and their role in the establishment of HABs. Joint Research and Technology Programmes. Turkey- Greece, 2010 – 2011.

At the Department of Botany, Aristotle University of Thessaloniki, Greece, the Project "Harmful Algae Monitoring Programme in Greek coastal waters" runs since 2000 and is funded mainly by national sources (Prefectures). The monitoring schedule covers 8 mussel (*M. galloprovincialis*) culture and bivalve molluscs fishing areas at the coastal areas of the Aegean Sea and 1 area in the Ionian Sea.

Mussels are examined for three categories of toxins, DSP, PSP and ASP by either mouse bioassay and/or HPLC method in compliance of the Decisions 2002/225/EC, 2002/226/EC, which are an amendment of Council Directive 91/492/EEC. The majority of the examined mussels belong to *Mytilus galloprovincialis*. The National Reference Laboratory of Marine Biotoxins, Ministry of Rural Development and Foods in Thessaloniki, Greece is the main laboratory of marine biotoxins and operates since 1993 in compliance of the above Decisions. A 100% of the shellfish fishing or shellfish cultures are inspected from 15 provinces of the country, of which about 65% from Thermaikos Gulf. Moreover, the Hellenic Centre for Marine Research administers chemical analyses using Liquid Chromatography Mass Spectroscopy (LC-MS) for the analyses of okadaic acid and DTXs and domoic acid.

Also, at the Department of Botany, Aristotle University of Thessaloniki, and at the University of Ioannina, research on toxic phytoplankton in lakes is realised, through monitoring projects.

Research on phytoplankton (including HABs) is also carried out in other universities (e.g. University of Aegean, Department of Marine Sciences, Lesbos Island, Greece).

Recently the General Secretariat for Research and Technology approved a project proposed by a consortium, which includes private companies and universities, in order to "Develop and validate a telemetric system monitoring and predicting HAB species and events in coastal ecosystems".

Capacity building

- A culture collection of some harmful microalgae has been established at HCMR, Athens and at the Department of Botany, Thessaloniki.
- Bachelor, MSc, and Ph.D students are supported via monitoring and research projects in HAB research, as well as in modelling and management/mitigation of HAB events and areas, including ICZM application.
- Lectures in summer schools and postgraduate students regarding HABs
- Participation in GEOHAB-Open Science Meeting on Harmful Algal Blooms in Benthic Systems
- Participation of two young scientists in training course for CO₂ influence on HABs is scheduled, in the frame of MEDSEA EU project.

Priorities

At the last IPHAB IOC meeting (Paris, April 2009), Greece proposed the following priorities:

- Continuation of national HAB species and phycotoxin monitoring by extending it in time and space
- Participation of young scientists in training courses for identification of toxic species and shellfish toxins
- Participation of young scientists in training courses of new methodologies (e.g. molecular biology, genetic diversity, biosensors)
- Application of new methodologies for identification of toxic species and shellfish toxins
- Strengthening the collaboration among universities, research laboratories, social, economic and public services (e.g. port and/or prefectures authorities), in order to achieve a significant progress in research and management of HAB problems that would not be possible if similar studies were undertaken independently (e.g. coordination of research, input to solutions/decisions)
- Exchange of information on toxic species and shellfish toxins with other countries
- Establishment of data bank of HAB events

Many of these priorities for the period 2009-10 were achieved through national and EU cooperation, however strengthening among interested parties needs improvement, as well as exchange of information and establishment of the data bank.

Greek priorities for 2011-12 are:

- Continuation of monitoring programmes regarding harmful algal blooms and phycotoxins, especially in the aquaculture areas to ensure a sustainable shellfish activity.
- Development of knowledge on the relationships between phytoplankton dynamics (including toxic species and discoloration events) and water quality, in compliance with the EU Water Framework Directive and EU Marine Strategy Framework Directive and national legislation.
- Further training of younger scientists in species identification, both in morphological and molecular level.
- Application of the new methodologies for toxic species identification and toxins' determination in shellfish material (as are biosensors, etc).
- Early warning / predicting HAB events, with close link to operational oceanography/observing systems.
- Further strengthening the collaboration among universities, research laboratories, social, economic and public services (e.g. port and/or prefectures authorities), in order to achieve a significant progress in research and management of HAB problems, which would not be possible, if similar studies were undertaken independently (e.g. coordination of research, input to solutions/decisions).

- Further exchange of information on toxic species and shellfish toxins with other countries.
- Establishment of data bank of HAB events.

Communications

During the last years a large number of scientific papers and scientific reports have been published concerning HABs species dynamics, toxicity and toxin transfer through food webs.

The 14th International Conference on Harmful Algae, was held in Crete, 1-5 November 2010, under the auspices of the Institute of Oceanography-HCMR, and ISSHA (International Committee for the Study of Harmful Algae). Members of the International Scientific Committee for the 14th International Conference on Harmful Algae, were: Beatriz Reguera, Kin Chung Ho, Mingjiang Zhou, Kalliopi Pagou, Donald M. Anderson, Rita Horner, Stephen Bates, JoAnn Burkholder, Jose Bustillos-Guzman, HenriK Enevoldsen, Patricia M. Glibert, Edna Graneli, Gustaaf Hallegraeff, Grant Pitcher, Sandra Shumway, Takashi Yasumoto, Yasuwo Fukuyo. In the Local Organizing Committee of the 14th International Conference on Harmful Algae participated: Pagou K. (chair), Christou E., Dassenakis M., Economou-Amilli A., Giannakourou A., Giannoudi L., Gotsis-Skretas O., Katsaros C., Karydis M., Moustaka M., Papadakis M., Papathanassiou E., Reizopoulou S., Varkitzi I. Almost 600 papers were submitted, 530 were accepted (150 orals, 380 posters). In the conference participated 500 scientists from 66 countries.

D. Italy

Italy, like other Mediterranean countries is experiencing enhanced problems that derive from the apparent expansion and intensification of the impact of benthic harmful algal species, namely *Ostreopsis* cf. *ovata*. Since the first outbursts in Tuscany in 1998, followed by those in Apulia and Liguria in 2005, Sicily in 2006 and Marche in 2008, the regional agencies for environmental protection (ARPA) have set up regular monitoring operations in the benthic system during late spring-summer season. These operations and the relevant management procedures follow the guidelines provided by the Italian Ministry of Health.

At national level the regional agencies are coordinated by the Institute for Environmental Protection and Research (ISPRA), who has also coordinated a multidisciplinary scientific project on *Ostreopsis* in 2009. Another national project (PRIN) on algal toxins has been completed in 2009, while several regional projects are still ongoing. Results of these scientific and monitoring efforts have shown that the risks deriving from *Ostreopsis* blooms are shared by almost all Italian coastal regions. In several cases toxicity due to palytoxin is recorded during the summer-early autumn period in sea-urchins and wild mussels living on rocky shores of the areas where the species proliferates. No accident due to food consumption has been recorded so far.

In autumn 2010, the first case of intoxication of ca 300 people due to DSP toxins was reported in northern Italy. The area of provenance of the toxic mussels, the Gulf of Trieste, is regularly checked, but the mussels had been put on the market despite a block imposed by public authorities.

Several Italian scientists participated in the IOC-SCOR GEOHAB Open Science Meeting (Honolulu, Hawaii June 2010) contributing new information and relevant elements to the discussion.

The main Italian priorities on HAB research/management/education still concern the problems caused by *Ostreopsis* and include:

- The development of appropriate methods for monitoring benthic microalgae: this issue was raised during the GEOHAB OSM on Benthic HABs and is still a matter of discussion among Italian ARPA agencies, who are also testing alternative methods.
- The evaluation, quantification and actual risks posed by toxins produced during *Ostreopsis* blooms. More palytoxin-like substances have been recently described in the

species, but their actual toxicity remains to be assessed. No regulatory limits have been set for these toxins. At the same time, the mouse test, which is officially required by the Ministry of Health, is more sensitive than chemical methods.

- The continuation of research on the dynamics of benthic harmful algal blooms and of their relationships with environmental factors and benthic populations. Progress has been made due to research over the last years, but several aspects of *Ostreopsis* ecology, physiology and toxicity still require research to be elucidated. The continuation of GEOHAB and activities within the BHAB core project represents an important opportunity to link science activities at national level with those from different areas on the same topic.
- The establishment of a regional working group on harmful algae in the Mediterranean region. Such regional group would allow to share data and knowledge, intercalibrate methods and practices and adopt consistent regulations. As a sound experience has been built in Italy as in other countries on *Ostreopsis* taxonomy, molecular phylogeny, toxin chemistry and ecology over the last decade, the network could also facilitate capacity building in the Mediterranean region by exchanges of scientists and organisation of courses.

E. Slovenia

Harmful algae in Slovenian waters fall into 3 categories: red tide species (e.g. blooms of *Noctiluca scintillans*), toxic species and nuisance phenomena such as gelatinous macroaggregates.

The first and the third types involve trophic interactions, organic matter cycling, eutrophication and their relationships with global/regional environmental changes.

PSP and ASP events are uncommon although several species of *Alexandrium* and *Pseudo-nitzschia* are regularly found in the seawater. DSP, on the other hand, represents major threat to human health and shellfish farms of *Mytilus galloprovincialis* are recurrently subjected to closures of various lengths. To date, the longest period of embargo on shellfish harvesting known was from May 2010 onwards and it was lifted only recently (April 2011). In comparison, DSP events in years preceding 2010 were followed by temporary closure of 3 months at the most. The long-lasting intoxication of shellfish in 2010 was accompanied by the highest abundances of *Dinophysis* spp. in the last decade.

Since the monitoring of phytoplankton and toxins is mandatory and operates in compliance with EU and national regulations, the priorities in the field of HAB are foreseen mainly in research (basic and applied – target), the observing system, training and capacity building. The issue has to be properly addressed in collaboration with the heterogeneous HAB community (researchers, the veterinary inspectorate, shellfish cultivators, and the public).

- Research. Scientific and public interest has shifted from the study of mucous macroaggregates, which prevailed in the 90's and early 2000s within the frame of various mostly international cooperative efforts such as the EU project (4th framework programme), regional EU Cross-Border Cooperation Programmes (INTERREG II and INTERREG IIIA), and several bilateral collaborations between Slovenia and Croatia and Slovenia and Italy towards the study of toxic species and toxins in recent years. This is probably due to recent events, such as the longest-lasting ban on shellfish trade accompanied by the inevitable economic loss, and the first recorded bloom of *Ostreopsis* cf. *ovata* in northern Adriatic coastal waters in autumn 2009. These events influenced public awareness in a similar way as gelatinous aggregates did, although in the latter case the public interest derived merely from the affect on tourism. In 2010 a multidisciplinary and target national project was approved aimed at re-establishing proper measures in case of viral, microbial or toxic contamination of shellfish. Several regional projects within the frame EU IPA and INTERREG were submitted of which one passed to the 2nd phase of evaluation. Its objectives are focused on the development of rapid and innovative detection techniques for palytoxin and its analogues.

- Activities in the field of the observing system. The set-up and wider exploitation of the observing system is one of the national priorities as well as in the IOC-GOOS program, and as such, the national IOC-HAB program could only benefit from it. Information on the status of the seawater in real-time are provided by oceanographic buoys not only in Slovenian coastal waters but also in the larger northern Adriatic area, which in the past suffered from eutrophication and its severe consequences (red tides, bottom oxygen depletion) and nuisance events (copious gelatinous aggregates) with economic loss in tourism and the fishery besides ecosystem perturbation. These observations are most useful in monitoring spatial coverage and the time evolution of high-biomass harmful blooms. This activity has been identified as the national priority by means of permanent financing (maintenance of the buoy, data processing and release through a web site) and creation of jobs.
- Training. In past years Slovenia has supported the participation of experts in various training courses in the fields of phytoplankton taxonomy and systematics, ecology and the modelling of HAB and chemotaxonomy. Participation was in large part granted by the National Commission of UNESCO through an annually approved program which supports IOC activities, including the IOC-HAB program. Just in the period 2009-2010 three such training courses were visited by phytoplankton experts: the GEOHAB Modelling Workshop in 2009 (Galway, Ireland), the Phytoplankton Pigment Analysis Workshop in 2010 (DHI group, Denmark) and the IOC Training Course and Identification Qualification in Harmful Marine Microalgae in 2010 (Copenhagen, Denmark).
- Capacity building. Although there is no national HAB policy *per se* for capacity building we can see this effort in the preservation of job positions of post-doc students in research institutions, which apply for funds in the field of HAB issues, either through research projects or monitoring programs. There are also educational aspects to capacity building, which involve undergraduate study programs where HABs are integrated into the courses on marine resources and coastal zone management.

F. Sweden

Background

Harmful Algal Blooms (HAB:s) are recurrent phenomena in the waters surrounding Sweden,. Most are likely to be of natural origin. The HAB-problems for the waters surrounding Sweden are very different for the Baltic Sea and the Skagerrak-Kattegat areas. In the brackish water of the Baltic Sea blooms of cyanobacteria, e.g. the toxic species *Nodularia spumigena*, is the major problem while in the waters with higher salinities in the Skagerrak and the Kattegat fish killing species and species that produce toxins that accumulate in filter feeders (e.g. mussels) is the major concern. However, both fish killing species and species causing shellfish poisoning occur in the Baltic Sea as well. Commercial farming and harvesting of wild mussels and oysters for human consumption is ongoing only along the Swedish coast of the Skagerrak at present.

National priorities

The main priority is to protect human health and ecosystem services. Another priority for Sweden is that international integrated observing systems of HABs are created in the Baltic and in the Kattegat-Skagerrak-North Sea areas. This should be part of the Global Ocean Observing System, GOOS, which is supported by the IOC. A collaboration regarding sharing of results from harmful algal bloom monitoring using analysis of water samples (e.g. microscopy) and analysis of algal toxins in shellfish should be established or further developed. Water sampling is made from research vessels, instrumented buoys and on commercial vessels with FerryBox systems. Sharing of data from automated systems in near real time is also important and can be accomplished through further development of existing systems. The existing systems are today focused on physical parameters but should be further developed to include biological parameters. The existing systems for data sharing in real time relevant for Sweden are the Baltic Operational Oceanographic System (BOOS) and the North West Shelf Operational Oceanographic System (NOOS). Further development of satellite remote sensing for observation of high biomass HAB:s is also of importance.

Harmful algal blooms in the seas surrounding Sweden in 2009 and 2010

No major harmful algal blooms occurred in the area in 2009-2010.

The Bothnian bay and the Bothnian Sea

Blooms of cyanobacteria were observed along the Swedish coast of the Bothnian Sea in the summers of 2009 and 2010. This caused concern among the public but no harmful effects were observed. Surface accumulations of cyanobacteria were observed in the off shore part of the Bothnian sea in August 2010. These off shore blooms did not reach the Swedish coast. It was confirmed that the toxic species *Nodularia spumigena* was part of the bloom.

The Baltic proper

The potentially harmful flagellate *Chrysochromulina* cf. *polylepis* was observed in bloom abundances (max ca 1 500 000 cells per litre) in the southern Baltic proper the first half of June 2009. No harmful effects were reported. Surface accumulations of cyanobacteria were observed around Bornholm and around the southern part of the island of Öland in the latter half of June 2009. In early July 2009 surface accumulations of cyanobacteria were observed along the western coast of the Baltic proper, e.g. in Skåne, Blekinge, northern Öland and in the archipelago of Stockholm. The toxin producing species *Nodularia spumigena* was found in the water together with non toxic *Aphanizomenon* sp. and *Dolichosperum* sp. (synonym *Anabaena* sp.) In October 2009 local blooms of cyanobacteria were observed in several locations along the Swedish coast of the Baltic proper. In July 2010 surface accumulations of cyanobacteria were observed in several parts of the Baltic proper. Due to wind conditions the blooms did not reach the coast of Sweden in large amounts. A few observations were made on the beaches of the island of Gotland.

The Skagerrak and the Kattegat

Closures of harvesting of shellfish (mainly blue mussels, *Mytilus edulis*) due to accumulation of algal toxins did occur on the Skagerrak coast but not for long periods. The main reason was levels of yessotoxins above the regulatory level. This toxin is produced e.g. by the dinoflagellate *Protoceratium reticulatum*. In May 2010 mouse bioassays indicated Paralytic Shellfish Toxins (PST) in blue mussels on two occasions.

In spring 2009 and 2010 the harmful flagellate *Pseudochattonella farcimen* (Dictyochophyceae) was observed in the Skagerrak and the Kattegat. The potentially harmful flagellate *Chrysochromulina* sp. was observed in early June 2009 with abundances of max c. 800 000 cells per litre. The diatom *Pseudo-nitzschia* cf. *delicatissima*, potentially a producer of Amnesic Shellfish Toxin, was observed on several occasions in 2009 and 2010. The highest abundance was 1 000 000 cells per litre in December 2009 in the bay Skälderviken in the Kattegat and in Danafjord near Gothenburg in January 2010. The diatom *Chaetoceros concavicornis*, known to affect the gills of fish negatively, was observed in both 2009 and 2010. Other potentially harmful algae observed include *Akashiwo sanguinea*, *Karenia mikimotoi*, *Prorocentrum minimum* and *Karlodinium veneficium*.

Abundances of algae producing toxins accumulating in shellfish were below the warning level most of the time in the data set from the monitoring program for bivalve harvesting (National Food Administration). The species of interest are mainly *Alexandrium* spp. (Paralytic Shellfish Toxin, PST-producers), *Dinophysis* spp. (Diarrhetic Shellfish Toxin, DST producers), *Protoceratium reticulatum* (Yessotoxin, YTX producer), *Azadinium spinosum* (Azaspiracidic Shellfish Poisoning, AZT-producer) and *Pseudo-nitzschia* spp. (Amnesic Shellfish Toxins, AST producers).

An improved method (LC-MS) for analysing algal toxins in shellfish was introduced early in 2009. Azaspiracidic Shellfish Toxin was possible to detect and detected for the first time in Sweden. It was found in low quantities in February and September-October 2009. In 2009 and 2010 PST, DST, AZT and AST were not recorded at levels above the regulatory limits in blue mussels (*Mytilus edulis*), oysters (*Ostrea edule*), Pacific oysters (*Crassostera gigas*) or in cockles (*Cerastoderma edule*). One exception was the indication for PST in mouse bioassays which showed PST in blue mussels on two occasions in May 2010. Yessotoxins above the regulatory

limit of 1 mg kg⁻¹ mussel meat were observed in May and June 2009 and in May-Sep 2010 in blue mussels.

G. Thailand

Bloom categories in Thai waters

The first report of plankton bloom in Thailand was in 1952, in the upper Gulf of Thailand, while the actual research started in 1974. The blooms have occurred regularly but toxic species were rarely found. At present, algal blooms in Thai waters are reported directly to Department of Marine and Coastal Resources (DMCR) and information was distributed to relevant institutions. Blooms information is collected at Phuket Marine Biological Center (PMBC), and primary information on bloom event is posted as news [at www.coastaldatabase.com](http://www.coastaldatabase.com).

During the 2009-2010, phytoplankton blooms regularly happened in the Gulf of Thailand, especially in the river delta in the inner gulf area where blooms were found almost all year round. The common bloom species in the Gulf of Thailand were *Noctiluca scintillans*, and *Ceratium furca*. In the Andaman Sea coast of Thailand, a few and short-time blooms occurred in the coastal area off the popular tourist areas. The bloom species were mostly small diatom, *Chaetoceros socialis*, or blue-green algae, *Oscillatoria erythraeum*. The blooms often co-occurred with the seaweeds blooms (mostly green and red filamentous algae).

Institutions involved

Department of Fisheries (DOF) used to be in charge of all researches dealing with phytoplankton. Now the DOF mainly concentrates on the fishery resources and products, especially in the case of shellfish safety and biotoxins according to the instruction of FAO. The Pollution Control Department (PCD) involved more in terms of researches, monitoring, database, and capacity building, where continuous activities were carried out and a number of publications were released to public. Besides, researchers and lecturers from various universities always are the important resources in all research and co-operative activities.

Since late 2002, Department of Marine and Coastal Resources (DMCR), under Ministry of National Resources and Environment (MNRE), has direct response on algal blooms, having the Phuket Marine Biological Center (PMBC) as research institute taking care of the subject. The PMBC is in charge of the Andaman Sea coast, while its 4 other research centers actively respond in the Gulf of Thailand. Unfortunately, the staffs in charge of phytoplankton study are in limited number and relatively new to this field of study, so the need during these years are to educate them in various aspects of phytoplankton studies. Trainings have been organized at least twice a year by PMBC for the staff and as well open for the researchers from other institutions/universities, which were very well assisted by the available experts in the countries. Staffs are also encouraged to participate in the relevant trainings, meetings, and conferences, both inside and outside the countries. Net working in phytoplankton research is very important as all research institutions and universities face the same problem of lacking of phytoplankton researchers.

DMCR/PMBC activities on algal blooms/studies

At present, there are a number of projects run by PMBC and the 4 centers.

1. Monitoring program: A 5-year coastal monitoring program was set in 2006 as routine sampling of water quality and watch on phytoplankton bloom along the coastal area of all 14 coastal provinces on the Andaman Sea coast and the Gulf of Thailand. The monitors were performed either bi-annually, bi-monthly, or more frequent, up to the problem of each area. Local communities are invited to participate in the regular monitoring program, at least to report the bloom in their areas. Database on the monitoring data, (www.coastaldatabase.com) is now linked to the PMBC (www.pmbc.go.th) and DMCR (www.dmcr.go.th) websites. Unfortunately, most of the information is still in local language. Another 5-year project is extended start in fiscal year 2011 (from October 2010).
2. Community studies: Apart from the monitoring program, studies on phytoplankton communities in the coastal ecosystems are still continuously conducted, as we not yet have a complete species list for our waters.
3. Ballast water from ships moored at the Bangkok harbor is monitored for possible invasive species.
4. Capacity building:

- Arrange trainings on sampling techniques for general phytoplankton and specifically for watched phytoplankton species, taxonomy of common bloom and toxic species in Thai waters. The latest training was on “taxonomy of diatoms in Thai waters”, during 20-24 March 2011, at Prince of Songkhla University (PSU) organized by DMCR (PMBC) and PSU.
 - Encourage staff to attend workshops, conferences, trainings, arranged by other institutions, and if possible to the regional and international level.
5. Institutional cooperation: since 2009, under an MOU between Thai (DMCR) and China (First Institute of Oceanography: FIO), a number of research projects have been developed, such as a project on developing a mathematical model of the circulation in the Gulf of Thailand, which is also concerning the plankton bloom events.

Other Institutional activities

Apart from DMCR/PMBC, there are various research topics conducted under a number of universities, both by national funding and also some from individual cooperative research project. The universities those are active in marine plankton studies are Chulalongkorn University in Bangkok, Kasetsart University in Bangkok, Burapha University in Chon Buri, and Prince of Songkhla University in Songkhla. Department of Fisheries (Fish Inspection and Quality Control Division) is also active particularly in the screening process of marine product quality especially in mussel and fish meat.

Since 2000, the “Algal and Plankton Society of Thailand” was established with its objectives to develop research methods/directions to be applicable for and respond the need of the country. The society arranges bi-annual conferences and trainings, where researchers, students, and public have opportunity to share their information and experiences. This society is much stronger these days but, unfortunately, the marine plankton group is still relatively small compared to the freshwater group.

Capacity building needs

There is still a strong need of training in species identification, basically in terms of morphological study, and also in the molecular level. Another need is to be educated in the forecasting/early warning system for the bloom, especially in the Gulf of Thailand. Lack of funding is a major obstacle for Thai researchers to participate regional/international trainings/workshops. Another option is to organize a local/regional training workshop using local/regional budget, with invited lecturers/experts sponsored by another source of funding. Cooperative project is another possibility to have our staff learning by doing, along with experts from other countries.

H. United States of America

Harmful algal blooms (HABs) are now recognized as persistent threats to coastal resources, local economies, and human health in the U.S. Increased attention to the occurrence and problems associated with HABs is being demanded at National and State levels. Currently, U.S. waters are subject to most of the major HAB poisoning syndromes and impacts (Figure 1). These include paralytic shellfish poisoning (PSP), amnesic shellfish poisoning (ASP), neurotoxic shellfish poisoning (NSP), ciguatera fish poisoning (CFP), as well as a host of HABs that kill fish or cause ecosystem or recreational impacts. Diarrhetic shellfish poisoning (DSP) has historically not been a problem in the U.S., but a large *Dinophysis* sp. bloom in Texas in 2008 led to harvesting closures and product recalls. A recent discovery is that more than half of all marine mammal mortalities in U.S. waters are now attributed to marine biotoxins. Improved techniques and increased sampling of animal tissues may account for this apparent increase, but the lack of earlier data makes it impossible to determine if this also represents an expansion of the problem.

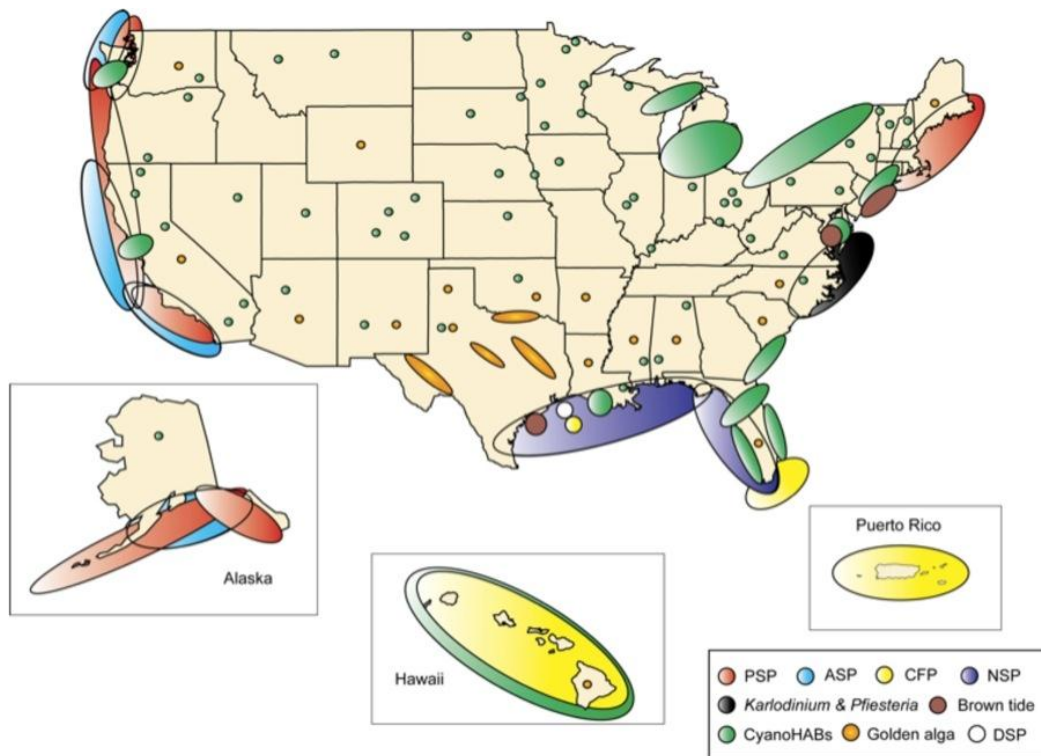


Figure 1. Distribution of major HAB syndromes and events in the U.S. Source: NOAA U. S. National Office for Marine Biotoxins and HABs, Woods Hole, MA.

National Programs and Activities

The national commitment to management and research of HABs through new understanding of their causes, and development of new tools to predict, mitigate, and prevent HABs, was renewed when the Harmful Algal Bloom and Hypoxia Research and Control Act, originally passed into law in 1998, was reauthorized in Dec. 2004 (HABHRCA 2004, <http://www.cop.noaa.gov/stressors/extremeevents/hab/habhrca/>). Besides authorizing the research and response programs listed below, HABHRCA 2004 called for four HAB reports.

1. *Prediction and Response Report* (Jewett et al., 2007)
2. *HAB Management and Response Report* (Jewett et al., 2008)
3. *Scientific Assessment of Freshwater Algal Blooms* (Lopez et al., 2008)
4. *Scientific Assessment of Marine Algal Blooms* (Lopez et al., 2008)

These reports have been completed and are available at: <http://www.cop.noaa.gov/stressors/extremeevents/hab/habhrca/ReportPlans.html>. Together they provide a blueprint for future U.S. HAB management, research and response programs. HABHRCA 2004 is due to be reauthorized by the U.S. Congress.

Basic research on bloom development, persistence, and food web interactions as well as basic ecology, physiology, behavior, and toxicity of individual HAB species is addressed through several agencies, with the largest effort being the ECOHAB Program (Ecology and Oceanography of Harmful Algal Blooms, <http://www.cop.noaa.gov/stressors/extremeevents/hab/current/fact-ecohab.aspx>), one of the three national HAB Programs. This Program, established in 1997, led by NOAA and authorized by HABHRCA, has provided competitive research to over 124 projects (11 of them regional studies) with almost US\$96.6 million (1996 through 2010 commitments) contributed by NOAA, EPA, NSF, ONR, and NASA. There are 4 regional studies in progress now (*Pseudo-nitzschia* in the Pacific Northwest, *Alexandrium fundyense* in the Gulf of Maine, *Karenia brevis* on the west Florida shelf and *K. brevis* on the Texas shelf). Recent projects focused on the following themes:

- improve understanding of HABs leading to predictive models that can be used for forecasting and prevention
- track trophic transfer of toxins and determine impact of toxins on higher trophic levels

NOAA also manages two additional major national HAB Programs authorized by HABHRCA. The Monitoring and Event Response for Harmful Algal Blooms program (MERHAB, <http://www.cop.noaa.gov/stressors/extremeevents/hab/current/fact-merhab.aspx>) has provided US\$31.8 million (1998 through 2010 commitments) for 29 projects, including 12 regional projects and 17 targeted projects. Peer reviewed projects fund science-management partnerships to demonstrate how functional methods for detecting, tracking, and predicting HABs can improve existing monitoring capabilities and incorporate advances into operational programs. Targeted projects fund the demonstration of management applications for proven methods of HAB toxin and cell detection. Past and present regional projects are enhancing monitoring and response capabilities for *Karenia brevis* in the eastern Gulf of Mexico, cyanobacteria in the lower Great Lakes, *Pseudo-nitzschia* and *Alexandrium* along the US Pacific Coast, and *Karlodinium micrum* and other HAB species in the Chesapeake Bay.

The Prevention Control and Mitigation of Harmful Algal Blooms Program (PCM HAB, http://www.cop.noaa.gov/stressors/extremeevents/hab/current/PCM_08.aspx) was initiated in 2010 and funds research in two main areas: PCM research, development, demonstration, and technology transfer (PCM RDDTT) and socioeconomic impacts. PCM RDDTT develops, demonstrates, and makes widely available new socially and environmentally acceptable strategies and methods for preventing, controlling, and mitigating HABs and their impacts. accelerating the transition of promising PCM technologies and strategies to end-users. PCM HAB will also assess the social and economic costs of HAB events and the costs and benefits of PCM strategies, which will aid managers in devising cost-effective management strategies. In its first year, 3 projects were funded (\$2M committed in 2010)

NOAA also oversees a modest Event Response Program (http://www.cop.noaa.gov/stressors/extremeevents/hab/current/fact-ev_resp.aspx) through which states can request Federal assistance for immediate response to HAB events that exceed normal response capabilities. Several NCCOS laboratories also offer analytical chemistry and other support in response to outbreaks around the country.

Since 2003, the NCCOS Event Response Program has responded to numerous HAB events impacting states along the East, Gulf and West Coasts. These responses have addressed a wide range of state and federal management and scientific needs - from assessing human health risks, identifying causes of marine mammal mortalities, offering training opportunities for managers, to establishing baseline conditions for new or re-emerging HABs.

Two major Federal initiatives for “Oceans and Human Health” (OHH) began in 2004, one by NSF and NIEHS (National Institute for Environmental Health Sciences) (<http://www.whoi.edu/science/cohh/>), and the other by NOAA (<http://www.eol.ucar.edu/projects/ohhi/>). The NSF and NIEHS program established four national academic “centers” with external funding and the NOAA program established three “centers of excellence” within NOAA. The NOAA program also has an external research grants program. All of these programs encompass a wide range of research topics concerning the impacts of the oceans on human and animal health. A large part of the portfolio of research in each of these initiatives is HAB-related. Another aspect of human health, seafood safety, including monitoring for HAB toxins, is also an identified Federal responsibility, generally under the purview of the FDA. Research on HAB-seafood safety linkages is focused in two Federal agencies, FDA and the CDC (Centers for Disease Control), developing diagnostics for HAB exposure and therapies as well as determining toxin pharmacologies, with intra- and extramural programs.

Some oceanographic HAB research is conducted through non-specific internal and/or external funding programs of NOAA, FDA, NIEHS, and NSF. Findings on basic HAB ecology/oceanography and toxin/cell identification and assay development, are rapidly incorporated into the expanding Federal-State partnered monitoring programs described below. The NSF focus is on the many aspects of species-specific dynamics of plankton, macroalgal populations, and species succession that contribute to bloom formation, maintenance and demise. NSF's interest is in increasing our understanding of the direct and indirect causes of HABs in our coastal regions and their ecological consequences through research on the physiological and ecological basis for bloom formation, the physical and chemical attributes of coastal oceans that

facilitate them, the population attributes of bloom species, and the long-term consequences of ecosystem changes.

Intertwined with federal programs addressing HABs are extensive outreach and synthesis activities involving managers, scientists, NGOs, Congress and other stakeholders. An early example of this was the original *National HAB Plan* (Anderson et al., 1993) that was recently revised - *Harmful Algal Research and Response National Environmental Science Strategy 2005-2015* (HARRNESS, 2005). HARRNESS called for increased efforts to assess socioeconomic, seafood safety, public health and recreational/drinking water impacts of HABs. For the socioeconomic recommendations, the NOAA-sponsored *Harmful Algal Research and Response: A Human Dimensions Strategy* workshop and report (Bauer, 2006) provides a detailed implementation plan. Implementation of other major recommendations of HARRNESS will be guided by the HABHRCA reports described above and major regional workshops that include identification of priority research in those areas; examples of these are contained in the following paragraph.

A West Coast Regional HAB Summit was held February 10-12, 2009, which endorsed the vision of the West Coast Governors' Agreement (WCGA) of a West Coast regional harmful algal bloom (HAB) monitoring, alert and response network and forecasting system: http://www.cop.noaa.gov/stressors/extremeevents/hab/current/HAB_Summit09/west_coast_summit_post.html. Seizing on the opportunities of new and emerging technologies, the monitoring network and forecasting system will provide advanced early warning of HABs, minimize fishery closures, protect the economy of coastal communities, mitigate the impacts to marine life and continue to protect public health. The next step will be to incorporate outcomes from the workshop into a plan for implementing the monitoring network and forecasting system, and present that plan to the WCGA.

In addition to the efforts of the aforementioned agencies, a NOAA-supported *National Office of Biotoxins and Harmful Algae* has been established at the Woods Hole Oceanographic Institution to serve as a national resource for dissemination of information and coordination of outreach and synthesis activities. This National Office also serves as a focal point for many of the interactions between U.S. and international researchers, works closely with the IOC Intergovernmental Panel on HABs, and is the North American "node" for distribution of conference proceedings and other publications of the IOC.

Every two years, a U.S. National HAB meeting is convened to provide a unique opportunity for U.S. scientists to communicate and exchange research results. The 5th Symposium on Harmful Algae in the U.S. was held Nov. 15-19, 2009 in Ocean Shores, WA: <http://www.whoi.edu/habsymposia/>. The 6th Symposium on Harmful Algae in the US will be held Nov. 13-17, 2011 in Austin, TX (<http://www.whoi.edu/habsymposia/>).

The U.S. Integrated Ocean Observing System (IOOS) is the coastal component of the Global Earth Observing System for the U.S., and is comprised of 17 government agencies and 11 regional associations. NOAA is the lead federal agency for IOOS. In 2010 the IOOS Regional Associations identified the need to minimize harm from HABs as a critical issue in their plan to deliver products and services related to Ecosystems, Fisheries and Water Quality (2010 NFRA report; http://www.usnfra.org/documents/03.10_RCBooklet_lo-res.pdf). NOAA IOOS and the Regional Associations are potential partners in transitioning HAB observing and forecasting systems into operations. The Northeastern Regional Association of Coastal Ocean Observing Systems (NERACOOS) which has provided oceanographic data for use in conjunction with other data in order to monitor and predict *Alexandrium* bloom movement in the Gulf of Maine, offers a preliminary example of their application for enhancing HAB prediction. The Environmental Sensor Processor (ESP) technology is being implemented with support from NSF, EPA, and NOAA IOOS to assist the transition into use within NERACOOS. In California, two regional associations (CeNCOOS and SCCOOS) have existing infrastructure relevant to HABs. This includes sensor platforms (e.g., moorings, gliders), data visualization and delivery systems, modeling capabilities, on-line user products, and education and outreach activities. Recently completed MERHAB regional research partnerships involving California Department of Public Health, water districts, aquaculture industry, and marine animal responders have transitioned

enhanced monitoring capability into a new state-wide HAB monitoring system called CalHABMAP.

Much of the “front lines” work on protecting public health from HAB toxins occurs through state monitoring of shellfish and shellfish waters, including measurements of accumulated toxins in fisheries resources. The needs of these shellfish managers are regularly incorporated into federal research priorities and there has been significant progress in developing new capabilities for monitoring HABs and responding to HAB events that are being transitioned to operational use by a variety of end-users, including federal and state agencies, and the shellfish industry. The coordinated efforts described above result in a comprehensive National research capability for HABs, toxins, and human health that is linked to management agencies and industries that are on the front lines of preventing, controlling, and mitigating the impacts of HABs.

International Activities

The U.S. remains very active in international HAB activities. Fundamental to this is the general support of the U.S. through the IOC and SCOR partnership (NOAA and NSF) to support activities such as GEOHAB planning, development of international HAB data bases, support for international meetings and capacity building.

The U.S. participates in numerous working groups and sections, such as those by ICES/IOC (Harmful Algal Bloom Dynamics Working Group) and PICES (Harmful Algal Bloom Section), and sends high-level delegations to the IPHAB panels. U.S. support is expected to continue for international GEOHAB efforts through funding by NSF and NOAA. Both agencies are among the sponsors of the June 15-19, 2009 GEOHAB Modeling Workshop in Ireland. In addition, NOAA has provided support for the further development of the Harmful Algal Event Data Base (HAEDAT – now known as HAIS) maintained by ICES and IOC.

Many U.S. scientists and centers also maintain bi-lateral research cooperation with scientists from many other countries. NOAA's research centers in Seattle, WA, (Northwest Fisheries Science Center), in Charleston, SC (Coastal Environmental Health and Biomolecular Research), and in Beaufort, NC (Center for Coastal Fisheries and Habitat Research) have continued to assist foreign countries with toxin assays and HAB identification. NOAA Seattle helps lead a PICES initiative to build HAB research capacity in developing nations through training classes in toxin screening tools, phytoplankton identification, and database management. The initial training class was held in Manila in January 2009, and focused on assisting the Bureau of Fisheries and Aquatic Resources, the agency that manages HAB events in the Philippines. NOAA Charleston is leading an effort to validate a method of HAB toxin analysis called the receptor binding assay (RBA) with the Association of Analytical Communities (AOAC). The RBA is a promising candidate to replace the mouse bioassay. An AOAC international collaborative trial including 14 labs from around the world is set to begin this year. NOAA Charleston also continues to support work of the International Atomic Energy Agency (IAEA) to transfer capabilities to run the RBA assay to developing nations in Southeast Asia, Africa and the Caribbean to help mitigate the human illness known as paralytic shellfish poisoning (PSP). Caribbean region efforts initiated this year will also develop strategies for implementing the RBA for ciguatera fish poisoning (CFP) toxins.

NOAA, IOC, and Algas Nocivas del Caribe (ANCA) y IOC-Vigo (España) have implemented a four-year regional study with the International Atomic Energy Agency (IAEA) to “Design and Implement Systems for Early Warning and Evaluation of the Toxicity of Harmful Algal Blooms in the Caribbean Region” for the coastal zones of Chile, Colombia, Costa Rica, Cuba, the Dominican Republic, El Salvador, Haiti, Honduras, México, Nicaragua, Uruguay and Venezuela. The project transfers technologies developed by NOAA scientists for the detection of saxitoxins and ciguatoxins through the conduct of hands-on training workshops, the set-up and coordination of collaborative inter-laboratory validation studies, and providing the assistance required to integrate protocols into national HAB/toxin monitoring and regulatory programs.

NOAA and the University of Karachi scientists have initiated a monitoring program along the Pakistani coast sponsored by the Higher Education Commission, Islamabad, Pakistan. To date

over 25 known toxin producing species have been observed in waters of the Northern Arabian Sea, most of which are first records. This research will provide a scientifically sound foundation for the detection and monitoring of potentially toxic species by Pakistani coastal managers and to establish a HAB monitoring program to mitigate the effects of potential toxic events.

Advanced Scanning Electron Microscopy techniques to identify potentially HAB species were transferred to researchers at the Institut National de Recherche Halieutique, Morocco during a training course offered by NOAA. NOAA researchers also assisted in the review of the current monitoring program with particular emphasis on sampling strategies and toxin analysis. The program objectives include the establishment of a monitoring program for HABs and their toxins in Moroccan coastal waters which meets the requirements for export of seafood products to the European Union.

Researchers from NOAA and collaborators at the University of Maine, Queen's University Belfast, and Dublin City University have initiated a joint US-Ireland R&C Partnership project focused on HAB toxin detection and supported by NSF, Invest Northern Ireland, and Science Foundation Ireland. The aim is to deliver working prototypes for the sensor-based measurement of selected marine and freshwater HAB toxins in the food supply chain. A critical component of this effort is development of a microfluidic 'front-end' essential for preparation and introduction of samples into the toxin detectors. End-users will benefit directly from simple, rapid tests for assessing potential risks associated with HAB toxin contamination of coastal and freshwater fishery resources.

A phytoplankton-sampling program established by NOAA and the Environmental Research and Wildlife Development Agency of the United Arab Emirates (UAE) has identified *Cochlodinium polykrikoides* as the causative organism for massive red tide along the coast of the southern Arabian Gulf. The species, known for producing copious amounts of mucus, was responsible for the Emirate's capital, Abu Dhabi, ceasing operations of desalination plants that produce most of the Emirate's fresh water. This first report of this dinoflagellate in the region may have uncovered a recurring problem in the Arabian Gulf, but also may have identified a previously unrecognized impact of HABs.

Researchers from NOAA assisted the Kuwaiti Institute of Scientific Research (KISR) to develop research projects targeted on understanding HAB ecology and dynamics, and their possible influence on drinking water quality generated from desalination plants in Kuwait. A delegation of researchers visited the NOAA-Charleston Laboratory in April to determine equipment and personnel needs for this new institute.

NOAA has also regularly supported international HAB meetings including meeting and student travel support for the 13th and 14th International Conferences on Harmful Algae in Hong Kong in 2008 and Greece in 2010, and GEOHAB meetings on *Harmful Algal Blooms in Eutrophic Systems* (GEOHAB, 2006), and *Modeling* (GEOHAB, 2010).

With respect to future priorities to be pursued in coordination with the IOC HAB Programme, the U.S. comments and recommendations about international activities that could be coordinated by IPHAB include:

1) **Program coordination.** The IOC HAB Program, led by the IOC Science and Communication Center in Copenhagen, has had an extraordinary impact on the development of HAB monitoring and management programs worldwide. Funding for these offices is threatened, however, and this bodes ill for the future of the program. We urge all IOC Member States with HAB problems to provide support for these program coordination activities, either financially, or through the support of their delegations at the IOC Assembly, when HAB budget issues are discussed.

2) **Capacity building and training.** We note that the IOC Science and Communication Centers in Copenhagen and Vigo have shown clear benefits to the international community through their outreach and training efforts, and continued support for these centers should be provided. U.S. scientists are willing to assist in these activities. It is recommended that a list of course

prospectuses be developed to help secure the necessary funding or in-kind support from various sources for these training efforts in the future.

3) **The newsletter, *Harmful Algae News***, is an excellent communication tool, and should be continued.

4) **Regional IOC HAB groups**, such as WESTPAC, FANSA, HANA and ANCA-IOCARIBE are important mechanisms to prioritize, plan, and implement HAB activities throughout the world. Efforts should be made to continue and expand upon these activities.

5) **Regional and national regulations** on algal toxins in seafood products are unfortunately not uniform internationally. The U.S. supports activities that will lead to harmonization of regulations, as this is critical to efficient importation and exportation of seafood potentially contaminated with algal toxins. Other health-related activities that could benefit from international coordination, including potential interactions with UN intergovernmental committees responsible for human health, such as FAO, are also encouraged.

6) **HAB databases** of international scope are a valuable service that is provided by the IPHAB and by ICES. NOAA has recently provided support to obtain the necessary expertise to add interactive mapping capabilities to the Harmful Algal Event Data Base (HAEDAT, now known as HAIS) and continues to support the inclusion of U.S. data through the National Office of Biotoxins and Harmful Algae.

7) The **Global Ocean Observing System (GOOS)** is of great relevance to HAB monitoring and research activities worldwide. Likewise, there is a growing recognition in the global observing community that capabilities to detect HABs, their toxins or environmental conditions that may indicate that a HAB is likely, increase the value of observing systems. The incorporation of HAB-related detection capabilities, tailored to regional needs would be of great value in documenting trends and in facilitating monitoring and management efforts, and may lead to prediction and forecasting of HAB events. For example, the Regional Coastal Ocean Observing Systems (RCOOSs) of IOOS provide local-scale data and information to address issues that are important to the stakeholders in a particular region, including HABs. In the Gulf of Mexico, the Gulf of Mexico Coastal Ocean Observing System (GCOOS) has held a series of stakeholder and technical workshops to develop a Harmful Algal Bloom Integrated Observing System. An initial meeting between the U.S. and Mexico on HAB monitoring in the Gulf of Mexico has already taken place. Continued involvement of HAB scientists and management experts in the GOOS program is highly recommended, and pilot projects on HABs should be considered by GOOS during program implementation.

We believe that highlighting specific elements of international programs and their benefits to public health and economies of affected nations holds the best promise of near and long-term support.

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ANNEX IV

LIST OF WORKING DOCUMENTS

1. WORKING DOCUMENTS

Document code	Document Title	Agenda Item
IOC/IPHAB-X/1 prov.	Provisional Agenda with annotations	All
IOC/IPHAB-X/1 Add. Prov.	Provisional Timetable	All
IOC/IPHAB-X/3 prov.	Executive Summary, Resolutions and Recommendations Summary Report	All
IOC/IPHAB-X/4 prov.	Provisional List of Documents (this document)	All
IOC/IPHAB-X/5 prov.	Provisional List of Participants	All

2. INFORMATION DOCUMENTS

Document Number	Title	Agenda Item
IOC/IPHAB-IV/3, Annex IV	Terms of Reference of IPHAB	All
IOC/IPHAB-IX/3	Report of the IOC Intergovernmental Panel on Harmful Algal Blooms, Ninth Session, Paris, 22-24 April 2009 Executive summary in French, Spanish, Russian.	3 and 4
IOC/IPHAB-X/Inf.1	Extract re IPHAB-IX from: Twenty-sixth Session of the IOC Assembly, Paris, 2009	1
IOC/IPHAB-X/Inf.2	Information on HABP developments 2009-2010	4
IOC/IPHAB-X/Inf.3	Overview of resources and needs: Draft HABP Work Plan, 2012-2013	8
IOC/IPHAB-X/Inf.4	IPHAB Strategy (also included as Annex XV in IOC/IPHAB-IX/3)	4.3
IOC/IPHAB-X/Inf.5	Report on IOC/WESTPAC-HAB	5, Panel 1
IOC/IPHAB-X/Inf.6	Integrated Coastal Research: NEWS2USE	5, Panel 6
IOC/IPHAB-X/Inf.7	Report of the IX IOC Regional Working Group on Harmful Algal Blooms in South America (FANSA)	5, Panel 1
IOC/IPHAB-X/Inf.8	Report of the IOC Regional Group on Harmful Algae of North Africa, HANA	5, Panel 1
IOC/IPHAB-X/Inf.9	Overview of IOC training courses on HAB	5, Panel 2
IOC/IPHAB-X/Inf.10	GEOHAB SSC Terms of Reference and Members 2011	5, Panel 3
IOC/IPHAB-X/Inf.11	Global Ecology and Oceanography of Harmful Algal Blooms (GEOHAB) Program: Report 2009 -2010	5, Panel 3
IOC/IPHAB-X/Inf.12	GEOHAB BHAB OSM	
IOC/IPHAB-X/Inf.13	ICES-IOC Working Group on Harmful Algal Bloom Dynamics: Report of the meeting 31 March-2 April 2009, Spain Report of the meeting 6-10 April 2010, Bermuda	4 and 5, Panel 3

	Executive summary of the meeting 5-8 March 2011, Gothenburg, Sweden (if available)	
IOC/IPHAB-X/Inf.14	Report on IPHAB Task Team on HAB Observation Systems Implementation of HAB Monitoring Within the Global Ocean Observing System (GOOS) Strategic Implementation Plan for the Coastal Module of the Global Ocean Observing System	5, Panel 5
IOC/IPHAB-X/Inf.15(1)	Reports of the ICES/IOC/IMO Working Group on Ballast and Other Ship Vectors, 2010 (2011)	4
IOC/IPHAB-X/Inf.15(2)	Report from the ICES Workshop on harmful phytoplankton that could potentially be transported or introduced by ballast water	4
IOC/IPHAB-X/Inf.16	Global Partnership on Nutrient Management, Information Brief	5, Panel 6
IOC/IPHAB-X/Inf.17	Joint IPHAB/IODE Harmful Algal Information System (HAIS)	4
IOC/IPHAB-X/Inf.18	HAB Activities of the International Atomic Energy Agency (IAEA)	4 and 5, Panel 2
IOC/IPHAB-VIII/Inf.19	FAO Activities in the Area of Shellfish Safety and Biotoxins	4 and 5
IOC/IPHAB-X/Inf.20	General Information	
IOC/IPHAB-X/Inf.21	List of Hotels for IPHAB-X	
IOC/IPHAB-X/Inf.22	Report of the IOC Regional Working Group on Harmful Algal Blooms in the Caribbean (ANCA)	5, Panel 1
Other documents		
GEOHAB OSM 6	GEOHAB OSM 6, Core Research Project:: HABS in Benthic Systems	5, Panel 3
GEOHAB Report No. 6	Global Ecology and Oceanography of Harmful Algal Blooms in Asia: A Regional Cooperative Programme	5, Panel 3
GEOHAB Report No. 7	GEOHAB Core Research Project: :HABs in Fjords and Coastal Embayments	5, Panel 3
GEOHAB Report No. 8	GEOHAB Modelling, Linking Observations to Predictions	5, Panel 3
IOC/INF-1259	The Ocean Sciences Section Functions, Activities and Work Plan Within the IOC Medium Term Strategy 2008-2013	4.3
IOC-XXIV/2 Annex 6	Perspective of the Ocean Sciences Section Programme in Light of The Draft IOC Medium Term Strategy	4.3
IOC Annual Report No. 9	IOC Annual Report 2009 (on request)	

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ANNEX VI

**TERMS OF REFERENCE OF
THE IOC INTERGOVERNMENTAL PANEL ON HARMFUL ALGAL BLOOMS**

Resolution XVI-4

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 VII

IOC HARMFUL ALGAL BLOOM PROGRAMME PLAN
(Revised extract from **IOC Workshop Report No. 80, 1991**)

IPHAB-IV REVISION

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 2nd edition of the IOC manual containing standardized methodology for the study of harmful algae.
- (iii) Prepare identification sheets and reference slides for harmful species, preserved material and video documentation, updated as necessary.
- (iv) Maintain and update as necessary the IOC lists of experts grouped according to areas of expertise.
- (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 that 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, v_{max} , allelopathic substances, grazer repellent, 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.
- (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 reproducibility 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.

ANNEX VIII

INFORMATION ON DEVELOPMENTS IN THE INTERSESSIONAL PERIOD

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PROGRAMME DEVELOPMENT

1. STAFFING

1.1 Staffing of the Programme Office

The IOC Secretariat has one staff assigned to the HAB Programme. H. Enevoldsen is located at the decentralized Programme Office at the IOC Science and Communication Centre on Harmful Algae at University of Copenhagen (UCPH), Denmark. The post for the HAB Programme is since June 2010 a permanent post. In the period 2008-2009 funded through extra-budgetary contributions and savings. Ms. Virginie Bonnet was the administrative Assistant for the HAB Programme until early 2011 where after support is provided by Ms. Christiane LeConan located at IOC Headquarters, Paris.

1.2 HAB Science and Communication Centres

The establishment of HAB Programme activity centres was 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). At the Seventeenth Session of the IOC Assembly (Paris, 25 February-11 March, 1993), Denmark and Spain offered to host and establish Science and Communication Centres on Harmful Algae. The main purpose of the Centres is to provide the framework for systematic assistance in training and capacity building to developing countries with respect to harmful algae.

The IOC Science and Communication Centre on Harmful Algae in Copenhagen, Denmark, opened in May 1995. The Centre is a decentralized programme Office for the IOC HAB Programme and as support office for GEOHAB (jointly with the SCOR secretariat) and is staffed by Mr. Henrik Enevoldsen, Head of Centre, and Associate Professor Dr. Jacob Larsen. The Centre is hosted by, and located at, the Department of Biology with Professor Ø. Moestrup as the focal point at the UCPH. Activities are centred on capacity building in identification of harmful algae and associated services. As a follow-up to IPHAB-VI.3 the partnership in the Copenhagen Centre was expanded through formal memoranda of understanding with Alfred Wegener Institute for Polar and Marine Research, the Research Institute Senckenberg, and the Friedrich Schiller University Jena, Germany. The partnership is intended to provide the platform for implementation of training courses on qualitative and quantitative determination of algal toxins.

The Centre operates on funds sought through UCPH and IOC and thus combines funds from IOC budget with project funds held at UCPH. There have in recent years been a period of uncertainty and lack of funding. The situation has now stabilised without the previous longstanding direct support from DANIDA. The most significant implication of this is less opportunity for activities targeted at developing states.

The IOC-IEO Science and Communication Centre on Harmful Algae in Vigo, Spain, was established in October 1996, after a document of understanding was signed between IOC and IEO (Instituto Español de Oceanografía). The Centre is located at the Oceanographic Centre in Vigo. The Centre staff is the head, Mrs. Monica Lion, and one assistant, Mrs. Cristina Sexto. The Centre also draws on the scientific staff of the IEO in Vigo under the coordination of Dr. Beatriz Reguera. The Centre provides advice, and scientific and technical assistance on problems related with monitoring and management of harmful algae events, and the characterization of the microalgae and their toxins (taxonomy, toxin content, ecology). Priority is given to the cooperation with Iberoamerican and the Maghrebian research institutions. The Centre in particular assists with the implementation of training courses, the development of HAEDAT, the back-up for the regional networks HANA, ANCA and FANSA, and the production of Harmful Algae News. The Centre is sponsored by the IEO (through the IOC Trust Fund), and IOC. The "Spanish Agency for International Cooperation" (AECI) cosponsors the courses held at the Vigo Centre. The agreement and sponsorship was renewed in 2006 to continue the activities of the Centre until end of 2011. Spain committed during the XXIV Session of the IOC Assembly (June 2009), to continue the Centre in Vigo until 2016.

The activities of the two Centres are coordinated and coupled as appropriate, and are intended to be as complementary as possible. Both Denmark and Spain have provided part of the resources for the Centres to the IOC Trust Fund.

The IOC Assembly has expressed its wish to continue the Centres through Resolution XX-3.

2. REGIONAL GROUPS AND WORKSHOPS

2.1 IOC Working Group on Harmful Algal Blooms in South America (COI-FANSA)

The FANSA group have met in 1994 in Montevideo (Uruguay) and subsequently in Mar del Plata, Argentina (1995), Punta Arenas, Chile (1997), Rio Grande, Brazil (2000), Montevideo, Uruguay (2001), Guayaquil, Ecuador (2003), Lima, Peru (2006) Mar del Plata, Argentina (2008) and Chile (2011).

See Document IOC/IPHAB-X/Inf.7

2.2 IOC Working Group on Harmful Algal Blooms in the Caribbean (COI-ANCA)

The main objective of ANCA is to improve the understanding of harmful algal blooms (HABs) in the Caribbean region and adjacent areas and the ability of national authorities to manage with the impacts. ANCA works to increase international cooperation, taking advantage of the existent knowledge in the region, to train researchers in countries where HABs knowledge is less advanced. To examine the advances of the group and to plan future activities, ANCA has organized workshops in Cuba 1998, Costa Rica 2002, Venezuela 2003 and Colombia 2007.

See Document IOC/IPHAB-X/Inf.22.

2.3 IOC/WESTPAC HAB

IOC/WESTPAC-HAB is chaired by Chair Dr. Y. Fukuyo (Japan).

See Document IOC/IPHAB-X/Inf.5.

2.4 Harmful Algae of North Africa: HANA , a regional network

The First IOC/HANA Workshop was held in Casablanca, Morocco, 2007 and the Second in Alexandria in 2010.

See Document IOC/IPHAB-X/Inf.8

EDUCATIONAL ELEMENTS

3. INFORMATION NETWORK

3.1 *Harmful Algae News* - an IOC newsletter on harmful algae and algal blooms;

Issues Nos. 38-43 of *Harmful Algae News* have been published in the intersessional period. HAN is published whenever there is sufficient material for an issue. The number of subscribers has stabilized just around 2,000. HAN is produced by the IOC Centres in Vigo and Copenhagen. Subscriptions and back issues are available at <http://ioc-unesco.org/hab> HAN relies on the dedicated and longstanding efforts of the Editor, Dr. Timothy Wyatt, Instituto de Investigaciones Marinas, Spain. A reader survey was planned for 2009 to assess if a majority of the readers maintain a preference for a printed version of HAN. However this has been delayed and will be carried out during 2011

3.2 IOC HAB Internet Site

The sites are maintained by the IOC HAB Centre with technical back-up by the IOC IODE Programme Office in Oostende, Belgium. Both sites allow for multiple editors. The GEOHAB SSC has co-editors for the GEOHAB site and HANA has a web site editor for the HANA site.

Of the regional groups WESTPAC/HAB has a portal for the South East Asia and FANSA during 2004-2005 established FANSA Portal at www.algasnocivas.net/ . UNESCO is 2006-2007 funded the expansion of the Portal to cover the Caribbean. The expansion of the portal is developed as cooperation between the FANSA and ANCA groups. Since the 2009 the Portal server was not maintained by UNESCO. Silvia Mendez (FANSA, Uruguay) has drafted a structure for a content management site to replace the portal but it has not yet been implemented due to limited resources.

3.3 Harmful Algal Information System - HAIS

IPHAB-VIII in 2007 through Resolution IPHAB-VIII.5 endorsed the development of an integrated Harmful Algal Information System (HAIS) in cooperation with the IOC International Ocean Data Information and Exchange Programme (IODE). Through Resolution IPHAB-IX.2 the Panel endorsed the Plan for HAIS as it was prepared by the Joint IPHAB/IODE Task Team on the Development of the Harmful Algal Information System.

The HAIS will when fully established consist of access to information on harmful algal events, harmful algae monitoring and management systems worldwide, current use of taxonomic names of harmful algae, and information on biogeography of harmful algal species. Supplementary components are an expert directory and a bibliography. The expectation is that it will be a service to scientists, managers of regulatory monitoring programmes, and to policy administrators to access to high quality data on current taxonomic names of harmful algae, the biogeography of harmful species and occurrence of harmful algal events, together with details of monitoring and management systems worldwide, directories of experts, and bibliography on harmful algae. The HAIS System is being built by IPHAB and IODE in cooperation with [WoRMS](#), [ICES](#), [PICES](#) and [ISSHA](#). The Joint IPHAB/IODE Task Team on the development of the Harmful Algal Information System oversees the development. The network and HAB related groups within IOC, ICES, PICES etc gives an unique position at a cross road of very diverse and multidisciplinary sets of data. HAIS comprises:

- HA Events with ICES, PICES et al (HAEDAT)
- Biogeography in OBIS with ISSHA (HABMAP)
- Taxonomy with WoRMS ('IOC Taxonomic Reference List on Toxic Species' which is the back bone of HAIS)
- References with ASFA and OceanDoc
- Expert Directory with IODE (OceanExpert - HABDIR)
- Monitoring and management design with ICES (MONDAT)

During 2009-2010 the IPHAB Taxonomic Task Team met in October 2010 to update the 'IOC Taxonomic Reference List on Toxic Species' in WoRMS. Action has been taken to have all ICES Countries update and complete submissions to HAEDAT before March 2011. HABMAP was re-launched jointly with OBIS at 14th Int Conference on HAB at Crete Nov 2010 (joint poster and Editors meeting) and the HAEDAT format has been customized to OBIS. A FP7 proposal entitled SpEcoSS (SPecies to ECOSystems using Semantic Standards) has been submitted with IOC HAB Centre as partner but was not approved for funding. A FP7 'Initial Training Network' Proposal has been submitted IOC UNECO as partner and will if approved provide a 2 year post doc full time to compile and analyze data for HAIS primarily but not exclusively from EU. The implementation of the projects will in 2011-2013 involve the staff at the IODE Project Office in Oostende. If the project is funded HAIS is expected to progress significantly. If not funded focus in 2012-2013 will be at ensuring continuous data submission to HAEDAT, stepwise establishment of HABMAP in OBIS and maintenance of the 'IOC Taxonomic Reference List on Toxic Species'. This will require technical support from IODE PO staff at same level as during 2009-2010.

IPHAB-IX requested that the regional networks and groups ANCA, FANSA, HANA and WESTPAC/HAB and their respective IOC sub-commissions and regional committees to include as a permanent Term of Reference the collation and submission of harmful algal event data to HAIS HAEDAT.

ANCA has due to its reorganization not progressed on this. FANSA and HANA have included it and has started to progressively upload reports starting from 2000. WESTPAC/HAB has for the time being not included it in its ToR.

The PICES HAB Section has committed itself to yearly submit HAEDAT reports and has taken action to complete data submission of all PICES countries starting from 2000.

The Regional Organization for the Protection of the Marine Environment (ROPME) has been invited to participate in HAEDAT and has shown positive interest, but is for the time being establishing its own data system with a structure very similar to HAEDAT.

The elements of HAIS currently available are located at <http://www.iode.org/haedat/>.

The HAIS Plan is available as document IOC/IPHAB-X/Inf.17

3.4 IOC co-sponsorship of International Conferences related to HAB

The HAB Programme co-sponsored the 14th International Conference on Harmful Algae, Crete, Greece, 3-7 November 2010. A summary of the Conference is available in Harmful Algae News No. 42 at <http://www.ioc-unesco.org/hab>. Proceedings will be published as a publication of the International Society for the Study of Harmful algae (ISSHA).

3.5 IOC Manuals and Guides, no. 55: Microscopic and molecular methods for quantitative phytoplankton analysis

A new manual on microscopic and molecular methods for quantitative phytoplankton analysis was published in 2010 in cooperation with ICES. The manual includes illustrated step by step instructions on how to carry out the methods. The editors are Karlson, B., Cusack, C. and Bresnan, E. The aim of the Manual is to provide a guide for phytoplankton analysis methods. A number of different methods are described and information about applicability, cost, training, equipment etc. is included to facilitate information on choosing the right method for a certain purpose. The method descriptions are more detailed than what is usually found in scientific articles to make the descriptions useful when setting up monitoring or research programmes that include inexperienced researchers. Some of the methods described are relatively old and well tested while a few must be considered to be emerging technology. The hope is that the Manual will supplement existing literature and that the free distribution of the Manual as hard copy or via the Internet will make it useful in environmental monitoring and for students, researchers and regulators. The production of the Manual was initiated during an international workshop at Kristineberg Marine Research Station in Sweden 2005 and the Participants in this Joint ICES/IOC Intercomparison Workshop on New and Classic Techniques for Estimation of Phytoplankton Abundance (WKNCT) agreed to write chapters of the Manual. A scientific paper describing the results of this workshop can be found in Godhe et al. (2007).

3.6 Provision of literature

The provision of HAB related literature to scientist in developing countries has been taken care of by the IOC HAB Centres in Copenhagen, Vigo and through WESTPAC/HAB. As many of the titles list below are now available on-line via the IOC web site, the Centres have experienced a dramatic decline in the requests for hard copies. The book grants offered include the titles listed below.

- GEOHAB: HABs in eutrophic systems. Glibert, P. (ed.). IOC and SCOR, Paris and Baltimore, 2006
- Manual on aquatic cyanobacteria. A photo guide and a synopsis of their toxicology. Cronberg, G. & Annadotter, H.. (Eds.), ISSHA and IOC of UNESCO, Copenhagen, 2006
- GEOHAB: GEOHAB Core Research Project: HABs in Upwelling Systems. Pitcher, G. et al. (eds.). SCOR and IOC, Baltimore and Paris, 2005
- Harmful Algal Management and Mitigation. Hall, S. et al, APEC, 2004
- Manual on Harmful Marine Microalgae, Hallegraeff, G. et al. (eds.), UNESCO Publishing 2003 and 2004
- Red tides. Okaichi, T. (eds.), Ocean Sciences Research (OSR). Terra Scientific Publishing Company & Kluwer Academic Publisher. Japan, 2003
- Molluscan Shellfish Safety, Villalba A. et al(eds.), Consellería de Pesca e Asuntos Marítimos da Xunta de Galicia and IOC of UNESCO, 2003
- GEOHAB. Global Ecology and Oceanography of Harmful Algal Blooms, Implementation Plan. P. Glibert and G. Pitcher (eds.) SCOR and IOC, 2003
- Proceedings of the Ninth International Conference on Harmful Algae Blooms, G. Hallegraeff et al. (eds.), UNESCO, 2002
- LIFEHAB – Life history of microalgal species causing harmful blooms. Garcés, E. et al. (Eds.), Environment and Sustainable Development Programme, European Communities, 2002.
- Floraciones Algales Nocivas en el Cono Sur Americano, E.A. Sar et al. (eds.), 2002.
- Monitoring and Management Strategies for Harmful Algal Blooms in Coastal Waters, D. M. Anderson et al (eds.) , APEC Report # 201-MR-01.1, APEC Programme and IOC of UNESCO, Technical Series No. 59, Paris, France ,2001
- GEOHAB. Global Ecology and Oceanography of Harmful Algal Blooms, Science Plan. P. Glibert and G. Pitcher (eds.) SCOR and IOC, 2001

- Potentially Harmful Microalgae of the Western Indian Ocean. A Guide based on a preliminary survey. IOC Manuals and Guides No. 41, IOC of UNESCO 2001.
- Technical Guide for Modern Dinoflagellate Cyst Study, Matsuoka, K., and Fukuyo, Y. WESTPAC-HAB/WESTPAC-IOC, 2000
- Algae, Graham, L.E., Wilcox, L.W. Prentice Hall, Upper Saddle River, NJ, 2000
- Toxic Cyanobacteria in Water, Chorus, I., and Bartram, J., WHO, 1999
- Los dinoflagelados del Atlántico Sudoccidental. Balech, E., Ministerio de Agricultura Pesca y Alimentación, Madrid, 1998
- Proceedings of the Seventh International Conference on Toxic Phytoplankton, Yasumoto, T. et al. (eds.), IOC of UNESCO, 1996
- Proceedings of the Eighth International Conference on Harmful Algae, Reguera, B. et al. (eds.), Xunta de Galicia and IOC of UNESCO, 1998
- Biology, Epidemiology and Management of *Pyrodinium* Red Tides. Hallegraeff, G. M. et al. (eds.), ICLARM Conf. Proc. 21, 1989
- The Genus *Alexandrium* Halim, E. Balech, Sherkin Island Marine Station, Cork, Ireland, 1995
- Identifying Marine Phytoplankton, C. Tomas et al. (eds.), Academic Press, USA, 1997
- The Biology of Dinoflagellates, F.J.R. Taylor (ed.), Blackwell Scientific Publications, Oxford, 1987
- Physiological Ecology of Harmful Algal Blooms, D. Anderson et al. (eds.), NATO ASI Series, Springer-Verlag, Bermuda, 1998
- Algal Toxins in Seafood and Drinking Water, I. Falconer (ed.), Academic Press, London, 1993
- Phytoplankton Pigments in Oceanography, S.W. Jeffrey et al. (eds.), UNESCO Publishing, Paris, 1997
- Proceedings of the First International Congress on Toxic Cyanobacteria, Ø. Moestrup et al. (eds.), 1996

4. TRAINING

4.1 HAB Training and Capacity Building Programme

The HAB Training and Capacity Enhancement Programme as adopted by IPHAB-VI is composed of 4 main modules on species identification, toxin chemistry and toxicology, design of monitoring, and management. See Document IOC/IPHAB-X/Inf.9 for an overview of courses implemented between 1993 and 2011. A total of 1062 people were trained, 38 through individual training stays at the IOC-Sciences and Communication Centres and 1024 participating in the 79 courses organized all over the world. The gender ratio of all the trainees is: 41% males and 59% females.

In order to strengthen partnerships for the development and implementation of capacity development initiatives the Secretariat met in March 2001 with the FAO and IAEA Secretariat to discuss closer cooperation. A Memorandum of Understanding has been signed with the IAEA and it has been agreed between the Secretariats of the IOC, IAEA and FAO to coordinate initiatives and on a case to case basis make use of and support each other's CD activities.

The IOC HAB Centre Copenhagen has via the Marine Institute (Ireland) made an agreement with The Biological Effects Quality Assurance in Monitoring Programmes (BEQUALM) project which was initiated in 1998 as an EU funded research programme. BEQUALM aims to develop appropriate quality standards for a wide range of biological effects techniques and devise a method for monitoring compliance of laboratories generating data from these techniques for national and international monitoring programmes. BEQUALM thus provides a Quality Assurance (QA) system for biological effects techniques and is self-financing on the basis of fees recovered from participants. The first BEQUALM-IOC intercalibration on marine phytoplankton will be conducted in the fall of 2011.

Courses and training implemented 2009-2011:

4.1.1. X IOC-AECID-IEO Training Course: Monitoring Programmes on Marine Biotoxins according to European Regulations. IOC - IEO Science and Communication Centre on Harmful Algae, IEO, Vigo, Spain. 9 – 25 September 2009.

4.1.2. IOC Training Course and Identification Qualification in Harmful Marine Microalgae, IOC Science and Communication Centre on Harmful Algae Copenhagen, University of Copenhagen, Denmark, E-learning May-June, practical course and examination 11-21 August 2009

4.1.3. IAEA-IOC Regional Training Course on Taxonomy and Monitoring of Toxic Marine Microalgae. Mazatlan, Mexico, 26 October – 6 November 2009

4.1.4. HAB training course in taxonomy and identification United Arab Emirates University at Al Ain, 14-18 March 2010.

4.1.5. XI Curso COI-AECID-IEO sobre Taxonomía de Fitoplancton Nocivo: Identification of Harmful Marine Microalgae. IOC - IEO Science and Communication Centre on Harmful Algae, IEO, Vigo, Spain. E-learning (April-May), Practical Course 2-18 June 2010.

4.1.6. IOC-SCOR GEOHAB Training Workshop on Benthic HABs, University of Hawaii, USA, 24-27 June 2010.

4.1.7. IOC Training Course and Identification Qualification in Harmful Marine Microalgae, IOC Science and Communication Centre on Harmful Algae Copenhagen, University of Copenhagen, Denmark, E-learning May-June, practical course and examination 17-27 August 2010.

4.1.8. Baltic Sea Phytoplankton Identification Course 14-26 November 2010, Nordic Marine Academy.

4.1.9. XII Curso COI-AECID-IEO: Monitoring Programmes on Marine Biotoxins according to European regulations. IOC - IEO Science and Communication Centre on Harmful Algae, IEO, Vigo, Spain. 8-24 June 2011.

4.1.10. IOC Training Course and Identification Qualification in Harmful Marine Microalgae, IOC Science and Communication Centre on Harmful Algae Copenhagen, University of Copenhagen, Denmark, E-learning May-June, practical course and examination 15-25 August 2011.

4.2 Planned courses:

4.2.1. XIII Curso COI-AECID-IEO sobre Taxonomía de Fitoplancton Nocivo: Identification of Harmful Marine Microalgae. IOC - IEO Science and Communication Centre on Harmful Algae, IEO, Vigo, Spain. E-learning (April-May), Practical Course June 2012.

4.2.2. IOC Training Course and Identification Qualification in Harmful Marine Microalgae, IOC Science and Communication Centre on Harmful Algae Copenhagen, University of Copenhagen, Denmark, E-learning May-June, practical course and examination August 2012.

4.2.3. XIV Curso COI-AECID-IEO: Monitoring programmes on marine biotoxins according to European regulations. IOC - IEO Science and Communication Centre on Harmful Algae, IEO, Vigo, Spain. June 2013.

4.2.4. IOC Training Course and Identification Qualification in Harmful Marine Microalgae, IOC Science and Communication Centre on Harmful Algae Copenhagen, University of Copenhagen, Denmark, E-learning May-June, practical course and examination August 2013.

4.2.5. IOC-AWI-BMU-BSH-DZMB-FSU Training Course on Qualitative and Quantitative Determination of Algal Toxins, Germany 200?, pending available funding.

4.2.6. Advanced Phytoplankton Course 10, University of Copenhagen and Statione Zoologica A. Dohrn, Denmark, fall 2012.

SCIENTIFIC ELEMENTS

5. ECOLOGY AND OCEANOGRAPHY

5.1 ICES-IOC Working Group on the Dynamics of Harmful Algal Blooms- WGHABD

The WGHABD (Chair: Dr Joe Silke, Ireland) met April 2009 in Huelva, Spain, April 2010 in Bermuda, and April 2011 in Gothenburg. The reports are available as Document IOC/IPHAB-X/Inf.13 (1, 2 and

3).

The main joint activities are HAEDAT and review of scientific issue relevant to GEOHAB. IPHAB can formulate tasks / terms of reference for WGHABD.

5.2 IOC-SCOR International Science Programme on the Global Ecology and Oceanography of Harmful Algal Blooms - GEOHAB

GEOHAB is a plan for co-ordinated scientific research and co-operation to develop international capabilities for assessment, prediction and mitigation. The approach of the GEOHAB Programme is comparative, from the cellular to the ecosystem level. GEOHAB fosters research that is interdisciplinary, focusing on the important interactions among biological, chemical, and physical processes. GEOHAB also fosters research that is multifaceted as the problems are complex and interactions and processes occur on a broad range of scales. Finally, GEOHAB research should be international in scope to encompass the global issues of HAB events.

The efforts of the SCOR-IOC Working Group 97 on the Physiological Ecology of Harmful Algal Blooms, resulted in a NATO-SCOR-IOC Advanced Study Institute on the Physiological Ecology of Harmful Algal Blooms, which was held at the Bermuda Biological Station, 27 May-6 June 1996. The deliberations and recommendations of the WG 97, together with the work of the ICES-IOC Working Group on the Dynamics of Harmful Algal Blooms, provided the basis for formulation of Recommendation IPHAB-IV.2 which Recommendation IPHAB-IV.2 instructed the IOC to develop an international science programme on the Global Ecology and Oceanography of Harmful Algal Blooms jointly with an appropriate organization. Partnership in the development of the new programme was agreed upon with the Scientific Committee on Oceanic Research (SCOR).

The initial development of GEOHAB received support from IOC, SCOR, The Maj and Tor Nessling Foundation (Finland), US National Aeronautics and Space Administration, US National Oceanic and Atmospheric Administration, US National Science Foundation, and IFREMER (France).

For the composition of the Scientific Steering Committee and its ToR please see Document IOC/IPHAB-X/Inf.10.

GEOHAB actions fall into the two broad categories of research and framework activities.

A detailed report on activities and outcome 2009-2011 is available in document IOC/IPHAB-X/Inf.11.

GEOHAB Report No. 1: GEOHAB Science Plan
GEOHAB Report No. 2: GEOHAB Implementation Plan
GEOHAB Report No. 3: Core Research Project: HABs in Upwelling Systems
GEOHAB Report No. 4: Core Research Project: HAB's in Eutrophied Systems
GEOHAB Report No. 5: Core Research Project: HABs in Stratified Systems,
GEOHAB Report No. 6: GEOHAB Asia: A Regional Cooperative Programme
GEOHAB Report No. 7: Core Research Project: HABs in Fjords and Coastal Embayments
GEOHAB Report No. 8: GEOHAB Modelling, Linking Observations to Predictions

5.3 ICES/IOC/IMO Working Group on Ballast and Other Ship Vectors

IPHAB-II requested the IPHAB Chair and the Programme Office to further investigate the possibilities and need for interaction with the activities of IMO and ICES. IPHAB-III adopted Recommendation IPHAB-III.3 on a Working Group on Transfer of Phytoplankton by Ballast of Ships. In response to this recommendation a Joint ICES-IOC-IMO Study Group on Ballast Water and Sediments was established. The ICES/IOC/IMO Study Group on Ballast Water and Sediments [SGBWS] was later been renamed the "ICES/IOC/IMO Study Group on Ballast and Other Ship Vectors [SGBOSV] and is now the ICES/IOC/IMO Working Group on Ballast and Other Ship Vectors (WGBOSV).

WGBOSV met in 2010 in Hamburg, Germany, and in 2011 in Nantes, France, under the chairmanship of Dr. Tracy McCollin, Scottish Government | Marine Laboratory, t.mccollin@marlab.ac.uk

WGBOSV reports are available at <http://www.ices.dk/> and as Document IOC/IPHAB-X/Inf.15(1). IPHAB-IX requested IOC and ICES to request the WGHABD, in collaboration with WGBOSV, to

advice on whether (i) it is possible to identify species of phytoplankton, especially HAB species (and their characteristics) which are more likely to be successful as invasive species, and have significant potential ecological or economic impact; (ii) there are particular characteristics of coastal waters which favor the establishment of invasive phytoplankters. The request was addressed through a 'Workshop on harmful phyto-plankton that could potentially be trans-ported or introduced by ballast water' (WKHABAL), held 14 - 15 October 2010, at ICES Headquarters, Copenhagen, Denmark.

The report is available as Document IOC/IPHAB-X/Inf.5(2)

IPHAB-IX decided to review at IPHAB-X the achievement of the WG and advice on its future direction.

6. TAXONOMY AND GENETICS

6.1 IPHAB Task Team on Algal Taxonomy

The Task Team was established through Resolution IPHAB-II.1. The Terms of Reference were updated by IPHAB-III, IV, VI, VIII, and IX. Chair is Prof. O. Moestrup. The Task Team meet in October 2010 to update the 'IOC Taxonomic Reference List on Toxic Species' in WoRMS. The Progress Report will be submitted to IPHAB-X.

7. TOXICOLOGY AND TOXIN CHEMISTRY

7.1 IPHAB Task Team on Aquatic Biotoxins

The Terms of reference for the Task Team are given in Resolution IPHAB-IX.1. Due to health problems the Chair of the Task Team, Phil Busby (New Zealand) have withdrawn from his position and this has implied that the Task Team has not been active in the inter-sessional period. However, the Chair did follow-up with the FAO Secretariat regarding the editing and publishing of the background papers to the Summary Report of the Joint FAO/IOC/WHO ad hoc Expert Consultation on Biotoxins in Bivalve Molluscs. FAO is now finalising a Fisheries Technical Paper entitled "Assessment and management of biotoxin risks in bivalve molluscs". This is based on background papers prepared for the 2004 FAO/WHO/IOC expert consultation that were subsequently reviewed and updated. This is expected to be released during 2011.

More details on FAO activities in the area of shellfish safety and biotoxins can be found in Document IOC/IPHAB-X/Inf.19.

OPERATIONAL ELEMENTS

8. MONITORING

8.1 IOC-ICES Meta Data Base on Design and Implementation of HAB Monitoring Programmes: MON-DAT

The MON-DAT meta-data-base contains information on the design and implementation of harmful algae monitoring and management systems from all over the world. MON-DAT include data from countries that have responded to the questionnaire circulated by the Secretariat.

The initial compilation of information was carried out within the ICES-IOC Working Group on the Dynamics of Harmful Algal Blooms, and the establishment of the data-base was made possible through the financial support of the Danish agency for development assistance, DANIDA. The first survey for information on HAB monitoring was made in 1995/96 and a summary of the result was published as IOC Technical Report No. 44. The base was updated in 2000/01.

MON-DAT was planned to have been updated in 2005 but resources did not allow. Update of MON-DAT is postponed until it has been integrated into a new Harmful Algal Event Information System which is a new data base platform initially holding the data of HAE-DAT (see item as to have one comprehensive data source for information on harmful algal events, geographical distribution and

descriptions of the monitoring systems that generate the event data.

MON-DAT is unavailable on-line until its integration in to the Harmful Algal Event Information System.

8.2 Implementation of HAB Monitoring within the Global Ocean Observing System (GOOS)

IPHAB-IX decided to continue the IPHAB Task Team on HAB Observations and Forecasting Systems with terms of reference to:

- (i) act as the focal and coordination point of the IPHAB regarding interaction with GOOS, in particular with the Panel for Integrated Coastal Observations (PICO);
- (ii) together with PICO suggest HAB-related products from automated observation and forecasting systems in selected GOOS Regional Alliances (GRA's) and if possible make these available through the IOC-HAB Programme web site;
- (iii) keep informed, and solicit input from, the regional IOC HAB networks in relation to development within GOOS and its GRA's of HAB observation, forecasting and warning systems;

A progress report is available as Document IOC/IPHAB-X/Inf.14.

APPENDICE I. RESOURCES AVAILABLE TO THE IOC FOR DEVELOPMENT AND IMPLEMENTATION OF THE IOC HARMFUL ALGAL BLOOM PROGRAMME

This is not an actual account (for this see documentation provided for the IOC Assembly 2009 and 2011) the equivalent document which will be available for the IOC Assembly June 2011).

2009–2010

<u>IOC-UNESCO REGULAR PROGRAMME</u>	US Dollars
IOC HAB Programme Regular Budget 2009-2010	58.100
1 IOC Staff	-
<u>EXTRA-BUDGETARY CONTRIBUTIONS TO THE IOC:</u>	
Spain: -Spanish Institute of Oceanography: Support for the IOC Science and Communication Centre at the Oceanographic Centre in Vigo, Spain 2009-2010	81.000
USA (SD and NOAA): Contribution 2009/10 for implementation of GEOHAB, M&G55, HAIS and NEWS2USE):	20.000
<u>SPONSORSHIP OF ACTIVITIES AND FUNDS ADMINISTERED AT THE SCIENCE AND COMMUNICATION CENTRES:</u>	
Denmark: -DANIDA: Training through research -University of Copenhagen: IOC Science and Communication Centre on Harmful Algae, Copenhagen, staff, operation and activities:	25.000 125.000
Spain: -Spanish Institute of Oceanography: IOC-IEO Science and Communication Centre on Harmful Algae, Vigo, 2 staff, operation and activities:	291.000
-AECID (Spanish Agency for International Cooperation & Development), Scholarships for participants in training activities at Vigo Centre 2009:	37.000
-AECID (Spanish Agency for International Cooperation & Development), Scholarships for participants in training activities at Vigo Centre 2010:	49.100

Budget 2011

<u>IOC-UNESCO REGULAR PROGRAMME</u>	US Dollars
IOC HAB Programme Regular Budget	33.100
IOC Staff funded as permanent staff	
<u>EXTRA-BUDGETARY CONTRIBUTIONS TO THE IOC:</u>	
Spain: -Spanish Institute of Oceanography: Support for the IOC Science and Communication Centre at the Oceanographic Centre in Vigo, Spain	42.600
<u>SPONSORSHIP OF ACTIVITIES AND FUNDS ADMINISTERED AT THE SCIENCE AND COMMUNICATION CENTRES:</u>	
Denmark: -DANIDA: Training through research	10.000
University of Copenhagen: IOC Science and Communication Centre on Harmful Algae, Copenhagen, staff, operation and activities:	65.000
Spain: -Spanish Institute of Oceanography: IOC-IEO Science and Communication Centre on Harmful Algae, Vigo, 2 staff, operation and activities:	153.000
-AECID (Spanish Agency for International Cooperation & Development), Scholarships for participants in training activities at Vigo Centre:	39.800

GEOHAB Funds 2010-2011

Income	2010	2011
Carry-over from previous year	\$26.493,21	\$28.306,33
US NSF (through SCOR)	\$49.645,34	\$40.000,00
GEOHAB Modeling Workshop Registration Fees	\$8.683,00	
IOC	\$20.000,00	\$20.000,00
SCOR Support for LDC Travel	\$2.101,08	
US NOAA Funding for Eutrophication CRP (through IOC)	\$9.600,00	
Total	\$116.522,63	\$88.306,33

**APPENDICE II: IMPLEMENTATION OF IPHAB-IX RESOLUTIONS
AND RECOMMENDATIONS**

CODE	TITLE	IMPLEMENTATION
Resolution IPHAB-IX.1	Task Team on Biotoxin Monitoring, Management and Regulations	TOR (I) AND (II) IMPLEMENTED, (III) NOT FEASIBLE DUE TO WITHDRAWAL OF CHAIR, (IV) NOT IMPLEMENTED
Resolution IPHAB-IX.2	Development of the Harmful Algal Information System	TOR 8I) IMPLEMENTED, (II) PARTLY, (III) NOT IMPLEMENTED.
Resolution IPHAB-IX.3	Task Team on Algal Taxonomy	IMPLEMENTED
Resolution IPHAB-IX.4	Task Team on HAB Monitoring within the Global Ocean Observing System	Pending report of the TT Chair.
Resolution IPHAB-IX.5	Regional HABP Development	PARTLY IMPLEMENTED. REGIONAL COURSES CONTINUED, PARTLY SUBMISSION OF DATA TO HAEDAT. LITTLE PROGRESS RE ALGAS NOCIVAS PORTAL AND REGIONAL COOPERATION RE HABS IN POICT,
Recommendation IPHAB- IX.1	Visualizing the IPHAB Strategy for Assisting the Ocean Science Section in the Development of a Workplan for Integrated Coastal Research	IMPLEMENTED
Recommendation IPHAB- IX.2	HABP Workplan 2010-2011	IMPLEMENTED WITHIN THE AVAILABLE RESOURCES
Recommendation IPHAB- IX.3	Operation of the IOC Intergovernmental Panel on Harmful Algal Blooms	IMPLEMENTED

ANNEX IX

IPHAB STRATEGY

A Strategy for enhanced Global Management OF HABs

The IOC Intergovernmental Panel on Harmful Algal Blooms (IPHAB) is a global partnership of decision makers, policy makers, managers, scientists, international organisations and NGOs to address the problem of harmful microalgae. The IOC IPHAB was established in 1991 as the organizational framework for the Partnership.

Why a strategy?

With this strategy for enhanced global management of harmful algal events the IOC of UNESCO wish to visualise the need for and benefits to governments of international cooperation in research, data products, and uniform food safety HAB standards to facilitate international trade and capacity building. We also wish to engage and commit stakeholders to take active part in and contribute to the activities. Without such engagement and contribution at the scientific, financial and governmental level such international cooperation cannot succeed.

Vision and goal

The vision of IPHAB is a global international network of national authorities and institutions involved with sea food safety, statutory monitoring of harmful algae & toxins and HAB research, with capacity to adequately manage and mitigate the affects of harmful algae.

The overall goal of the IOC Harmful Algal Bloom Programme is to foster the effective management of, and scientific research on, Harmful Algal Blooms (HABs) in order to understand their causes, predict their occurrences, and mitigate their effects.

What are Harmful Microalgae?

Phytoplankton blooms, micro-algal blooms, toxic algae, red tides and harmful algae are all terms for naturally occurring phenomena. About three hundred species of micro-algae are reported to form mass occurrences, so called 'blooms', and nearly one fourth of these species are known to produce toxins. These events are referred to by the generic term, 'Harmful Algal Blooms' (HAB), recognising that, because a wide range of organisms is involved and some species have toxic effects at low cell densities, not all HABs are 'algal' and not all occur as 'blooms'

What are the negative effects of Harmful Algae?

- Fish kills and contaminated seafood
- Toxic effects on humans
- Aesthetic problems affecting tourism
- Marine ecosystem impact
- Technical barriers to seafood trade

Occurrences of harmful microalgae in marine or brackish waters can cause fish kills, contaminate seafood with toxins, and alter ecosystems in ways that humans perceive as harmful. A broad classification of harmful algae distinguishes two groups of organisms: the toxin producers, which can contaminate seafood or kill other organisms, and the high-biomass

producers, which can cause anoxia and indiscriminate destruction of marine life after reaching dense concentrations. Some HABs have characteristics of both. Although HABs are natural and occurred long before human activities began to transform coastal ecosystems, reporting from affected regions on economic losses and intoxication of humans demonstrates that there has been a significant increase in the impacts of HABs over the last few decades and that the HAB problem is now widespread, and serious. However, the harmful effects extend beyond direct economic losses and impacts on human health. When HABs contaminate or destroy coastal resources, the functioning of coastal ecosystems is impaired, the livelihoods of local residents are threatened and the sustenance of human populations is compromised.

Some algal toxins are extremely potent and may be several times more toxic than, for example, cobra venom, and more than a thousand times more toxic than cyanide. At least six human syndromes are presently recognized to be caused by consumption of seafood which is contaminated with algal toxins:

- Amnesic Shellfish Poisoning - ASP
- Ciguatera Fish Poisoning - CFP
- Diarrhetic Shellfish Poisoning - DSP

- Neurotoxic Shellfish Poisoning - NSP
- Paralytic Shellfish Poisoning - PSP
- Azaspiracid Poisoning - AZP

Some of these syndromes can be fatal. There is currently no international record of the number of incidents of human intoxication caused by contaminated seafood. Many cases and even fatalities are thought to pass undiagnosed and hence unreported in the official statistics. In addition to posing serious health risks to consumers of seafood, some microalgae may have devastating effects on fish and other marine organisms, both in the wild and in aquaculture. Species of microalgae belonging to different taxonomic groups can produce toxins which damage fish gills by haemolytic effects. This has resulted in extensive fish kills with major economic losses. Additional losses may be inferred due to loss of confidence in seafood products by consumers. In coastal areas where tourism is important to the local or national economy, the loss of aesthetic quality due to microalgae proliferations may have severe impacts. HAB species are also of concern as potential invasive species when transported with ballast of ships or aquaculture stocks.

HABs in the broader context

The IOC addresses the issue of harmful algae and their effects in the broader context of marine research and management.

Integrated coastal area management and nutrient loading to the coastal environment

Improved understanding of population dynamics of harmful marine microalgae, modelling capabilities of harmful marine microalgal events, as well as improved capability to model and link global patterns of nutrient input to coastal ecosystem effects in Large Marine Ecosystems, contributes to the overall goal of the IOC to achieve healthier ocean ecosystems and sustainable coastal and ocean environments by means of development and diffusion of scientific research, better information and procedures on which policies can be based.

Global observing systems

The Intergovernmental Panel on HAB works closely with the Intergovernmental Panel for the Global Ocean Observing System (GOOS) on the inclusion of HAB observations in Coastal GOOS and through proactive interaction with the Regional Alliances of GOOS on strengthened HAB monitoring and management.

Climate change

With regard to the impact of climate change on the marine ecosystem, the IOC-SCOR Global Ecology and Oceanography Programme (GEOHAB) facilitates basic research in the factors that control HAB events and are thus giving answers to how the occurrence of HAB may change as climate change influence fundamental controlling factors from e.g. temperature, Ph, nutrient access, to hydrography.

Food safety

Through a Task Team on Marine Biotoxins, the IOC interacts with sister UN agencies FAO and WHO in the area of food safety to provide guidance on marine biotoxin test methods, toxicology and management. Enhancing capacity to monitor and manage HABs is a precondition to seafood safety and is offered via training opportunities, manuals and guides for national agencies responsible for regulatory control of marine biotoxins and seafood safety.

How is IOC IPHAB assisting Member States?

The IOC is working with the issue of harmful algae in the context of coastal management, protection of public health, wild and farmed fish and shellfish resource protection, livelihood of coastal populations, tourism, eutrophication, and climate change.

In 1992, IOC established a programme with the overall goal of assisting member states in mitigating the effects of harmful algae. This was in recognition that no single country held the expertise to understand the mechanisms underlying the occurrence of harmful algae and that to build own capacity for research and management many countries need to develop collaborative links.

The Programme is supervised and guided by the IOC Intergovernmental Panel on Harmful Algal Blooms (IPHAB). The IPHAB is composed of IOC Member State representatives and identifies priorities and resources for the implementation of the Programme.

Within the Medium Term Strategy of the IOC for 2008-2013 and the overall trans-disciplinary Harmful Algal Bloom Programme Plan, the IPHAB focuses on four priorities:

- Training, capacity building and networks for enhanced knowledge and mitigation
- International cooperative research on bloom dynamics, modelling and forecasting
- An authoritative integrated harmful algal information system

The IOC HAB Programme operates in close cooperation with national institutions and relevant organizations, in particular the Scientific Committee on Oceanic Research (SCOR) the International Council for Exploration of the Sea (ICES), and the North Pacific Marine Science Organization (PICES).

HAB TRAINING, CAPACITY BUILDING AND NETWORK STRATEGY – levels and horizons

Strategy level:

Intergovernmental

- Overall mission and vision
- Overall objectives
- Overall structure

Topic

- What issues?
- Which regions?
- Which services?
- Which beneficiaries?
- What competences?

Operation

- How CB can contribute to the overall objectives

Strategy horizon:

Permanent

Strategic aim:

- Enhance national capacity to mitigate harmful algal events

Key issue:

- Target CB to national need and context

Values:

- Demand and user driven CB

Periodically

Target:

- Be normative*
- Qualifying training
- Minimum 4 courses per biennium

Sub-strategies:

- Strengthen institutional partnerships
- Broaden sponsorship

Action plans:

- Secretariat and Partners to systematically submit proposals

Budget:

- E-learn platform
- Manuals&Guides
- Trainers
- Travel grants

Current

Rooting:

- Careful selection of trainees
- Sustainability at institutional level
- Regional networks

Implementation:

- Via HAB Centres, partners and regional networks

Follow-up:

- Regular assessment by IPHAB: are we on the right track?

The over all plan, with vision, objectives, topics and operation, for HAB training capacity building and networks is described in the 'HAB Training and Capacity Enhancement Programme' as adopted by IPHAB-VI. The Programme is composed of 4 main modules on species identification, toxin chemistry and toxicology, design of monitoring, and management.

Explanatory notes to strategic model:

Strategic aim: What will we do for Member States?

Key issue: What do we have to be good at?

Values: What should characterize our work?

Target: What is most important to achieve in the period?

*Normative: Set standards and or procedures for relevant HAB training; develop concepts, manuals, guides.

Sub-strategies: How do we reach targets, what actions do we take?

Action Plans: What shall we do, who and when?

Budget: How will we spend the money?

Rooting: How to achieve understanding for and ownership of strategy?

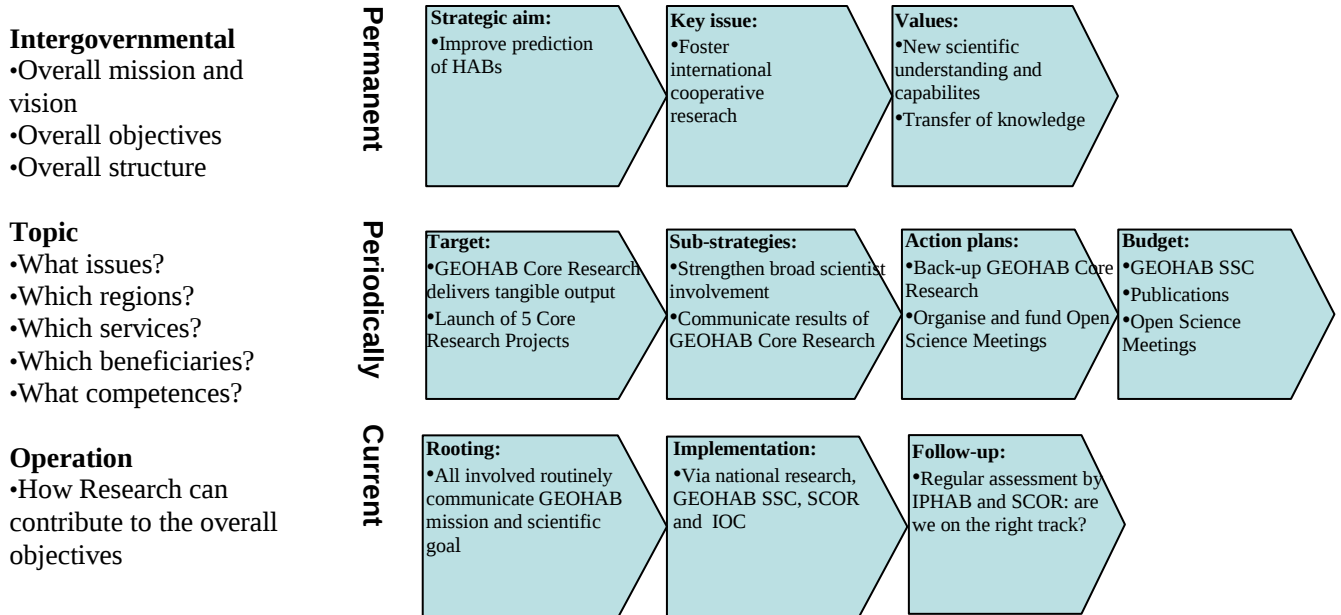
Implementation: How to do it?

Follow-up: Are we on the right track?

INTERNATIONAL COOPERATIVE HAB RESEARCH STRATEGY – levels and horizons

Strategy level:

Strategy horizon:



The over all plan, with vision, mission, objectives, topics and operation, for international cooperative research on HAB is described in the Science and Implementation Plans for the SCOR-IOC Global Ecology and Oceanography of Harmful Algal Blooms Programme GEOHAB (www.geohab.info). The GEOHAB Programme is composed of 5 programme elements on upwelling systems, eutrophication, stratified systems and fjords & coastal embayments, and is implemented through a number of Core Research Projects.

Explanatory notes to strategic model:

Strategic aim: What will we do for Member States?

Key issue: What do we have to be good at?

Values: What should characterize our work?

Target: What is most important to achieve in the period?

Sub-strategies: How do we reach targets, what actions do we take?

Action Plans: What shall we do, who and when?

Budget: How will we spend the money?

Rooting: How to achieve understanding for and ownership of strategy?

Implementation: How to do it?

Follow-up: Are we on the right track?

Harmful Algal Information Strategy– levels and horizons

Strategy level:

Intergovernmental

- Overall mission and vision
- Overall objectives
- Overall structure

Topic

- What issues?
- Which regions?
- Which services?
- Which beneficiaries?
- What competences?

Operation

- How HA information can contribute to the overall objectives

Strategy horizon:

Permanent

Strategic aim:
•Foster int. HAB data exchange and accessibility

Key issue:
•Global coverage
•Stable data input

Values:
•Quality assured data
•Reliability
•User friendly
•Interactive

Periodically

Target:
•Be the premier and authoritative facility for global HAB data
•All data components on-line

Sub-strategies:
•Develop components fully
•Develop userinterface with partner
•Expand data provider net

Action plans:
•Attract funding
•Formalise data submission
•Communicate HAIS

Budget:
•DB development
•Task Team Mtgs
•Data input

Current

Rooting:
•All involved routinely communicate HAIS mission

Implementation:
•With partners OBIS, WoRMS, ICES, PICES, ISSHA

Follow-up:
•Regular assessment by IPHAB and IODE: are we on the right track?

The over all strategy, with vision, objectives, topics and operation, for an authoritative integrated harmful algal information system is described in the Plan for the IPHAB-IODE Harmful Algal Information System (HAIS). The HAIS system is composed of 5 data elements on HAB species biogeography, HAB events, HAB species taxonomy, HAB monitoring practices, and a HAB expertise roster.

Explanatory notes to strategic model:

Strategic aim: What will we do for Member States?

Key issue: What do we have to be good at?

Values: What should characterize our work?

Target: What is most important to achieve in the period?

Sub-strategies: How do we reach targets, what actions do we take?

Action Plans: What shall we do, who and when?

Budget: How will we spend the money?

Rooting: How to achieve understanding for and ownership of strategy?

Implementation: How to do it?

Follow-up: Are we on the right track?

Beneficiaries and stakeholders

The immediate beneficiaries of the activities of the programme are

- institutions with regulatory responsibilities in relation to seafood safety, biotoxin monitoring, human or ecosystem health, or environmental monitoring;
- institutions and industries implementing HAB and biotoxin monitoring;
- research teams working on the dynamics, modelling and forecasting of harmful algal events

- the individual decision maker, manager, scientist or specialist benefiting from information, data and networks activities.

The enhanced capacity of these immediate beneficiaries contributes to the capability of economies, governments and fishery, seafood trade, tourism etc industry to manage and mitigate the effects of harmful algae.

The true stakeholders in international cooperation on harmful algae are thus a broad section of society that depend on, or interact with, marine resources and the marine environment.

Ownership and contributions

The IOC strives to ensure governmental and institutional ownership of the activities initiated and coordinated by the IOC and of the concerted action in and among Member States and individual stakeholders. Such ownership and the associated engagement and contribution are essential for successful international cooperation. Examples of how various stakeholders contribute are:

Stakeholder	Can contribute and benefit by:
Governments	• participation in IPHAB • financial support • in-kind sponsorship and hosting of activities • dissemination of IOC information and news to national institutions and private sector
Institutions	• Involvement, funding and participation in research programmes, working groups, regional networks and support to their staff for participating actively. • Financial support to specific activities. • in-kind sponsorship and hosting of activities • provide viewpoints and feedback on IOC activities to their Governments (IOC National Committees)
Private sector	• Partnerships in implementation of capacity building and research activities • Sponsorship of activities in return for visibility and acknowledgement
Research teams	• Collaboration in research programmes, working groups, regional networks

Stakeholder	Can contribute and benefit by:
Individual scientists, experts, managers	Actively participate in working groups, research programme, workshops, networks, subscribe to Harmful Algae News and provide feedback inside their organisations and to their leaders about IOC cooperation and activities

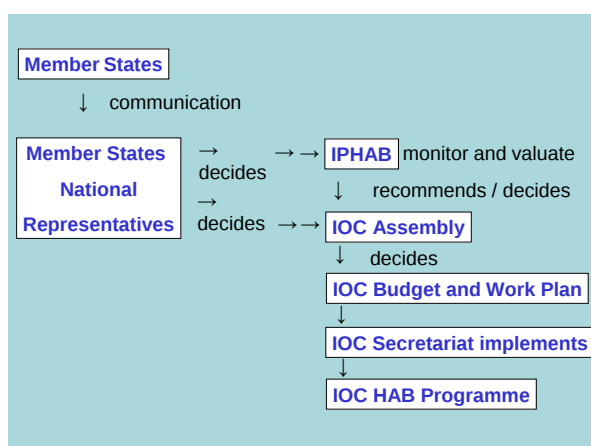
Implementation strategy: science and communication centre and regional networks

The IOC is implementing its HAB activities through an IOC Science and Communication Centre on Harmful Algae. The Centre is composed of a main unit hosted at University of Copenhagen, Denmark, and a complementary unit hosted at the Spanish Institute of Oceanography in Vigo. The Centre also consists of a consortium of national institutions that have committed to take on responsibility for and contribute to, the implementation of the activities. In this way, IOC Member States actively contribute to international cooperation and at the same time achieve a deep rooting of the IOC programme at the institutional level. An equally important mechanism for implementation and concerted action is the IOC regional networks and working groups on harmful algae established in the Caribbean, South America, Western Pacific, North Africa and North Atlantic.

Metrics of impact assessment

The achievements of the IOC HAB Programme are reviewed and valued every second year by the IOC Intergovernmental Panel on HAB. The Panel assesses needs, decides on priorities and identifies funding or funding opportunities.

At a higher level the achievements are assessed by the IOC Assembly every second year and as a part of IOC achievements by the UNESCO General Conference every second year. This assessment and the feedback from Member States are taken as an indication of the impact of activities at the national level. Particular attention is given to the effects that the accomplishments have had in e.g. facilitating international trade, monitoring practices, focus of national and regional research agendas, and the extent to which concerted action among Member States has occurred.



Achievements and planned deliverables

Training, Capacity Building and Networks

Achievements:

The IOC has jointly with national institutional partners trained more than 600 individuals from countries all over the world who need to enhance their capabilities to monitor and manage harmful algal events. In particular the IOC offers international training courses in harmful algal identification and toxicity testing. The courses are delivered by experts from leading research institutions world wide. The courses are open to applications from all qualified individuals, but priority is given to those charged with HAB monitoring and management in developing countries. The Courses have become recognised as a form of qualification in some Member States and since 2006 the courses in identification are upon passed examination giving certification in identification.

To facilitate knowledge exchange and regional cooperation, the IOC has established networks of professionals in five IOC regions which focus on training, expert assistance, exchange of information, planning of coordinating activities, inter-calibration as well as cooperative research projects.

- ANCA: Grupo COI sobre Algas Nocivas en el Caribe
- FANSA: Grupo COI sobre Floraciones de Algas Nocivas en Sudamerica
- HANA: The IOC North African Network on Harmful Algal Blooms.
- WESTPAC/HAB: Western Pacific Working Group on HAB
- WGHABD: Joint ICES-IOC Working Group on HAB Dynamic

As part of a global network support the IOC publish a newsletter HARMFUL ALGAE NEWS. It reports HAB events around the globe, ongoing research activities, training courses and workshops, publications and relevant announcements. The printed version of the newsletter has more than 2000 subscribers and is free of charge. Harmful Algae News and subscription requests are also available on the IOC HAB website.

The IOC and UNESCO has published and co-published a number of comprehensive manuals and guides to research and management of harmful algae. The 'Manual on Harmful Microalgae' in the series UNESCO Monographs on Oceanographic Methodology is a comprehensive manual on methodologies, identification, toxicity and toxin analysis, monitoring and management of harmful algae. In the same series is a Monograph on "Real-time Coastal Observing Systems for Marine Ecosystem Dynamics and Harmful Algal Blooms: Theory, Instrumentation and Modelling".

Planned deliverables 2008–2013:

The priorities for 2008-2013 are to further develop the series of training courses and to match course content with the needs of research and management institutions in Member States. The platform is extensive use of e-learning and the partner agreements with a number of national institutions with internationally recognised expertise in HAB. The IOC Science and Communication Centres on HAB will continue to facilitate and implement cooperative research projects to enhance research capacity in developing countries.

The regional networks are self driven, and their continuity depends on the initiative of the participating institutions. IOC will strive to provide seed funding for activities.

Manuals and guides will be developed to serve the needs of international research programmes as well as to fill gaps in relation to emerging technologies and application of these to research and routine monitoring for resource protection and/or as part of larger marine observation systems.

Achievements and planned deliverables

Cooperative Research and Scientific Working Groups

Achievements:

GEOHAB is a joint IOC-SCOR international science programme on the Global Ecology and Oceanography of Harmful Algal Blooms. It is a programme designed to coordinate research and cooperation to develop international capabilities for assessment, prediction and mitigation of harmful algal events. The mission of GEOHAB is to foster international cooperative research on HABs in ecosystems sharing common features to facilitate the comparison of the key species involved and the oceanographic processes that influence their population dynamics.

The scientific goal of GEOHAB is to improve prediction of HABs by determining the ecological and oceanographic mechanisms underlying the population dynamics of harmful algae, integrating biological, chemical and physical studies which are supported by enhanced observation and modelling systems. Thus, the key problem is to understand the critical features and mechanisms underlying the population dynamics of HAB species in a variety of oceanographic regimes. This understanding can be used as a basis for monitoring and predicting the occurrence, movement, toxicity, and environmental effects of HABs. In turn, monitoring and prediction are essential for management and mitigation of HABs.

The ICES-IOC Working Group on Harmful Algal Bloom Dynamics has been established to focus on the physical, chemical and biological interactions associated with harmful algal blooms, and provides technical advice to ICES and IOC e.g. upon request from IPHAB. The Group also collects and assesses national HAB event reports, maps HAB events and summarises the information in the harmful algae event database on a regional, temporal and species basis.

The IOC is jointly with ICES and IMO improving the knowledgebase for control of harmful organisms and pathogens in ballast water. The ICES-IOC-IMO Working Group on Ballast of Ships and other Vectors critically reviews and reports on the status of ballast water research with an emphasis on new developments in ballast water treatment technology, risk assessment, ballast water sampling devices, and selection of ballast water exchange zones to contribute to guidelines currently in preparation by IMO. Also, the group continuously review shipping vectors, prepares a Ballast Water Sampling Manual and works on a draft Code of Best Practice for the Management of Ships Hull Fouling and a Code of Best Practice for Port Sampling.

Planned deliverables 2008-2013:

GEOHAB is in the period of implementation and delivery of results. The GEOHAB Scientific Steering Committee will implement the GEOHAB Core Research Projects, organise framework activities for both Core research and GEOHAB affiliated national research, and will synthesise research results.

IOC will continue to co-sponsor the ICES-IOC Working Group on Harmful Algal Bloom Dynamics as a mechanism to review critical research issues, as a feed back mechanism for GEOHAB and to compile data for the Harmful Algae Information System.

The IOC will continue to cosponsor the ICES-IOC-IMO Working Group on Ballast of Ships and other Vectors until finalisation of the draft manuals and codes of practice, expected by the entry into force of the IMO Ballast Water Convention.

Achievements and planned deliverables

Data products for research and management

Achievements:

A data base has been established on harmful algal events as an on-line system in cooperation with the International Council for the Exploration of the Sea (ICES) and the North Pacific Marine Science Organisation (PICES) and is gradually being expanded to cover the entire globe. It provides a structure for data storage that allows easy integration of data, efficient search tools, and the possibility of conducting data analysis. Another data compilation is a meta-database with information on the design and implementation of harmful algae monitoring and management systems from all over the world, and there is an on-line international directory of experts in harmful algae and their effects on fisheries and public health. As the common backbone for the data products is the IOC Taxonomic Reference List of Toxic Plankton Algae.

Planned deliverables 2008–2013:

With respect to data products work will be initiated in 2008 to integrate and expand the existing data products into a Harmful Algae Information System (HAIS). This system will be developed as a joint activity with the International Oceanographic Data exchange Programme (IODE) of the IOC and in partnership with ICES, PICES, ISSHA, and OBIS.

ANNEX X

REPORT ON IOC/WESTPAC-HAB PROGRESS

Project name:

Harmful Algal Blooms in the Western Pacific (WESTPAC/HAB)

Project Leader (Chairperson) and Project Steering Group (as of 28 May 2008)

Project leader: Yasuwo Fukuyo (The University of Tokyo, Japan)

Project Steering Group

- Australia :Kezong Yin
- China Mingyuan Zhu, Zongling Wang
- Indonesia :Hikmah Thoha
- Japan Yasuwo Fukuyo, Mitsunori Iwataki
- Malaysia :Normawaty Mohd Noor, Yong Ai Hua
- Philippines Rhodora Azanza, Elsa Furio
- Thailand:Thaithaworn Lirdvitayaprasit
- Viet Nam :Bui Hong Long, Dao Viet Han

Objectives:

1. To understand the biological and chemical nature, population dynamics and environmental effects of harmful algae and their bioactive products
2. Prevent ill consequences caused by HABs, through providing scientific knowledge useful for establishment of reliable cost- and load-effective management systems including monitoring and research

Terms of Reference of the Project Steering Group**1. Composition**

The Project Steering Group shall consist of all member states of WESTPAC interested to participate. Each Country, through its IOC National Focal Point shall designate one or two members with HAB expertise. Once the Project Leader is identified by IOC Sub-Commission for the Western Pacific, he/she shall sever as the Chairperson of this Steering Group. The Group is encouraged to conduct the work through correspondence. However, they shall meet if needed at the expense of the participating countries as far as possible. Other participants may be invited as observer if deemed necessary.

2. Functions

The Project Steering Committee is established to meet the scientific, managerial, implementation, and resource needs of the WESTPAC- Harmful Algal Blooms Project.

The Group will carry out the following functions:

1. Review and identify project requirements;
2. Promote efficient and cost-effective implementation of the WESTPAC Project and prepare recommendations on this implementation to the IOC Sub-Commission for the Western Pacific and the IOC's Intergovernmental Panel for HAB;
3. Identify the resources necessary to meet HAB project needs;
4. Ensure effective interaction and communication with WESTPAC and IOC' Intergovernmental Panel on HAB, as well as other regional intergovernmental (NOWPAP, PEMSEA, PICES) and non-governmental (e.g., SCOR) organizations involved in research on toxic algae and harmful algal blooms; and
5. Report to the IOC Sub-Commission for the Western Pacific and IOC's Intergovernmental Panel on HAB.

Terms of Reference

General Terms of Reference:

1. WESTPAC/HAB is established by the IOC Sub-Commission for the Western Pacific (WESTPAC), as the regional mechanism for implementing the IOC Harmful Algal Bloom Programme as adopted by the IOC Assembly through Resolution XVII-2 and with specific priorities and tasks as decided by WESTPAC.
2. WESTPAC will assign the tasks of Chair and steering committee for each period between WESTPAC Sessions or as required. A chair and the steering committee members can be assigned for successive periods. The Terms of Reference for the Steering Committee will be prepared elsewhere.
3. The Chair of WESTPAC/HAB will report its activity to WESTPAC and the IOC Intergovernmental Panel on Harmful Algal Blooms, and through the IOC Secretariat to other relevant IOC Governing and advisory bodies.
4. The Chair and the steering committee will with support of the IOC Secretariat organize WESTPAC/HAB strategic planning workshops as required and feasible in order to develop and implement the Programme.
5. Participation in WESTPAC/HAB strategic planning workshops is open to scientist and managers in WESTPAC. The WESTPAC/HAB executives may together with the secretariat also select a number of participants for full or partial support among individuals who have expressed their interest.
6. The Chair may invite other experts in the WESTPAC region to take on responsibility for specific activities.

Report of WESTPAC HAB activities in 2009-2011

WESTPAC-HAB was established in 1991 at the First Session of WESTPAC, IOC Sub-Commission for the Western Pacific, assigning Dr. Tomotoshi Okaichi as the Project Leader. In 1993 at its Second Session WESTPAC-HAB proposed to develop HAB research capacity in the WESTPAC region, especially in Southeast Asia where utilization of coastal area was intensively and extensively progressed and consequent occurrence of HAB was highly worried, having Yasuwo Fukuyo as the new leader. After then WESTPAC-HAB has been conducting international and local training courses, workshops and seminars, and providing several types of reference materials such as CDs and booklets on harmful microalgae and HAB events with the objectives:

1. To understand the biological and chemical nature, population dynamics and environmental effects of harmful algae and their bioactive products
2. Prevent ill consequences caused by HABs, through providing scientific knowledge useful for establishment of reliable cost- and load-effective management systems including monitoring and research

At WESTPAC 8th Session held in Bali, Indonesia in May 2010, WESTPAC-HAB proposed its main activity as the development of human capacity to study on HAB and to manage HAB problems which has multidisciplinary nature. The Session supported the continuation of HAB project. The advisory Group of the WESTPAC asked the HAB Project to work as the regional component of Global Program and also develop region specific activities. Project leader was asked to coordinate both activities from global program (GEOHAB Asia research, information dissemination etc.) and from regional HAB project (training course, workshop etc.) for the benefit of scientists in the region. Cooperation with other international organization implementing various HAB related activities in the region such as PICES HAB Session and NOWPAP HAB working group was also strongly recommended.

An international training course was held at the University of Malaysia Sarawak in Kuching, Malaysia on 20-23 March 2011 on taxonomy of toxic diatom *Pseudo-nitzschia*. Dr. Lim Po Teen and Y. Fukuyo organized the course using financial support from the University of Tokyo, Japan and University of Malaysia Sarawak. Eight trainees from abroad (China, Indonesia, Philippines, Thailand, Vietnam) and more than 10 local trainees were attended for lectures and laboratory practice guided by four lecturers, Dr. Nina Lundholm of Denmark, Dr. Dao Viet Ha of Vietnam, Lim and Fukuyo.

A strategic workshop of WESTPAC HAB was held in Busan, Korea on 29-30 March 2011 during the 8th WESTPAC Scientific Symposium. More than 50 participants attended the workshop to discuss on future possible structure and activities of HAB, considering the situation that HAB events in WESTPAC regions become changing in terms of variety of problems (ASP and ciguatera in addition to PSP and DSP), expansion of affected area (Cochlodinium to southeast Asia) maybe by the environmental change (eutrophication, tsunami etc.). So important issue is whether we will keep current one WESTPAC-HAB or establish multiple HAB related projects. Several participants presented important topics potentially to be established as new projects as follows:

1. Cyst Mapping by Ms. Elsa Furio (Philippines)
A brief review of the concluded regional project on cyst mapping (WESTPAC-TTR project Cyst Mapping) was presented and a proposal for mitigating blooms of cyst forming HABs was presented
2. Green Noctiluca vs. Eutrophication by Dr. Ken Furuya (Japan)
Expansion of blooming areas of Green Noctiluca with green symbionts has been observed with association of eutrophication in Asia. Construction of a regional/ global database was proposed.
3. *Pseudo-nitzschia* by Dr. Lim Po Teen (Malaysia)
Networking is proposed, because most data to date comes from temperate countries. Region-wide database with accurate identification of species is urgently necessary to mitigate potential harm from toxic *Pseudo-nitzschia* bloomings in the region. Establishment of mechanisms to assist species identification is important. For this purpose, Training course on taxonomy was recently held at University of Malaysia Sarawak.
4. *Cochlodinium* by Dr. Kazumi Matsuoka (Japan)
Blooms by *Cochlodinium* blooms in Asia occurred mostly in Japan and Korea before, but recently they expands to Southeast Asian countries. Critical species identification using genetic, morphological and ecophysiological characters were presented on studies made in several countries.
5. Benthic Dinoflagellates by Dr. Takuo Omura and Fukuyo (Japan)
Ciguatera fish poisoning occurred several times in main land Japan and causative benthic dinoflagellates were found in wide area. Some strains from the main land show tolerance to lower temperature than those collected from tropical areas. Regional project on taxonomy and ecophysiological study of toxic benthic organisms was proposed
6. 3D numerical model on HAB occurrence by Dr. Buui Hong Long & Tran Van Chung (Vietnam)
Physical characters of South China Sea were analyzed and 3D numerical model was proposed to use for prediction of HAB occurrence.

In addition to them, Fukuyo explained the procedure for establishment of a new project in WESTPAC. It include steps to communicate national IOC focal points to get endorsement,

to propose to WESTPAC Secretariat, to be reviewed by WESTPAC advisory group, and to be adopted at WESTPAC Session.

Dr Gires Usup (Malaysia) explained GEOHAB Asia Scientific Plan which was a result of two earlier conference. He gave explanation of mission and specific objectives of GEOHAB. He mentioned that major difference between GEOHAB and WESTPC existed in big input of individual member states and GEOHAB can help with framework activities (meetings, training, access to expertise etc.). He further mentioned that the ultimate goal is modelling and prediction, and regional/National programmes can be endorsed as GEOHAB programmes.

Information on a workshop on benthic HABs in Malaysia to be held in late 2011, IAEA-driven co-organized workshop by GEOHAB Asia on sodium channel toxins will be also held in 2011, another workshop on *Phaeocystis* is planned in 2012, and a training course on taxonomy of benthic dinoflagellate to be held in Nha Trang, Vietnam were introduced.

Dr. Rhodora Azanza (Philippines) presented the Philippine Habs Program (Phil Habs) funded by the country's Department of Science and Technology (DOST) which is on the ecology and oceanography of HABs in 8 selected sites/ ecosystems nationwide. The PhilHABs program has been recently recognised as a national program of GEOHAB. She said that In the Philippines, HABs situation should be managed based on science like in the aspects of: Site selection, Monitoring of culture/ harvest, and HAB management responses. The program consist of thematic projects including the 1. Biodiversity/genetic diversity, 2. Proj 2 HAB microbial Community 3. eutrophication and algal blooms 4. Sediment/ cyst studies 5. Toxicology 6. Nutrient in puts into the study areas 7. Physical oceanography and modelling and 8. Mitigation strategies.

Dr Kim Hak Gyoon (Korea), the Chairman of the HAB 2012 Conference in Changwon, explained the plan of the conference and invited all participants to attend it.

After having these presentation and extensive discussion, participants agreed to continue its present activities and initiate other new projects on HAB related issues, and seek support from all member states. Fukuyo requested all participants to create clear idea of new projects and contact IOC national focal points for establishment.

At Busan Fukuyo explained a new activity of WESTPAC-HAB using JFiT for UNESCO. The activity is creation of outreach materials such as poster, flyer and boklet for public, especially school children and fishermen. Participants agreed on its importance and expressed their concern to publish the materials in local languages. Fukuyo asked them to send photographs, figures and data useful for publication, and proposed to make draft version in this year to send some participants for review and revision.

In addition to them scientists working on HAB from five ASEAN countries and Japan had a meeting during the JSPS Scientific symposium at Haiphong, Vietnam in October 2009, and also at the Horiba International Conference held at Chiba, Japan in October 2010.

ANNEX XI

PRINCIPLES FOR CAPACITY ENHANCEMENT IN RESEARCH ON AND MANAGEMENT OF HARMFUL ALGAL EVENTS

The following principles are drafted to guide the development, coordination and implementation of a broad variety of international, regional and in-country capacity enhancing activities in relation to harmful algae and phycotoxins, and the associated impacts on sea food safety, public health, aquaculture, fisheries, tourism, drinking water, environmental impacts etc. (HA).

- I. HA capacity enhancement is focussed and addresses the prioritised needs of the governments and institutions of the trainees. [The implication of this principle is that with limited resources, capacity enhancement cannot and should not address every need].
- II. All capacity HA enhancing interventions are imbedded in the larger mandate to promote international cooperation on protection of the marine environment and preservation of human life and property in the ocean and coastal areas and work towards sustainable development.
- III. HA capacity enhancement is based on the concept of “Community-based, participatory action research” which requires that the HA trainers offer services only at the request of the host community and that the services are created as a collaboration between the HA trainers and the stakeholders. In most cases this would involve communities that require assistance in sustainable resource management or resource capacity building, rather than new research avenues for the HA trainers. Thus the program and activity of the HA trainers must be structured in such a way that the target group acquires a clear realisation that they have the sole responsibility for their own capacity-building and a high probability of a sustained program after the contribution of the HA training activities cease to be requested. This means that they will:
 - a. Identify areas for collaboration.
 - b. Seek partners through clearer enunciation of the requirements,
 - c. Review and reconstruct the terms of reference through stakeholder consultation, and
 - d. Seek funds to co-finance the capacity enhancement in a business mode – (that is, return a product that is beneficial to the public).
- IV. HA capacity enhancement interventions are structured and have enduring long-term impacts. This requires contributions that lead to sustainable, community-based management and research. The ultimate goal is to achieve independence of the community from the HA training group.
- V. HA capacity enhancement focuses on developing management, operational and research capabilities.
- VI. HA capacity enhancement is approached in a holistic, community participation manner. Depending on the type of intervention, decision-makers, directors of institutes, scientists, technicians, and the public are involved. The community has the final ownership of the outcome of the activities.

- VII.** Interventions are seen and treated as investments. Therefore, the executing agency will maintain appropriate contact with strategic partners, collaborating institutions, key decision makers, sponsors/funding organisations, thought leaders in relevant scientific disciplines, and participants.
- VIII.** HA capacity enhancement will optimise limited resources and reduce/eliminate duplication and overlap. This will include liaising closely with other agencies that also provide capacity enhancement services to improve coordination and increase efficiency.
- IX.** Different agencies are invited to share information on their list of trainees. IOC database of HAB capacity building is offered for consultation at any time to inquire about whether individuals have received previous training, where and when.

ANNEX XII

OVERVIEW OF IOC HAB TRAINING COURSES AND WORKSHOPS

IMPLEMENTED CAPACITY ENHANCEMENT ACTIVITIES 1993-2011

For overview, complete details not included. Includes course implemented by IOC, jointly with partners or by partners with IOC contributions

MODULE:	LEVEL, no. of part.:	TARGET GROUP/ Region:	WHERE:	WHEN:	NEED IDENTIFIED WHERE:	FUNDING in 1000 US \$
TAXONOMY OF HARMFUL MARINE MICROPLANKTON						
Course name: IOC-Danida Training Course on the Taxonomy of Harmful Marine Phytoplankton Organizer: Prof. O. Moestrup, University of Copenhagen	M.Sc, Ph.D 15	Global, developing countries	University of Copenhagen, Denmark	16-28 August 1993	HABP Plan, Pilot Course	Danida- IOC-TF: 42K IOC: 10K Total: 52K
Course name: IOC-Danida Training Courses on the Taxonomy and Biology of Harmful Marine Microplankton Organizer: IOC Science and Communication Centre on Harmful Algae, (Moestrup, Larsen, Fukuyo, Matzuoka, Enevoldsen)	Advan. M.Sc Ph.D 15-18	Global, developing countries	University of Copenhagen, Denmark	August 1995 1996 1997 1998 1999 2000 2001 2004	HABP Plan BMTC WS HAB Survey 1 st IOC-Danida Training Course. Survey 1999 IPHAB 2003	Danida- IOC-TF: 50 K/course until 2005

Course name: IOC- Training Course and Identification Qualification in Harmful Marine Microalgae Organizer: IOC Science and Communication Centre on Harmful Algae	Advan. M.Sc Ph.D 15-18	Global, self paying	University of Copenhagen, Denmark	E-learn May- June/ Course and examinat ion August: 2006 2007 2008 2009 2010 2011	HABP Plan IPHAB 2003. After 2005 'training on demand'	After 2005 based on cost recovery from participants
Course name: IOC-AECI-IEO Training Course: Identification of Harmful Marine Microalgae Organizer: IOC Science and Communication Centre on Harmful Algae, Vigo	M.Sc./ Ph. D 12	Global, developing countries	Centro Oceanográfico de Vigo. Instituto Español de Oceanografía, Vigo, Spain	E-learn May, Course and examinat ion June 2008 2009 2010	IPHAB	Funded by Spain IOC TF 35K/course
Course name: Advanced Phytoplankton Course Organizer: Dr. A. Zingone, Zool. Sta. A. Dorhn, Napoli, Italy	Advan. M.Sc, Ph.D. 20	Global, self paying	Zoological Station Anton Dorhn, Napoli, Italy	(6 th) 24 Sep.- 14 Oct. 1995 (7 th) 10- 30 May 1998 (8 th) 2-23 April 2005. (9 th) 5-26 April 2008		MAST, ONR, IOC

Course name: Regional Training Course: Advanced Phytoplankton Course on Harmful Marine Microalgae. Organizer: Marta Ferrario, Facultad de Ciencias Naturales y Museo, Universidad Nacional de La Plata (UNLP) and Instituto Nacional de Investigaciones Pesqueras (INIDEP), Argentina	M.Sc, Ph.D. 13	FANSA	Universidad Nacional de La Plata, Argentina	19-30 Nov 2007	FANSA	Self funded, IOC
Course name: IOC-SAREC-Danida Training Course on the Taxonomy and Biology of Harmful Marine Microplankton Organizer: IOC Science and Communication Centre on Harmful algae, Cph.(Dr. Larsen), Dr. F.R.J. Taylor. Univ. of British Columbia	Basic M.Sc. 15	IOCINCWIO	University of Mauritius	5-14 Feb. 1996	IOCINCWIO-III Implementation Plan	IOC: 30K NAI 4K TEMA 6K SAREC: 20K Danida: printed material, equipment Total: 30K
Course name: IOC-IEO-AECI Training Course on Toxic Phytoplankton Organizer: IOC Science and Communication Centre on Harmful Algae, Vigo	M.Sc./ Ph. D 12	Latin America, developing countries	Centro Oceanográfico de Vigo. Instituto Español de Oceanografía, Vigo, Spain	13-28 Feb 1996	IPHAB	IOC:16K AECI:10K IEO: 10K

Course name: IOC/WESTPAC Training Course on Species Identification of Harmful Microalgae Organizer: Dr. Yasuwo Fukuyo, Asian Natural Environmental Science Center, the University of Tokyo, Tokyo, Japan	M.Sc./Ph.D, 10	WESTPAC	Asian Natural Environmental Science Center, the University of Tokyo, Tokyo, Japan	28 February - 8 March, 1997	WESTPAC-HAB	Funded by Japan
Course name: IOC-FURG-DANIDA Training Course on the Biology and Taxonomy of Harmful Marine Microplankton Organizer: Dr. Clarisse Odebrecht, University of Rio Grande (FURG); IOC Science and Communication Centre on Harmful Algae, Copenhagen.	M.Sc, Ph.D. 20	South America	University of Rio Grande, Rio Grande, Brazil	3-14 March 1997	COI-FANSA	FURG and national Brazillian : 27 K IOC: 8K WESTPAC/HA B-Japan:4K DANIDA:10K

Course name: IOC-NorFa Training Course on the Taxonomy and Biology of Harmful Marine Microplankton Organizer: IOC Science and Communication Centre on Harmful Algae, Copenhagen	Advanced M.Sc./Ph.D. 18	Baltic Sea	Tvärminne Zoological Station, Finland	16-22 Aug. 1997	NorFa	Nordic Research Academy (NorFa):18K IOC: 2K Total: 20 K
Course name: IOC/WESTPAC Training Course on Species Identification of Harmful Microalgae Organizer: Asian Natural Environmental Science Center, the University of Tokyo	M.Sc, Ph.D. 10	WESTPAC	Asian Natural Environmental Science Center, the University of Tokyo, Tokyo, Japan	22-30 Aug. 1997	WESTPAC-HAB	Funded by Japan
Course name: IOC-APEC Training Course on the Identification and Monitoring Harmful Marine Microplankton Organizer: IOC Science and Communication Centre on Harmful Algae, Copenhagen	Basic M.Sc. 12	APEC	University of Copenhagen, Denmark	11-19 Oct. 1997	APEC	APEC: 10K IOC: 10K Self paying participants Danida: printed material, equipment

Course name: IOC-NorFa Training Course on the Taxonomy and Biology of Harmful Marine Microplankton Organizer: IOC Science and Communication Centre on Harmful Algae, Copenhagen	Advanced M.Sc./Ph.D. 18	Baltic Sea	Võrtsjärv Limnological Station, Estonia	1-9 Sept. 1998	NorFa	Nordic Research Academy (NorFa):18K IOC: 2K Total: 20 K
Course name: IOC Distant Learning Course in Harmful Algae for South East Asia.	M.Sc./Ph. D 18	SE Asia	Universities of the Philippines, Tokyo, Tasmania, and Copenhagen and the IOC Science and Communication Centre on Harmful Algae Copenhagen, Final workshop Hue University of Sciences	September-December 2003., 6-13 January 2004	IPHAB	UNESCO Cross Cutting Project: 35K
Course name: IOC Distant Learning Course in Harmful Algae for South East Asia.	M.Sc./Ph. D 18	SE Asia	Universities of the Philippines, Tokyo, Tasmania, and Copenhagen and the IOC Science and Com. Centre on Harmful Algae Copenhagen, Final workshop University of the Philippines, Manila	January-May 2003. 5-12 August 2003	IPHAB	UNESCO Cross Cutting Project: 35K

Course name: Taxonomy of Harmful Microalgae Organizer: ,Faculdade Ciências Universidade Lisboa (Portugal), Facultad de Ciencias Naturales y Museo (Argentina), Fundação Universidade Federal do Rio Grande (Brazil), Instituto de Botânica (Brazil), Instituto Nacional de Investigación y Desarrollo Pesquero (Argentina), Universidade de Taubaté (Brazil), and the IOC Science and Communication Centre on Harmful Algae, University of Copenhagen (Denmark). Co-organised with the Brazilian Phycological Society (Sociedade Brasileira de Ficologia).	M.Sc./ Ph. D 18	South America	University of Sao Paolo, Brazil.	E-learning March-May 2005, microscope course 16-27 May 2005,	UNESCO CCT	UNESCO Cross Cutting Project: 35K
Course name: IOC-ROPME Regional Training Workshop on Harmful Algae, Organizer: IOC Science and Communication Centre on Harmful Algae and INCO	M.Sc./ Ph. D 16	Gulf region	Iranian National Center for Oceanography, INCO, Tehran, Iran,	22-31 January 2006	IOCINDIO	IOC: 5 K ROPME 15K~

Course name: Biology of Marine Phytoplankton/ Taxonomy of Harmful Algae in-country Training Course Organizer: Hue University of Science, HABViet	M.Sc. 25	Vietnam,	Hue University of Science, Hue, Vietnam	9-17 March / 15-18 May 2006	HABViet Plan	HABViet / Danida 20 K
Course name: IOC Regional Course for North Africa (HANA) Organizer: Btissam Ennaffah			Casablanca, Morocco,	5-11 January 2007		
Course name: IAEA Regional Training Course on Harmful Algae Organizer: IAEA	Basic 9	Angola, Namibia, South Africa	Cape Town, South Africa	7- 10 May 2007	IAEA	Unknown
Course name: BCLME Regional Training Course on Harmful Algae Organizer: BCLME	Interme diate 14	Benguela region	Swakopmund, Namibia	22 January – 2 February 2007	BCLME	Unknown
Course name: HAB training course in taxonomy and identification	Interme diate	Gulf	United Arab Emirates University at Al Ain	14-18 March 2010	UAE	Unknown
Course name: . IOC-SCOR GEOHAB Training Workshop on Benthic HABs,	Advance d	Global	University of Hawaii, USA,	24-27 June 2010.	GEOHAB	25K
Course name: Baltic Sea Phytoplankton Identification Course	Advance d	Baltic Sea	Finland	14-26 Novemb er 2010,	Nordic Marine Academy.	Unknown

MODULE: TOXIN CHEMISTRY AND TOXICOLOGY	LEVEL no. of part.:	TARGET GROUP/ Region:	WHERE:	WHEN:	NEED IDENTIFIED WHERE :	FUNDING IDENTIFIED: in US \$
Course name: IOC-UNEP-WHO-FAO Training Course on Qualitative and Quantitative Determination of Algal Toxins Organizer: Prof. B. Lukas Univ.of Jena,Germany	Advan. M.Sc., Ph.D. 12	Mediterranean, global	Friedrich- Schiller University of Jena, Germany	Oct. 1994	HABP Plan BMTCS HAB Survey	UNEP: 15K IOC: OSLR 5K TEMA 8K Univ. Jena: equipment + accom. Japan: equipment Total: 45K
Course name: IOC-UNEP-WHO-FAO- Italy Training Course on Toxin Chemistry and Toxicology related to Harmful Algae Organizer: Prof. R.D. Loggia, Dr. A. Tubaro	Advan. M.Sc., Ph.D. 10	Developing countries, East Med., Black Sea	University of Trieste	3-12 Sep. 1995	HABP Plan BMTCS HAB Survey	IOC: 8.4K MAP: 1.6K FAO: 7 K Univ. of Trieste: 22K Japan: equipment Total: 39K
Course name: IOC-AECI-IEO Training Course on Analytical Methods for the Detection of Marine Toxins Organizer: IOC Science and Communication Centre on Harmful Algae Vigo (Reguera)	Basic M.Sc., Ph.D. 10	Latin America	IEO, Vigo, Spain.	25 June- 6 July 1997	IOC-FANSA	Funded by Spain IOC TF 36K/course

Course name: IOC-UNEP Training Course on Qualitative and Quantitative Determination of Algal Toxins Organizer: Prof. B. Lukas University of Jena, Germany	Advan. M.Sc., Ph.D. 12	Global	Friedrich- Schiller University of Jena, Germany	2-12 March 1999	HABP Plan BMTCS HAB Survey	UNEP: ?K IOC: HAB 8K Univ. Jena: equipment, Total: 40K
Course name: IOC Training Course on Phycotoxins Organizer: Dr. Kevin J. James, Director, Ecotoxicology Res. Unit, Chemistry Dept, Cork Inst of Techn., Cork, Ireland	Advan. M.Sc., Ph.D. 14	Global	Cork Institute of Technology, Cork, Ireland	1-14 Sep., 2000	IPHAB	CIT: 13,5K IOC: 12,5K requested EU and WHO subject to application
Course name: IOC Training Course on Qualitative and Quantitative Determination of Algal Toxins Organizer: Dr. Matthe Elbraechter, Senckenberg Museum, Germany	Advan. M.Sc., Ph.D. 16	Global	Wattenmeerstation Sylt, Alfred Wegener Institut für Polar- und Meeresforschung, List/Sylt, Germany	22 February to 3 March 2005	IPHAB	IOC: HAB 7K German partners: 12K Total: 19K excl airfare for all

MODULE: <i>RISK ASSESSMENT, CONTINGENCY PLANNING AND MANAGEMENT OF HARMFUL ALGAL EVENTS; DESIGN AND IMPLEMENTATION OF MONITORING PROGRAMMES</i>	LEVEL no of part.:	TARGET GROUP/ Region:	WHERE:	WHEN:	NEED IDENTIFIED WHERE :	FUNDING IDENTIFIED: in US \$
Course name: FAO/SIDA International Workshop on Safety of Shellfish From Harmful Algae and Biotoxins Organizer: IOC Science and Communication Centre on Harmful Algae, Vigo	Intermediate 20	Asia	Mangalore, India	21-25 January 2008	FAO	unknown
Course name: VI IOC-AECI-IEO Training Course on Toxic Phytoplankton and Marine Phycotoxins: Monitoring programmes on Toxic Phytoplankton and Marine Phycotoxins according to European Union Directives Organizer: IOC Science and Communication Centre on Harmful Algae, Vigo	Advanced 10	Latin America	IOC-IEO Science and communication Centre on Harmful Algae. Instituto Español de Oceanografía, Vigo, Spain.	10-26 June, 2002. 2006 2007 2009	IPHAB	25K Spain TF Spain: 8K AECI: 7K IEO: 10K

Course name: IOC-IEO-AECI Training Course on Toxic Microalgae and Marine Phycotoxins Organizer: IOC Science and Communication Centre on Harmful Algae, Vigo	M.Sc./ Ph. D 12	Global, developing countries	Centro Oceanográfico de Vigo. Instituto Español de Oceanografía, Vigo, Spain	June 1998 1999 2000 2001	IPHAB	Funded by Spain IOC TF 35K/course
Course name: IOC-APEC Symposium: Harmful Algal Mmanagement Organizer: IPHAB Task Team and APEC	Manage rs, Administ rators, Scientist s 40-60	Global	Subic Bay, Philippines	9-14 May 1999	HABP Plan, BMTc WS,	Danida funds for prep. of WS: 15K IOC: 15K APEC : remainder 30K
Course name: IOC-Japan Training Workshop on Monitoring of PSP Plankton and Shellfish Toxicity Organizer: Dr. Y. Fukuyo, Univ. of Tokyo, Dr. M. Kodama, Kitasato Univ	Basic, M.Sc., Ph.D. 15	WESTPAC	Kitasato University	17-21 July 1995	HABP Plan BMTc WS HAB Survey WESTPAC WS	IOC: 11K Japan: 30K Kitasato Univ: 5K Total 46K

MODULE: <i>THEME WORKSHOPS, AND REGIONAL INTERDISCIPLINARY WORKSHOPS</i>	LEVEL no. of part.:	TARGET GROUP/ Region:	WHERE:	WHEN :	NEED IDENTIFIED WHERE :	FUNDING IDENTIFIED: in US \$
Course name: WESTPAC - LIPI - P30 Seminar on HAB Organizer: Mr. D.J. Praseno, P30 LIPI	Basic, Admin.a nd Scientist s 30	WESTPAC	Research and Development Centre for Oceanology, LIPI, Indonesia.	8 Nov. 1993	WESTPAC-II	Japan: 5K Indonesia: 3K Total: 8K
Course name: WESTPAC - China Workshop on HAB Organizer: Dr. Qi Yuzao, Jinan University	Basic M.Sc. 10	WESTPAC	Guangzhou, China	21-26 Nov. 1993	WESTPAC-II	Japan: 5K China: 3K Total: 8K
Course name: WESTPAC - PAMS - Thailand Workshop on HAB Organizer: Dr. R.A. Corrales, Univ. of the Philippines, Dr. A. Marasigan, Univ. of the Phil. in the Visayas.	Basi, admin., tech., scientist s 20	WESTPAC	Iloilo, Philippines	May 1994	WESTPAC-II	Japan: 3K Indonesia: 1K CIDA: ?K

Workshop name: IOC Regional Science Planning Workshop on Harmful Algal Blooms Organizer: Dr. Silvia Mendez, INAPE, Uruguay	M.Sc., Ph.D. 22	Scientists South America	INAPE, Montevideo, Uruguay	May 1994	IPHAB-II	IOC: MTD 4K Total: 4K
Workshop name: Second IOC Regional Science Planning Workshop on Harmful Algal Blooms Organizer: Dr. Jose I. Carreto, INIDEP, Argentina	M.Sc., Ph.D.	Scientists South America	INIDEP, Mar del Plata, Argentina	Oct. 1995	1 st Workshop	IOC: 10K
Workshop name: Third IOC Regional Science Planning Workshop on Harmful Algal Blooms (COI-FANSA-III) Organizer: Leonardo Guzman	M.Sc., Ph.D.	Scientists South America	Instituto Fomen Pesquero, Puente Arenas, Chile	28-30 July 1997	2 nd workshop	IOC
Course name: International Seminar on Red Tides, risks for human health and development Organizer: Raul Koch	M.Sc., Ph.D.	Scientists South America	Puerto Varas, Xa Region, Chile	3-5 August 1999	IOC FANSA	Health Ministry, Regional Government, IOC

Course name: Regional S-American Course on HAB, methodologies for marine biotoxins Organizer: Karim Keisser	M.Sc., Ph.D.	Scientists South America	Public Health Institute, Santiago, Chile	8-12 November 1999	III IOC FANSA	FURG IOC Ministry of Science and Technology
Course name: IV Regional Working Meeting on Harmful Algae Blooms in S-America (COI/FANSA) Organizer: Virginia Garcia	M.Sc., Ph.D.	Scientists South America	FURG, Rio Grande University, Brazil	Jan. 2000	III IOC FANSA	IOC 10 K + local sponsorship
Course name: WESTPAC-LIPI-P30 Red Tide training Course Canada Training Workshop on Harmful Algae Organizer: Mr. D.P. Praseno, P30 LIPI, Dr. Yasuwo Fukuyo, Univ. Tokyo	Basic, M.Sc. 10	WESTPAC ASEAN	LIPI, Ambon, Indonesia	13-18 Nov. 1995	WESTPAC-II	IOC: Japan: 5K Indonesia 3K
Course name: IOC/WESTPAC In-Country Training Courses: IOC/WESTPAC-Philippines : Dinoflagellate Identification	Basic M.Sc. 9	WESTPAC -	BEFAR, Manila, Philippines	6-19 Dec. 1995	WESTAPC-II	Japan 3K BEFAR 10K

IOC/WESTPAC-Vietnam: Phytoplankton Monitoring and Identification in Eastern Indonesia	8	-	Inst of Ocean., Haiphong Vietnam	12-15 Nov. 1996	WESTPAC-III	Japan 15K Vietnam 3K
IOC/WESTPAC-Indonesia: Phytoplankton Monitoring and Identification in Eastern Indonesia	15	-	Res.andDevelop. Centre for Oceanology,Jakarta, Indonesia	18-22 Nov. 1996	WESTPAC-III	Japan 15K Indonesia 3K
IOC/WESTPAC-Malaysia: Identification of PSP Plankton	15	-	Univ.of Malaysia Saba, Kota Kinabalu, Malaysia	9-11 Decem ber, 1996	WESTPAC-III	Japan 15K Malaysia 5K
Organizer: Asian Natural Environmental Science Center, the University of Tokyo, Tokyo, Japan,						
Course name: IOC/WESTPAC In-Country Training Courses:	Basic M.Sc.	WESTPAC				
IOC/WESTPAC-UPV: Red Tide Seminar Workshop	20	-	Univ.Phil.in the Visayas, Philippines	17 May 1996	WESTAPC-II	Japan 5K Phil. 10K
IOC/WESTPAC-PSU: Seminar on HAB	20	-	P.of Songkla Univ., Hat-Yai, Thailand	12-16 Dec. 1997	WESTPAC-III	Japan 25K Thailand 5K
IOC/WESTPAC-UPV: Red Tide Seminar Workshop	20	-	Univ.of the Phil.in Cebu	17-21 Nov. 1998	WESTPAC-III	Japan 35K Philippines 5K
IOC/WESTPAC-Chinese Taipei: Red Tide Seminar Workshop	13	-	National Taiwan University, Taipei	3-7 April 1999	WESTPAC-III	Japan 5K C. Taipiei 50K
IOC/WESTPAC-Hong						

Kong: Red Tide Seminar and Training Course Organizer: Asian Natural Environmental Science Center, the University of Tokyo, Tokyo, Japan.	20	-	Agriculture and Fisheries dept, Hong Kong	6-10 Dec, 1999	request	Japan 5K Hong Kong 50K
IOC/WESTPAC Training Course on PSP Toxin Monitoring Organizer: Dr. Y. Fukuyo, Asian Natural Environmental Science Center, University of Tokyo, and Dr. M. Kodama, School of Fisheries Sciences, Kitasato University	M.Sc/ Ph.D.	9	School of Fisheries Sciences, Kitasato University, Iwate, Japan	24-30 August 1998,	WESTPAC-HAB	Japan 16K
5th IOC/WESTPAC/HAB Training Course on Ecology and Physiology of Harmful Algae Organizer: Asian Natural Environmental Science Center, the University of Tokyo, Tokyo, Japan.	M.Sc/ Ph.D.	9	Chulalongkorn University and Burapha University, Thailand	19 – 24 March 2001	WESTPAC/HAB	Japan FiT
The 6th IOC/WESTPAC Training Course on Advanced Techniques on Characterization of Harmful Algal Species Organizer:	M.Sc/ Ph.D.	9	Manila, Philippines	May 13-18 2002	WESTPAC/HAB	Japan FiT

Asian Natural Environmental Science Center, the University of Tokyo, Tokyo, Japan. The 7th IOC/WESTPAC Training Course on Species Identification of Harmful Microalgae, Organizer: Asian Natural Environmental Science Center, the University of Tokyo, Tokyo, Japan.	M.Sc/ Ph.D.	9	Sabah, Malaysia	March 17-22, 2003,.	WESTPAC/HAB	Japan FiT, 16K
Course name: IOC Training course on HAB for the Caribbean Countries Organizer: Arturo Sierra	Basic M.Sc., 10	Caribbean	Mexico. CIBNOR (Centro de Inv. Biologicas del Noroeste)	2001	IOC Rep.of Gov. and Major Subsidiary Bodies No. 67, Dec. 1995	IOC 10K
Course name: OCEA Workshop on Harmful Algal Blooms Organizer: IOC Science and Communication Centre on HAB, Copenhagen	M.Sc/ Ph.D	10	University of Accra, Ghana	29 October 2 November 2001	IPHAB	Danida 10K IOC budget 20K
Course name: IOC-NAUTA-COPEMED Course on Identification of Harmful Algal Blooms, INSTM, Tunisia, Organizers: Monica Lion, Jacob Larsen, Souad Turki (INSTM)	M.Sc/ Ph.D	11	INSTM, Tunisia	1-10 December 2003	IPHAB	IOC HAB: 1,7K AECI-Nauta: 13,5K IEO: 10,5K Danida TF: 8K FAO-COPEMED:1,5

						K Total: 35,2K
Course name: IAEA-IOC Regional Training Course on Taxonomy and Monitoring of Toxic Marine Microalgae.	Basic M.Sc.,	Caribbean	Mazatlan, Mexico,	26 October – 6 November 2009	IAEA	

MODULE: <i>INDIVIDUAL TRAINING</i>	LEVEL no. of part.:	TARGET GROUP/ Region:	WHERE:	WHEN :	NEED IDENTIFIED WHERE :	FUNDING IDENTIFIED: in US \$
IOC-IEO Science and Communication Centre on Harmful Algae. Individual training visits under the supervision of one expert from a Galician Institution.	2002: 2 2003: 1 2004: 5 2005: 10 2006: Advanced	Latin America and North Africa	Instituto Español de Oceanografía, Vigo (Spain)	2002-2006	IPHAB	Spanish TF 2002: AECI: 2,5 K, IGACI: 2,5 K, IEO: 2 K 2003: AECI: 2,5 K, IEO: 1 K 2004: AECI: 12,5, IEO: 5 K 2005: AECI: 26,5 K
IOC Science and Communication Centre on Harmful Algae. Individual training visits/PhD under the supervision of expert from University of Copenhagen	6 Advanced	Developing countries	University of Copenhagen, Denmark	2001-	IPHAB	Danish TF ~6K/year IAEA 2010 5k

ANNEX XIII

GEOHAB: TERMS OF REFERENCE MEMBERSHIP OF THE GEOHAB SCIENTIFIC STEERING COMMITTEE

The Scientific Steering Committee of the GEOHAB Programme will

1. Coordinate and manage GEOHAB Core Research Projects (CRPs) in accordance with the GEOHAB Science and Implementation Plans.
2. Identify gaps in knowledge required to execute CRPs, and encourage targeted research activities to fill those gaps.
3. Review progress on CRPs over time and initiate new CRPs in priority research areas.
4. Foster framework activities to facilitate implementation of GEOHAB, including dissemination and information tools.
5. Establish appropriate data management activities to ensure access to, sharing of, and preservation of GEOHAB data, taking into account the data policies of the sponsors.
6. Promote comparative and interdisciplinary research on harmful algal blooms by providing coordination and communication services to national and regional research groups, encouraging explicit affiliation with GEOHAB via the endorsement process.
7. Collaborate, as appropriate, with intergovernmental organizations and their subgroups (e.g., ICES, PICES, FANSA, ANCA, WESTPAC/HAB, HANA, NOWPAP), as well as related research projects (e.g., GLOBEC, LOICZ, IMBER) and observational systems such as the Global Ocean Observing System and its regional alliances.
8. Report regularly to SCOR, the IOC Intergovernmental Panel on Harmful Algal Blooms (IPHAB), and the global HAB research community on the state of planning and accomplishments of GEOHAB, through annual reports and, as appropriate, the GEOHAB Web site, a GEOHAB Newsletter, *Harmful Algal News*, special sessions at scientific meetings, and other venues.
9. Interact with agency sponsors to stimulate the support of GEOHAB implementation through various mechanisms (e.g., direct support of GEOHAB initiatives and integration of the GEOHAB approach in national programs).

Acronyms

ANCA = IOC HAB working group for Central America and Caribbean Sea

FANSA = IOC HAB working group for South America

HANA = IOC HAB working group for North Africa

GLOBEC = Global Ocean Ecosystem Dynamics project

ICES = International Council for the Exploration of the Seas

IMBER = Integrated Marine Biogeochemistry and Ecosystem Research project

IOC = Intergovernmental Oceanographic Commission

LOICZ = Land-Ocean Interactions in the Coastal Zone project

NOWPAP = UNEP Northwest Pacific Action Plan

PICES = North Pacific Marine Sciences Organization

SCOR = Scientific Committee on Oceanic Research

WESTPAC/HAB = IOC Sub-Commission for the Western Pacific HAB working group

The SSC is chaired by:

Raphael Kudela (USA)

Vice-chair:

Elisa Berdalet (Spain)

Scientific Steering Committee Members:

Icarus Allan (UK)
Stewart Bernard (South Africa)
Liam Fernand (UK)
Songhui Lu (China)
Robert E. Magnien (USA) Ex officio member from IOC IPHAB
Susanne Roy (Canada)
Patricia Tester (USA)
Gires Usup (Malaysia)

Core Research Project Committee Members:

Allan Cembella (Germany)
Patricia Glibert (USA)
Wolfgang Fennel (Germany)
Patrick Gentien (France)
Grant Pitcher (South Africa)
Robin Raine, The Martin Ryan Institute, National University of Ireland
Ming-Jiang Zhou (China-Beijing)

Modelling Committee:

Dennis McGillicuddy (USA)
Wolfgang Fennel (Germany)
Marcel Babin (France)
Marine Lévy (France)

ANNEX XIV

GLOSSARY OF ACRONYMS AND SPECIAL TERMS

ANCA	Working Group on Harmful A lgae in the C aribbean and A djacent R egions
APC	A dvanced P hytoplankton C ourses
BEQUALM	B iological E ffects Q uality A ssurance in M onitoring P rogrammes
CFP	C iguatera F ish P oisoning
CIEMM	The Mediterranean Science Commission
DANIDA	D anish I nternational D evelopment A gency
DSP	D iarrhetic S hellfish P oisoning
EFSA	E uropean F ood S afety A uthority
FANSA	W orking G roup on H armful A lgal B looms in S outh A merica
FAO	F ood and A griculture O rganization of the U nited N ations
GEOHAB	G lobal E cology and O ceanography of H armful A lgal B looms
GOOS	G lobal O cean O bserving S ystem
GPNM	G lobal P artnership on N utrient M anagement
GRA	GOOS R egional A lliances
HAEDAT	H armful A lgal E vent D ata B ase
HAIS	H armful A lgal I nformation S ystem
HANA	IOC Regional Group on H armful A lgae in N orth A frica
IAEA	I nternational A tomc E nergy A gency
ICAM	I ntegrated C oastal A rea M anagement Programme
ICES	I nternational C ouncil for the E xploration of the S ea
IMO	I nternational M aritime O rganization
IOC	I ntergovernmental O ceanographic C ommission [UNESCO]
IOCARIBE	IOC Sub- C ommission for the C aribbean and A djacent R egions
IPHAB	I ntergovernmental P anel on H armful A lgal B looms
ISSHA	I nternational S ociety for the S tudy of H armful A lgae
LOICZ	L and- O cean I nteraction in the C oastal Z one
NEWS2USE	N utrient E xport from W atersheds 2 , U ser S cenario E valuation
PICES	N orth P acific M arine S cience O rganization
PICO	P anel for I ntegrated C oastal O bservations
PSP	P aralytic S hellfish P oisoning
SCOR	S cientific C ommittee on O ceanic R esearch
UNCED	U nited N ation C onference on E nvironment and D evelopment
UNEP/GPA	U nited N ations E nvironment P rogramme/ G eneral P lan of A ction
UNESCO	U nited N ations E ducational, S cientific and C ultural O rganization

WESTPAC	IOC Sub-Commission for the Western Pacific
WGBOSV	Working Group on Ballast and other Ship Vectors
WGHABD	Working Group on Harmful Algal Bloom Dynamics
WHO	World Health Organization
WoRMS	World Register of Marine Organisms

In this Series	Languages
Reports of Governing and Major Subsidiary Bodies , which was initiated at the beginning of 1984, the reports of the following meetings have already been issued:	
1. Eleventh Session of the Working Committee on international Oceanographic Data Exchange	E, F, S, R
2. Seventeenth Session of the Executive Council	E, F, S, R, Ar
3. Fourth Session of the Working Committee for Training, Education and Mutual Assistance	E, F, S, R
4. Fifth Session of the Working Committee for the Global Investigation of Pollution in the Marine Environment	E, F, S, R
5. First Session of the IOC Sub-Commission for the Caribbean and Adjacent Regions	E, F, S
6. Third Session of the <i>ad hoc</i> Task team to Study the Implications, for the Commission, of the UN Convention on the Law of the Sea and the New Ocean Regime	E, F, S, R
7. First Session of the Programme Group on Ocean Processes and Climate	E, F, S, R
8. Eighteenth Session of the Executive Council	E, F, S, R, Ar
9. Thirteenth Session of the Assembly	E, F, S, R, Ar
10. Tenth Session of the International Co-ordination Group for the Tsunami Warning System in the Pacific	
11. Nineteenth Session of the Executive Council, Paris, 1986	E, F, S, R, Ar
12. Sixth Session of the IOC Scientific Committee for the Global Investigation of Pollution in the Marine Environment	E, F, S
13. Twelfth Session of the IOC Working Committee on International Oceanographic Data Exchange	E, F, S, R
14. Second Session of the IOC Sub-Commission for the Caribbean and Adjacent Regions, Havana, 1986	E, F, S
15. First Session of the IOC Regional Committee for the Central Eastern Atlantic, Praia, 1987	E, F, S
16. Second Session of the IOC Programme Group on Ocean Processes and Climate	E, F, S
17. Twentieth Session of the Executive Council, Paris, 1987	E, F, S, R, Ar
18. Fourteenth Session of the Assembly, Paris, 1987	E, F, S, R, Ar
19. Fifth Session of the IOC Regional Committee for the Southern Ocean	E, F, S, R
20. Eleventh Session of the International Co-ordination Group for the Tsunami Warning System in the Pacific, Beijing, 1987	E, F, S, R
21. Second Session of the IOC Regional Committee for the Co-operative Investigation in the North and Central Western Indian Ocean, Arusha, 1987	E, F
22. Fourth Session of the IOC Regional Committee for the Western Pacific, Bangkok, 1987	E only
23. Twenty-first Session of the Executive Council, Paris, 1988	E, F, S, R
24. Twenty-second Session of the Executive Council, Paris, 1989	E, F, S, R
25. Fifteenth Session of the Assembly, Paris, 1989	E, F, S, R
26. Third Session of the IOC Committee on Ocean Processes and Climate, Paris, 1989	E, F, S, R
27. Twelfth Session of the International Co-ordination Group for the Tsunami Warning System in the Pacific, Novosibirski, 1989	E, F, S, R
28. Third Session of the Sub-Commission for the Caribbean and Adjacent Regions, Caracas, 1989	E, S
29. First Session of the IOC Sub-Commission for the Western Pacific, Hangzhou, 1990	E only
30. Fifth Session of the IOC Regional Committee for the Western Pacific, Hangzhou, 1990	E only
31. Twenty-third Session of the Executive Council, Paris, 1990	E, F, S, R
32. Thirteenth Session of the IOC Committee on International Oceanographic Data and Information Exchange, New York, 1990	E only
33. Seventh Session of the IOC Committee for the Global Investigation of Pollution in the Marine Environment, Paris, 1991	E, F, S, R
34. Fifth Session of the IOC Committee for Training, Education and Mutual Assistance in Marine Sciences, Paris, 1991	E, F, S, R
35. Fourth Session of the IOC Committee on Ocean Processes and Climate, Paris, 1991	E, F, S, R
36. Twenty-fourth Session of the Executive Council, Paris, 1991	E, F, S, R
37. Sixteenth Session of the Assembly, Paris, 1991	E, F, S, R, Ar
38. Thirteenth Session of the International Co-ordination Group for the Tsunami Warning System in the Pacific, Baja California, 1991	E, F, S, R
39. Second Session of the IOC-WMO Intergovernmental WOCE Panel, Paris, 1992	E only
40. Twenty-fifth Session of the Executive Council, Paris, 1992	E, F, S, R
41. Fifth Session of the IOC Committee on Ocean Processes and Climate, Paris, 1992	E, F, S, R
42. Second Session of the IOC Regional Committee for the Central Eastern Atlantic, Lagos, 1990	E, F
43. First Session of the Joint IOC-UNEP Intergovernmental Panel for the Global Investigation of Pollution in the Marine Environment, Paris, 1992	E, F, S, R
44. First Session of the IOC-FAO Intergovernmental Panel on Harmful Algal Blooms, Paris, 1992	E, F, S
45. Fourteenth Session of the IOC Committee on International Oceanographic Data and Information Exchange, Paris, 1992	E, F, S, R
46. Third Session of the IOC Regional Committee for the Co-operative Investigation in the North and Central Western Indian Ocean, Vascoas, 1992	E, F
47. Second Session of the IOC Sub-Commission for the Western Pacific, Bangkok, 1993	E only
48. Fourth Session of the IOC Sub-Commission for the Caribbean and Adjacent Regions, Veracruz, 1992	E, S
49. Third Session of the IOC Regional Committee for the Central Eastern Atlantic, Dakar, 1993	E, F
50. First Session of the IOC Committee for the Global Ocean Observing System, Paris, 1993	E, F, S, R
51. Twenty-sixth Session of the Executive Council, Paris, 1993	E, F, S, R
52. Seventeenth Session of the Assembly, Paris, 1993	E, F, S, R
53. Fourteenth Session of the International Co-ordination Group for the Tsunami Warning System in the Pacific, Tokyo, 1993	E, F, S, R
54. Second Session of the IOC-FAO Intergovernmental Panel on Harmful Algal Blooms, Paris, 1993	E, F, S
55. Twenty-seventh Session of the Executive Council, Paris, 1994	E, F, S, R
56. First Planning Session of the IOC-WMO-UNEP Committee for the Global Ocean Observing System, Melbourne, 1994	E, F, S, R
57. Eighth Session of the IOC-UNEP-IMO Committee for the Global Investigation of Pollution in the Marine Environment, San José, Costa Rica, 1994	E, F, S
58. Twenty-eighth Session of the Executive Council, Paris, 1995	E, F, S, R
59. Eighteenth Session of the Assembly, Paris, 1995	E, F, S, R
60. Second Session of the IOC-WMO-UNEP Committee for the Global Ocean Observing System, Paris, 1995	E, F, S, R

61.	Third Session of the IOC-WMO Intergovernmental WOCE Panel, Paris, 1995	E only
62.	Fifteenth Session of the International Co-ordination Group for the Tsunami Warning System in the Pacific, Papete, 1995	E, F, S, R
63.	Third Session of the IOC-FAO Intergovernmental Panel on Harmful Algal Blooms, Paris, 1995	E, F, S
64.	Fifteenth Session of the IOC Committee on International Oceanographic Data and Information Exchange	E, F, S, R
65.	Second Planning Session of the IOC-WMO-UNEP Committee for the Global Ocean Observing System, Paris, 1995	E only
66.	Third Session of the IOC Sub-Commission for the Western Pacific, Tokyo, 1996	E only
67.	Fifth Session of the IOC Sub-Commission for the Caribbean and Adjacent Regions, Christ Church, 1995	E, S
68.	Intergovernmental Meeting on the IOC Black Sea Regional Programme in Marine Sciences and Services	E, R
69.	Fourth Session of the IOC Regional Committee for the Central Eastern Atlantic, Las Palmas, 1995	E, F, S
70.	Twenty-ninth Session of the Executive Council, Paris, 1996	E, F, S, R
71.	Sixth Session for the IOC Regional Committee for the Southern Ocean and the First Southern Ocean Forum, Bremerhaven, 1996	E, F, S,
72.	IOC Black Sea Regional Committee, First Session, Varna, 1996	E, R
73.	IOC Regional Committee for the Co-operative Investigation in the North and Central Western Indian Ocean, Fourth Session, Mombasa, 1997	E, F
74.	Nineteenth Session of the Assembly, Paris, 1997	E, F, S, R
75.	Third Session of the IOC-WMO-UNEP Committee for the Global Ocean Observing System, Paris, 1997	E, F, S, R
76.	Thirtieth Session of the Executive Council, Paris, 1997	E, F, S, R
77.	Second Session of the IOC Regional Committee for the Central Indian Ocean, Goa, 1996	E only
78.	Sixteenth Session of the International Co-ordination Group for the Tsunami Warning System in the Pacific, Lima, 1997	E, F, S, R
79.	Thirty-first Session of the Executive Council, Paris, 1998	E, F, S, R
80.	Thirty-second Session of the Executive Council, Paris, 1999	E, F, S, R
81.	Second Session of the IOC Black Sea Regional Committee, Istanbul, 1999	E only
82.	Twentieth Session of the Assembly, Paris, 1999	E, F, S, R
83.	Fourth Session of the IOC-WMO-UNEP Committee for the Global Ocean Observing System, Paris, 1999	E, F, S, R
84.	Seventeenth Session of the International Coordination Group for the Tsunami Warning System in the Pacific, Seoul, 1999	E, F, S, R
85.	Fourth Session of the IOC Sub-Commission for the Western Pacific, Seoul, 1999	E only
86.	Thirty-third Session of the Executive Council, Paris, 2000	E, F, S, R
87.	Thirty-fourth Session of the Executive Council, Paris, 2001	E, F, S, R
88.	Extraordinary Session of the Executive Council, Paris, 2001	E, F, S, R
89.	Sixth Session of the IOC Sub-Commission for the Caribbean and Adjacent Regions, San José, 1999	E only
90.	Twenty-first Session of the Assembly, Paris, 2001	E, F, S, R
91.	Thirty-fifth Session of the Executive Council, Paris, 2002	E, F, S, R
92.	Sixteenth Session of the IOC Committee on International Oceanographic Data and Information Exchange, Lisbon, 2000	E, F, S, R
93.	Eighteenth Session of the International Coordination Group for the Tsunami Warning System in the Pacific, Cartagena, 2001	E, F, S, R
94.	Fifth Session of the IOC-WMO-UNEP Committee for the Global Ocean Observing System, Paris, 2001	E, F, S, R
95.	Seventh Session of the IOC Sub-commission for the Caribbean and Adjacent Regions (IOCARIBE), Mexico, 2002	E, S
96.	Fifth Session of the IOC Sub-Commission for the Western Pacific, Australia, 2002	E only
97.	Thirty-sixth Session of the Executive Council, Paris, 2003	E, F, S, R
98.	Twenty-second Session of the Assembly, Paris, 2003	E, F, S, R
99.	Fifth Session of the IOC Regional Committee for the Co-operative Investigation in the North and Central Western Indian Ocean, Kenya, 2002 (* Executive Summary available separately in E, F, S & R)	E*
100.	Sixth Session of the IOC Intergovernmental Panel on Harmful Algal Blooms, St. Petersburg (USA), 2002 (* Executive Summary available separately in E, F, S & R)	E*
101.	Seventeenth Session of the IOC Committee on International Oceanographic Data and Information Exchange, Paris, 2003 (* Executive Summary available separately in E, F, S & R)	E*
102.	Sixth Session of the IOC-WMO-UNEP Committee for the Global Ocean Observing System, Paris, 2003 (* Executive Summary available separately in E, F, S & R)	E*
103.	Nineteenth Session of the International Coordination Group for the Tsunami Warning System in the Pacific, Wellington, New Zealand, 2003 (* Executive Summary available separately in E, F, S & R)	E*
104.	Third Session of the IOC Regional Committee for the Central Indian Ocean, Tehran, Islamic Republic of Iran, 21-23 February 2000	E only
105.	Thirty-seventh Session of the Executive Council, Paris, 2004	E, F, S, R
106.	Seventh Session of the IOC-WMO-UNEP Committee for the Global Ocean Observing System, Paris, 2005 (* Executive Summary available separately in E, F, S & R); and Extraordinary Session, Paris, 20 June 2005	E*
107.	First Session of the Intergovernmental Coordination Group for the Indian Ocean Tsunami Warning and Mitigation System (ICG/IOTWS), Perth, Australia, 3-5 August 2005	E only
108.	Twentieth Session of the Intergovernmental Coordination Group for the Tsunami Warning System in the Pacific, Viña del Mar, Chile, 3-7 October 2005 (* Executive Summary available separately in E, F, S & R)	E*
109.	Twenty-Third Session of the Assembly, Paris, 21-30 June 2005	E, F, S, R
110.	First Session of the Intergovernmental Coordination Group for the Tsunami Early Warning and Mitigation System in the North Eastern Atlantic, the Mediterranean and Connected Seas (ICG/NEAMTWS), Rome, Italy, 21-22 November 2005	E only
111.	Eighth Session of the IOC Sub-commission for the Caribbean and Adjacent Regions (IOCARIBE), Recife, Brazil, 14-17 April 2004 (* Executive Summary available separately in E, F, S & R)	E*
112.	First Session of the Intergovernmental Coordination Group for the Tsunami and other Coastal Hazards Warning System for the Caribbean Sea and Adjacent Regions (ICG/CARIBE-EWS), Bridgetown, Barbados, 10-12 January 2006	E only
113.	Ninth Session of the IOC Sub-Commission for the Caribbean and Adjacent Regions (IOCARIBE), Cartagena de Indias, Colombia, 19-22 April 2006 (* Executive Summary available separately in E, F, S & R)	E S*

114.	Second Session of the Intergovernmental Coordination Group for the Indian Ocean Tsunami Warning and Mitigation System (ICG/IOTWS), Hyderabad, India, 14–16 December 2005	E only
115.	Second Session of the WMO-IOC Joint Technical Commission for Oceanography and Marine Meteorology, Halifax, Canada, 19–27 September 2005 (Abridged final report with resolutions and recommendations)	E, F, R, S
116.	Sixth Session of the IOC Regional Committee for the Western Indian Ocean (IOCWIO), Maputo, Mozambique, 2–4 November 2005 (* Executive Summary available separately in E, F, S & R)	E*
117.	Fourth Session of the IOC Regional Committee for the Central Indian Ocean, Colombo, Sri Lanka 8–10 December 2005 (* Executive Summary available separately in E, F, S & R)	E*
118.	Thirty-eighth Session of the Executive Council, Paris, 20 June 2005 (Electronic copy only)	E, F, R, S
119.	Thirty-ninth Session of the Executive Council, Paris, 21–28 June 2006	E, F, R, S
120.	Third Session of the Intergovernmental Coordination Group for the Indian Ocean Tsunami Warning and Mitigation System (ICG/IOTWS), Bali, Indonesia, 31 July–2 August 2006 (*Executive Summary available separately in E,F,S & R)	E*
121.	Second Session of the Intergovernmental Coordination Group for the Tsunami Early Warning and Mitigation System in the North Eastern Atlantic, the Mediterranean and Connected Seas (ICG/NEAMTWS), Nice, France, 22–24 May 2006	E only
122.	Seventh Session of the IOC Intergovernmental Panel on Harmful Algal Blooms, Paris, France, 16–18 March 2005 (* Executive Summary available separately in E, F, S & R)	E*
123.	Fourth Session of the Intergovernmental Coordination Group for the Indian Ocean Tsunami Warning and Mitigation System (ICG/IOTWS-IV), Mombasa, Kenya, 30 February-2 March 2007 (* Executive Summary available separately in E, F, S & R)	E*
124.	Nineteenth Session of the IOC Committee on International Oceanographic Data and Information Exchange, Trieste, Italy, 12–16 March 2007 (* Executive Summary available separately in E, F, S & R)	E*
125.	Third Session of the Intergovernmental Coordination Group for the Tsunami Early Warning and Mitigation System in the North Eastern Atlantic, the Mediterranean and Connected Seas, Bonn, Germany, 7–9 February 2007 (* Executive Summary available separately in E, F, S & R)	E*
126.	Second Session of the Intergovernmental Coordination Group for the Tsunami and other Coastal Hazards Warning System for the Caribbean Sea and Adjacent Regions, Cumaná, Venezuela, 15–19 January 2007 (* Executive Summary available separately in E, F, S & R)	E*
127.	Twenty-first Session of the Intergovernmental Coordination Group for the Pacific Tsunami Warning and Mitigation System, Melbourne, Australia, 3–5 May 2006 (* Executive Summary available separately in E, F, S & R)	E*
128.	Twenty-fourth Session of the Assembly, Paris, 19–28 June 2007	E, F, S, R
129.	Fourth Session of the Intergovernmental Coordination Group for the Tsunami Early Warning and Mitigation System in the North Eastern Atlantic, the Mediterranean and Connected Seas, Lisbon, Portugal, 21–23 November 2007 (* Executive Summary available separately in E, F, S & R)	E*
130.	Twenty-second Session of the Intergovernmental Coordination Group for the Pacific Tsunami Warning and Mitigation System, Guayaquil, Ecuador, 17–21 September 2007 (* Executive Summary available in E, F, S & R included)	E*
131.	Forty-first Session of the Executive Council, Paris, 24 June–1 July 2008	E, F, R, S
132.	Third Session of the Intergovernmental Coordination Group for the Tsunami and other Coastal Hazards Warning System for the Caribbean Sea and Adjacent Regions, Panama City, Panama, 12–14 March 2008 (* Executive Summary available separately in E, F, S & R)	E*
133.	Eighth Session of the IOC Intergovernmental Panel on Harmful Algal Blooms, Paris, France, 17–20 April 2007 (* Executive Summary available separately in E, F, S & R)	E*
134.	Twenty-third Session of the Intergovernmental Coordination Group for the Pacific Tsunami Warning and Mitigation System, Apia, Samoa, 16–18 February 2009 (*Executive Summary available separately in E, F, S & R)	E*
135.	Twentieth Session of the IOC Committee on International Oceanographic Data and Information Exchange, Beijing, China, 4–8 May 2009 (*Executive Summary available separately in E, F, S & R)	E*
136.	Tenth Session of the IOC Sub-Commission for the Caribbean and Adjacent Regions (IOCARIBE), Puerto La Cruz, Bolivarian Republic of Venezuela, 22–25 October 2008 (*Executive Summary available separately in E, F, S & R)	E, S*
137.	Seventh Session of the IOC Sub-Commission for the Western Pacific (WESTPAC-VII), Sabah, Malaysia, 26–29 May 2008 (*Executive Summary available separately in E, F, S & R)	E*
138.	Ninth Session of the IOC-WMO-UNEP Committee for the Global Ocean Observing System, Paris, France, 10–12 June 2009 (* Executive Summary available separately in E, F, S & R);	E*
139.	Fifth Session of the Intergovernmental Coordination Group for the Tsunami Early Warning and Mitigation System in the North Eastern Atlantic, the Mediterranean and Connected Seas, Athens, Greece, 3–5 November 2008 (* Executive Summary available separately in E, F, S & R)	E*
140.	Fourth Session of the Intergovernmental Coordination Group for the Tsunami and other Coastal Hazards Warning System for the Caribbean Sea and Adjacent Regions, Fort-de-France, Martinique, France, 2–4 June 2009 (* Executive Summary available separately in E, F, S & R)	E*
141.	Twenty-fifth Session of the Assembly, Paris, 16–25 June 2009	E, F, R, S
142.	Third Session of the Joint WMO-IOC Technical Commission for Oceanography and Marine Meteorology, Marrakesh, Morocco, 4–11 November 2009	E, F, R, S
143.	Ninth Session of the IOC Intergovernmental Panel on Harmful Algal Blooms, Paris, France, 22–24 April 2009 (* Executive Summary available separately in E, F, S & R)	E*
144.	Fifth Session of the Intergovernmental Coordination Group for the Tsunami and other Coastal Hazards Warning System for the Caribbean Sea and Adjacent Regions, Managua, Nicaragua, 15–17 March 2010 (* Executive Summary available in E, F, S & R)	E*
145.	Sixth Session of the IOC Regional Committee for the Central and Eastern Atlantic Ocean, Accra, Ghana, 28–30 March 2010 (* Executive Summary available in E, F, S & R)	E*
146.	Forty-second Session of the Executive Council; Paris, 15, 19 & 20 June 2009	E, F, R, S
147.	Forty-third Session of the Executive Council; Paris, 8–16 June 2010	E, F, R, S
148.	Sixth Session of the Intergovernmental Coordination Group for the Tsunami Early Warning and Mitigation System in the North Eastern Atlantic, the Mediterranean and Connected Seas, Istanbul, Turkey, 11–13 November 2009 (* Executive Summary available separately in Ar, E, F, S & R)	E*
149.	Seventh Session of the Intergovernmental Coordination Group for the Tsunami Early Warning and Mitigation System in the North Eastern Atlantic, the Mediterranean and Connected Seas, Paris, France, 23–25 November 2010 (* Executive Summary available separately in Ar, E, F, S & R)	E*
150.	Sixth Session of the Intergovernmental Coordination Group for the Tsunami and other Coastal Hazards Warning System for the Caribbean Sea and Adjacent Regions, Santo Domingo, Dominican Republic, 26–29 April 2011 (* Executive Summary available in E, F, S & R)	E*

151.	Twenty-fourth Session of the Intergovernmental Coordination Group for the Pacific Tsunami Warning and Mitigation System, Beijing, China, 24–27 May 2011 (*Executive Summary in E, F, S & R included)	E*
152.	Twenty-first Session of the IOC Committee on International Oceanographic Data and Information Exchange, Liège, Belgium, 23–26 March 2011 (*Executive Summary available separately in E, F, S & R)	E*
153.	Eighth Session of the IOC Sub-Commission for the Western Pacific (WESTPAC-VIII), Bali, Indonesia, 10–13 May 2010 (*Executive Summary available separately in E, F, S & R)	E*
154.	Tenth IOC Intergovernmental Panel on Harmful Algal Blooms, Paris, France, 12–14 April 2011 (* Executive Summary available separately in E, F, S & R)	E