ISSN 0253-2808

INTERNATIONAL COUNCIL OF SCIENTIFIC UNIONS

PROCEEDINGS OF THE SCIENTIFIC COMMITTEE ON OCEANIC RESEARCH

July 1998
Baltimore, MD, USA

Support for SCOR activities in 1997 came from the membership contributions of national committees, the United States National Science Foundation, the International Council of Scientific Unions, the International Geosphere-Biosphere Program, the United Nations Educational, Scientific and Cultural Organization, the Intergovernmental Oceanographic Commission of UNESCO, the Norwegian Research Council, the University of Bergen, the National Oceanic and Atmospheric Administration of the USA, the European Space Agency, the National Aeronautics and Space Agency of the USA, and the National Space Development Agency of Japan.

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SCOR Proceedings, Volume 33
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REPORT OF THE 33rd EXECUTIVE COMMITTEE MEETING OF SCOR

Rio de Janeiro, Brazil
September 8-12 1997

1.0 INTRODUCTION

1.1 Opening Remarks and Administrative Arrangements

The 33rd Executive Committee Meeting of the Scientific Committee on Oceanic Research (SCOR) took place at the Luxor Hotel Regente in Rio de Janeiro, Brazil on September 8 to 12 1996. The meeting was hosted by the Brazilian SCOR Committee which arranged for a number of lectures and presentations by Brazilian marine scientists. Representatives of nearly all Brazilian oceanographic institutions attended the SCOR meeting which provided an excellent opportunity for interactions between the members of SCOR and the local oceanographic community. The list of participants in the SCOR General Meeting is given in Annex 1.

The meeting was chaired by Professor J.G. Field, the President of SCOR, who welcomed the participants for this, his first meeting as President. Dr. G.E. Stemmer, the Secretary for Scientific Development of the Brazilian Ministry of Science and Technology welcomed the international participants to Brazil, noting the rapid increase of Brazilian involvement in SCOR activities in recent years. Mr. Gilvan Marcelino and Ms. Marilia Giovanette de Albuquerque of the same Ministry extended their appreciation to Professors Friedrich Herms and Izabel Gurgel of the University of Rio de Janeiro for their efforts as local organizers of the meeting and to several Brazilian agencies which had provided financial support to facilitate the excellent national representation.

1.2 Approval of the Agenda

The Agenda for the meeting was adopted with two additions: a request from the Intergovernmental Oceanographic Commission (IOC) for SCOR to assist in the development of a "science agenda" on harmful algal blooms was inserted under item 4.1 and Ian Jones introduced a proposal for discussion under item 7.0. This related to a possible SCOR initiative in the area of developing a regional approach to graduate education in oceanography in developing countries. This report follows the format of the agenda as adopted (and given in Annex 2). An explanation of all acronyms and abbreviations used in this report appears in Annex 20 on the final pages.

1.3 Report of the President of SCOR

The President briefly reviewed some of the highlights of his first year in office, since the 23rd General Meeting of SCOR in September 1996. He noted, in particular, the progress with plans for a potential future program, currently entitled the Surface Ocean - Lower Atmosphere Study, which would be a joint effort of SCOR and IGBP. It was also an important year for the Joint Global Ocean Flux Study (JGOFS) which began its transition from the field program phase to the crucial period of data analysis, integration, modelling and synthesis. This synthesis phase began with a very successful modelling symposium in Oban, Scotland, followed by a JGOFS Committee meeting, Field's last as Chair of the JGOFS SSC.

Another major SCOR activity, the program on Global Ocean Ecosystem Dynamics (GLOBEC) passed a major milestone with the formal approval and publication of its Science Plan in 1997 and its incorporation into the IGBP program. The SSC for GLOBEC is now beginning to develop an Implementation Plan for the program and is organizing an Open Science Meeting as part of this process. A matter of continuing concern is the lack of a funded International Project Office for GLOBEC.

The President and Executive Director represented SCOR at the 1997 Assembly of the Intergovernmental Oceanographic Commission where they noted a revitalized interest in collaboration with SCOR and an increase in the frequency of requests for SCOR's scientific advice. Specific IOC Resolutions calling upon SCOR to cooperate with the IOC were discussed under item 4.1.

SCOR continued to respond to requests from IOC for assistance in the development of the Global Ocean Observing System (GOOS), hosting a workshop on time series stations in Baltimore, and assisting with the organization of the GOOS Coastal Workshop in Miami in early 1997. Field welcomed the appointment of Colin Summerhayes as Director of the GOOS Project Office in the IOC Secretariat.

A SCOR Strategic Review meeting, chaired by the Past-president, took place at the SCOR Secretariat in April 1997 in order to review the mission of SCOR, its future directions and internal operations. Field anticipated that the recommendations of this meeting would be a major topic for discussion in the days to come.

One area in which the President hoped to see an expansion of SCOR activity during his term is in development and outreach. He noted that the Third World Academy of Sciences (TWAS) was holding its General Assembly just a short distance from the SCOR Executive Committee meeting and that there would be opportunities for interactions with TWAS during the week to come including a visit from the Executive Director of TWAS and a presentation by Field at the TWAS Assembly.

Finally, Field thanked the members of the SCOR Executive Committee and the Executive Director for their support during his first year in office.

1.4 Appointment of an *ad hoc* Finance Committee

In accordance with the Constitution of SCOR, an *ad hoc* Finance Committee was appointed to review the administration of SCOR finances during the previous fiscal year (1996) and the current year. It was also charged to consult with the Executive Director and to draw up a budget for activities in 1998, based on the decisions taken during the meeting. The Committee was chaired by Wolfgang Fennel (Germany) and included Carl Friehe (US), Izabel Gurgel (Brazil) and Shizuo Tsunogai (Japan). Its report was presented under agenda item 3.3.

2.0 SUBSIDIARY BODIES

2.1 Arising from Former Working Groups

2.1.1 WG 78 Determination of Photosynthetic Pigments in Seawater

The UNESCO monograph on pigment methods, entitled "Phytoplankton pigments in oceanography" was published in 1997, and edited by S.W. Jeffrey, R.F.C. Mantoura and S.W. Wright. It presents the results of three methodological workshops organized by SCOR WG 78 during the late 1980s

2.1.2 WG 80 Role of Phase Transfer Processes in the Cycling of Trace Metals in Estuaries

The Chairman of WG 80, Michael Whitfield, proposed in his report to the meeting that the most productive means of completing the final report of his group would be through a joint approach with IUPAC to provide a volume on estuarine particulate processes which would be a companion to the earlier IUPAC volumes on particulate processes in the aqueous environment. He felt that the papers originally submitted by the members of WG 80, although in need of updating, will provide a good framework for a new joint venture with IUPAC in a new effort to relate the (updated) environmental information to the exciting developments in the chemistry of estuarine particulate matter that have taken place over the past five years or so. The Executive Committee agreed that it would consider such a proposal once the Iron Working Group (WG 109) is underway and the mechanisms for IUPAC/SCOR collaboration are clearer.

2.1.3 WG 89 Sea Level and Erosion of the World's Coastlines (with IOC)

The Reporter, Nick McCave, informed the meeting that the Chairman of this WG, Paul Komar, is working towards completion of the final report of this group which will take the form of a book. The Table of Contents, given below, is only slightly modified from that given in an earlier report to SCOR. The main change is the addition of Chapter 7 on the erosion of sea cliffs backing beaches due to elevated water levels. It was added to provide a more complete coverage of the subject, with the prospect of producing a report that would be suitable for

book publication. The final product will provide a comprehensive examination of sea-level variations and coastal responses, with recommendations toward the direction of future research.

Preface	
Chapter 1:	Introduction - Sea Level Change and Coastal Impacts
Chapter 2:	Global Processes and Changing Levels of the Sea
Chapter 3:	The Coastal Response to Changing Levels of the Sea
Chapter 4:	The Morphology of Beaches and their Variations
Chapter 5:	Bruun-Type Models of the Beach Response to an Increase in Sea Level
Chapter 6:	Models of Beach Profiles and Erosional Responses to Storms
Chapter 7:	Elevated Water Levels and Sea-Cliff Erosion
Chapter 8:	Sea Level and Management Responses
Chapter 9:	Summary and Recommendations
References	
Appendix I:	Field Study Methods and Sea-Level Impacts

2.1.4 WG 93 Pelagic Biogeography (with ICES and IOC)

A written report from Annalies Pierrot-Bults included the information that the Proceedings of the International Conference on Pelagic Biogeography II were in the hands of the IOC and expected to be published in 1997. The Glossary of biogeographic terms by Johnson and Zahuranec is on floppy disk and is awaiting translation by the authors. She also transmitted a series of recommendations from the Working Group, some of which the Executive Committee felt should be formulated as a proposal for a new working group for consideration by SCOR.

2.1.5 WG 95 Sediment Suspension and Sea Bed Properties

Professor Krishnaswami reported that the WG had completed its activities with the publication of a collection of articles in Volume 11, *Journal of Marine Systems* and the submission of a final report to SCOR (see Annex 3). This report includes a number of recommendations relating to "gaps and open questions" in the field of sediment resuspension. The Executive Committee agreed that the Chair of WG 95, Gerhard Graf, should be invited to submit the most pressing of these as a proposal for a new SCOR Working Group. WG 95 was disbanded with thanks from SCOR.

2.1.6 WG 97 Physiological Ecology of Harmful Algal Blooms (with IOC)

The Reporter for the WG, Bjorn Sundby, presented the outline of the book under production in the Springer-Verlag NATO report series which is the proceedings of the very successful NATO Advanced Study Institute organized by WG 97 in 1996. He cited this as a good example of a SCOR working group which used its SCOR sponsorship and financial backing to mobilize significant funding (NATO in this case) for a major meeting and the resultant publication.

The final report of the WG itself was presented to SCOR in 1996 and had included a number of recommendations on needs for future research. Several of these were, in fact, being taken up by groups of ICES and IOC. In addition, the 1997 IOC Assembly approved the recommendation of its Intergovernmental Panel on Harmful Algal Blooms that SCOR be invited to assist the IOC in the development of a "science agenda" on harmful algal blooms. This request was well received by the SCOR meeting, and was discussed in detail under item 4.1.

2.1.7 WG 101 Influence of Sea State on the Atmospheric Drag Coefficient

Professor Duce reported that the monograph under production by WG 101 is nearly complete and would be sent, as agreed at the 1996 General Meeting, to Professor Henry Charnock for review Before the end of September 1997. Cambridge University Press has agreed to publish this monograph.

2.2 Current Working Groups

2.2.1 WG 86 Ecology of Sea Ice (with SCAR and AOSB)

Working Group 86's final activity was the successful organization and running of the Gordon Research Conference on Sea Ice Ecology, held in Ventura, California in March 1997. SCOR provided travel support for both the members of WG 86 and other participants from Russia, Estonia, and Mexico. The conference was attended by 118 scientists, graduate students and postdoctoral fellows from 15 countries representing the strong interdisciplinary activity associated with Sea Ice Ecology and Polar Marine Science in general. Since the conferences have a prohibition on the publication of proceedings, the WG has established an editorial committee for a book on Sea Ice Ecology to be published separately. This group held several meetings at the conference and prepared a preliminary outline for the book.

In his report, the Chair of WG 86, Stephen Ackley, pointed out that, although WG 86 had now completed its main tasks, it would leave a legacy ensuring a place for the field of sea ice ecology in the broader realm of polar marine science. These include a permanent series of biennial Gordon Research Conferences on Polar Marine Science, the second to be chaired by Louis Legendre, a WG 86 member. Ackley is now a member of the SCAR Group of Specialists on Global Change in Antarctica in his capacity as Chairman, Antarctic Sea Ice Processes and Climate (ASPECT), (a SCAR program to study the sea ice zone of Antarctica and its impact on Global Change). Several members of WG 86 have been appointed to the Nominating Committee for the Gordon Research Conferences on Polar Marine Science. Finally, as noted above, there will be a book on Sea Ice Ecology . The SCOR Executive Committee approved the establishment of an editorial panel for this book consisting of Rita Horner, Stephen Ackley and Richard Rivkin.

2.2.2 WG 98 Worldwide Large-scale Fluctuations of Sardine and Anchovy Populations (with IOC)

John Field reported that the final meeting of this working group was to be held in La Jolla in October 1997 in conjunction with a meeting of the steering committee for the GLOBEC project on Small Pelagic Fishes and Climate Change (SPACC), in anticipation of the merging of the WG 98 effort with that of SPACC. The Executive Committee agreed that this working group should be maintained (at no cost) for a period of one year following the final meeting, in order to ensure the completion of its final report.

2.2.3 WG 99 Linked Mass and Energy Fluxes at Ridge Crests (with InterRidge)

In September 1996, to coincide with the 1996 General Meeting of SCOR, WG 99 members presented a colloquium on mid-ocean ridge fluxes and processes. Review papers were given by H. Bougault, H. Fujimoto, G. N. Holm, S.K. Juniper, C. Langmuir, D. Needham and M. Sinha. The colloquium was held at the Southampton Oceanography Centre, Southampton University, and formed the first day of a 2-day science meeting, with the second day being devoted to presentations of new scientific results from the UK Natural Environment Research Council's "BRIDGE" (British Mid-Ocean Ridge Initiative) research programme. A report and set of abstracts from the 2-day meeting has been published (L.M. Parson & M. Sinha, Eds) as Southampton Oceanography Centre Report No. 3.

Following the successful Southampton Symposium, the members of the WG were invited by the Editor-in-Chief of the journal "Reviews of Geophysics" to submit a major review paper on the topic of linked mass and energy fluxes at mid-ocean ridges. The view of the WG is that such a review paper will reach a wide audience; will meet the current needs of both advanced level education and provision of reference material for active researchers; and will overall be of more direct benefit to the scientific community than would a special volume of several separate chapters on various aspects of ridge fluxes. Work on this review paper is proceeding in parallel with completion of an educational booklet.

The Executive Committee approved the plans of the Working Group for a final meeting in January 1998 at the Lamont-Doherty Earth Observatory of Columbia University, New York, USA. The purpose of the meeting will be to produce complete and final versions of the above publications.

2.2.4 WG 102 Comparative Salinity and Density of the Atlantic and Pacific Ocean Basins

Speaking on behalf of Vere Shannon, the Reporter for WG 102, Cintia Piccolo reminded the meeting that at the time of the General Meeting of SCOR in September 1996 the report of WG 102 (Comparative salinity and

density of the Atlantic and Pacific Ocean basins) was under review by a panel lead by Dr Nick Fofonoff. Comments from Dr Fofonoff and a number of the reviewers have since been received. These comments made it clear that some further editing was needed and that follow-up work is required to consider the practical implementation of the findings. The latter needs to be done prior to publication of the report. Shannon proposed the following course of action which was approved by the Executive Committee:

1. Advise the Chair of WG 102 that the report has been reviewed by a small panel and request WG 102 to consider the referees' comments and to revise the manuscript accordingly. The revised report would be regarded as the final output product of WG 102, as constituted.
2. Establish a small task team to consider the practical implication of the findings of WG 102. Such a task team, which would not be a SCOR working group as such, would meet once and undertake the remainder of its business by correspondence. The meeting could possibly take the form of a workshop and involve some members of WG 102 and reviewers. The task team/workshop would be required to expand on the WG 102 report (i.e. the practical implementation) and produce a report which, after formal approval by IAPSO, SCOR and IOC, could be published as a definitive statement on the subject.
3. The ocean science community needs to be informed that WG 102 has nearly completed its work, that its report is being edited following review and that the practical implementation of the findings is being considered prior to publication.

2.2.5 WG 103 The Role of Wave Breaking on Upper Ocean Dynamics

The report from the Chair of WG 103, Michael Banner, referred to two major review articles that had appeared in 1996 which seemed to address a considerable portion of the terms of reference of the group. At the same time, there had been new developments in the study of the relationship between wave breaking and the dynamics of the upper ocean which led him to suggest that the focus of the working group should be reoriented "towards embracing and discussing critically the recent developments related to wave breaking . . . and their impact on current knowledge and future research directions."

A meeting of WG 103 had been planned in late 1997 in conjunction with another event which was later postponed until 1998. Banner requested that the funding be held over for a WG meeting in 1998. However, the Executive Committee did not feel that the WG 103 report provided enough information on the new directions proposed for the group. It recommended that no funds be allocated until a more detailed document is received by SCOR. It proposed that those WG members, including the Chair, who would be in Baltimore in April 1998 for the Fluid Mechanics Symposium should use this opportunity to draft such a document for consideration by SCOR at the General Meeting in 1998.

2.2.6 WG 104 Coral Reefs Responses to Global Change: The Role of Adaptation (with LOICZ)

Bjorn Sundby reviewed the plans for a symposium entitled "Coral Reefs and Environmental Change - Adaptation, Acclimation or Extinction?" which was being organized by WG 104 as a high profile session during the January 1998 meeting or the Society for Integrative and Comparative Biology. The development of this symposium, and a three day working group meeting to follow it, was the primary focus for the group during 1997. The program for the symposium (as planned at the time of the SCOR meeting) is given in Annex 4. The refereed symposium proceedings will be published in *American Zoologist*, although the funds for page charges for this journal were a major concern to the Executive Committee. Alternatives were discussed, such as the publication of a summary article in *American Zoologist* with more detailed articles published elsewhere. Sundby will discuss this with the WG Chair, Robert Buddemeier.

2.2.7 WG 105 The Impact of World Fisheries Harvests on the Stability and Diversity of Marine Ecosystems (with ICES and PICES)

Brian Rothschild reviewed the terms of reference of WG 105 and the extensive report of its first meeting which took place in Halifax, Canada in November 1996 (see Annex 5). A work plan was developed to prepare for a SCOR/ICES symposium on the Ecosystem Effects of Fishing to be held in Montpellier, France in March 1999. ORSTOM, the French tropical research organization, has agreed to host the symposium and the papers will be published by ICES. Other sponsors were being sought. Team leaders will produce consensus syntheses on a broad range of issues related to the terms of reference on WG 105.

The Executive Committee gave its approval for a second formal meeting of WG 105 in Australia in January 1998. The main items to be addressed are the progress made by the team leaders and finalization of the program for the symposium.

At the same time, the Executive Committee recommended that the WG should consider the addition of a member with the sedimentary expertise required to adequately deal with the effects of trawling on the sea bottom, especially in deep areas with fine sediments where trawling may to serious damage to the habitat. In shallow areas, it is now recognized that the impact of storms on the bottom sediments may be greater than that of trawling. An addition to the terms of reference was also approved as follows:

Assess the current state of knowledge of ecosystem and food web dynamics, including numerical modelling that would enable the investigation of the ecosystem effects of:

- "overfishing" with particular respect to its definition and its quantitative impacts
- "bycatch"
- effects of fishing on habitat in relation to the impact of natural processes.

Finally, the Executive Committee expressed its concern at the addition of Associate Members from environmental activist organizations, especially if the fisheries industry is not also represented in the group. This concern would be communicated by Rothschild to members of the group who were planning to meet informally during the forthcoming ICES meetings in Baltimore.

2.2.8 WG 106 Relative Sea Level and Muddy Coasts of the World (with IOC)

The final meeting of this working group had taken place in Germany in conjunction with an international conference on Muddy Coasts just before the SCOR Executive Committee meeting. Eduardo Marone (Brazil, a member of WG 106) presented a report from the WG meeting, noting that the work on the preparation of a manuscript for a book is now nearly complete under the joint leadership of Ying Wang and Terry Healy. Nick McCave, the Executive Committee reporter for WG 106 expressed his gratitude to Healy for his willingness to assist with the editing of the manuscript which may be published by Elsevier.

2.2.9 WG 107 Improved Global Bathymetry (with IOC)

Piccolo (reporting for Shannon) reminded the Executive Committee that the first meeting of WG 107 took place in Southampton in November 1996. Briefing papers were available in advance of the meeting, which addressed issues such as the state of the art of ocean bathymetry, needs of modelling, regions requiring further study, resolution and accuracy requirements and priorities. Excellent progress was made at the first meeting and a comprehensive plan of follow-up action was developed. A report on the first meeting is available. A second meeting has been scheduled in Baltimore in October 1997, and the Chair is optimistic that the tasks of WG 107 will be concluded shortly thereafter. Shannon's report noted that, in addition to its quick response and evident professionalism, this WG has fostered close liaison with IOC. The IOC wishes to recommend plans for improved global bathymetry and, following the presentation made by the WG 107 chair, Colin Summerhayes, to the IOC Assembly in July 1997, the Commission will use the WG 107 report as guidance for their developing program. This is a clear indication of the relevance of SCOR activities at the intergovernmental level and is in accordance with the recognition by IOC of SCOR as it scientific advisory body. The Executive Committee congratulated the Chair and members of WG 107 for the excellent progress made to date.

2.2.10 WG 108 Double Diffusion

Ian Jones, Executive Committee reporter for WG 108, reviewed the report of its first meeting, held in conjunction with the May 1997 Liège Colloquium ("Marine Turbulence Revisited"). Brief reviews of various aspects of double-diffusion were presented and the Working Group agreed that its primary goal should be to consider and rank the unsolved problems that currently prevent double-diffusion from being quantitatively addressed in the ocean. It decided to develop a written article, and developed an outline addressing the following questions for each process:

- Why or where is this process important?
- What are the key unsolved problems that prevent quantitative parameterizations of this process from being used?
- What seems to be the best way of solving the problem?

This article will be published in a widely-read, refereed journal such as *Reviews of Geophysics* or *Progress in Oceanography*. Barry Ruddick (Canada) and Anne Gargett (Canada) will coordinate the overall writing process, and after it is nearly complete, will draft an introductory section which could also address the more general issues of differential turbulent diffusion and the large-scale effects of double-diffusive fluxes.

Barry Ruddick agreed to establish an electronic mailing list and a Home Page for the Working Group (see http://www.phys.ocean.dal.ca/programs/doubdiff/doublediffusion.html).

The Executive Committee approved support for a meeting of WG 108 in 1998, although it did not feel that the proposed conjunction with the General Meeting was necessarily appropriate for the group.

2.2.11 WG 109 Biogeochemistry of Iron in Seawater (with IUPAC)

This working group was approved in principle by the 23rd General Meeting in 1996, with the co-chairs being David Turner (IUPAC, Sweden) and Keith Hunter (SCOR, New Zealand). The joint chairmen were charged with the tasks of revising the terms of reference to reflect the discussion at the SCOR General Meeting and to finalize the membership list in consultation with IUPAC and the SCOR Executive Committee reporter, Bob Duce, taking into account the mode of operation of IUPAC for working groups (i.e a concentration on the production of a major publication), and the nominations received from SCOR national committees. The following terms of reference were developed and have been approved by IUPAC at its 1997 General Assembly:

- To review critically the current state of knowledge of the biogeochemistry of iron in seawater. The review will cover chemical speciation, analytical techniques, transformation between different forms of iron, fluxes and distribution of iron, bioavailability of iron and also the evidence for iron limitation of primary production in High Nutrient Low Chlorophyll (HNLC) areas of the ocean.
- To identify priorities for future research in the areas covered by the review.
- To forge links between scientists working on iron chemistry in seawater and in other aquatic environments
- To publish the review and recommendations as a joint SCOR-IUPAC volume in the well-established IUPAC series on Analytical and Physical Chemistry of Environmental Systems, published by John Wiley.

The SCOR Executive Committee approved these terms of reference. The main task of the WG is the production of a book which was outlined in the report to SCOR. A lead author is identified for each of 7 primary review chapters planned for the final publication.

These chapters are further grouped into three major subject areas:

Iron Chemistry and Speciation
- Ch. 1 Sources, sinks and distributions of iron
- Ch. 2 Atmospheric transport of iron to the ocean
- Ch. 3 Speciation and analytical methods

Iron Distributions in the Ocean
- Ch. 4 Equilibrium modelling of the iron system in seawater
- Ch. 5 Transformations between different forms of iron

Biological Interactions
- Ch. 6 Bioavailability of iron
- Ch. 7 Iron limitation in HNLC areas

The remaining 4 chapters of the book will comprise a sub-group report on each of the three major subject areas identified above, and an executive summary that will be the opening chapter. The co-chairmen will write the executive summary and will also act as editors of the final publication and coordinate its review according to the standard IUPAC and SCOR procedures.

There was considerable discussion over the proposed membership for WG 109 which consisted of a very large group of all the authors and reviewers of all chapters of the book. It was suggested that the two co-chairs and the authors should be the WG members, with the reviewers being considered as Associate Members.

As a major step in the production of this book, WG 109 proposed to organize a 4-day meeting for the

presentation and discussion of the review chapters and the drafting of the sub-group reports and executive summary. This will take the form of a symposium on the Biogeochemistry of Iron in the Ocean in conjunction with the 24th General Meeting in late 1998 in Amsterdam at which the review chapters could be presented to a wider scientific audience. The internal reviewing and report drafting processes will take place in a private meeting of the WG immediately after the symposium. IUPAC and SCOR will provide some support for this meeting and the possibility of additional support from the US National Science Foundation was also discussed. IUPAC will also finance the costs of the publication.

2.2.12 WG 110 Intercomparison and Validation of Ocean Atmosphere Fluxes (with WCRP)

Sergei Lappo reported that the membership of this new Working Group, which was approved at the 23rd General Meeting of SCOR in 1996 had been finalized in consultations between the two Co-Chairs (Sergey Gulev - Russia, Peter Taylor - UK) and himself:

Bernard Barnier	France	Drew Rothrock	USA
Frank Bradley	Australia	Jeorg Schultz	Germany
Tom Charlock	USA	Arlindo da Silva	USA
Peter Gleckler	USA	Andreas Sterl	The Netherlands
David Legler	USA	Glenn White	USA
Ralf Lindau	Germany		

The Executive Committee was very concerned at the apparent lack of international diversity in this membership and it was agreed that the Executive Director should communicate this concern to the WG at its forthcoming meeting in Washington. In future, the Executive Committee decided, the final membership of all working groups should be submitted to the SCOR Officers for approval.

In preparation for the first WG meeting, Gulev and Taylor co-convened Special Session OA8 "Intercomparison and Validation of the Ocean-Atmosphere Flux Fields" during the XXII General Assembly of European Geophysical Society in April 1997. During this Session some 45 scientists presented their results on the comparison of different data and methods, and presented new flux products. The Session helped in forming a preliminary list of available flux products, and in evaluating tentative priorities for validation. During the Joint IAMAS & IAPSO Symposia in Melbourne, Australia (July, 1997) several Working Group members had brief informal discussions with regard to the Working Group tasks. Subject to formal approval during the first WG meeting in October, it has been agreed that a WG web site will be created in late 1997 or early 1998 at Lawrence Livermore National Laboratory (CA, USA). Gulev and Taylor have drafted the Table of Contents of the final report of the WG. This Table will form a working plan for the WG activity during the initial years. It contains the review issues, the catalogue requirements, and the planned validation activities. The conjunction of the first meeting of the WG and the WCRP 1st International Conference on Reanalyses will give additional possibilities for useful discussions and contacts. The meeting will be co-sponsored by the JSC and SCOR.

2.2.13 WG 111 Coupling of Waves, Currents and Winds in Coastal Models

Ian Jones reviewed the final membership of this working group which had been agreed in discussions following the 1996 General Meeting between himself and its Chair, Norden Huang:

Chair:			
Norden E. Huang	USA		
Members:		**Associate Members:**	
Yeli Yuan	China	John Allen	USA
Roger Flather	UK	Mike Banner	Australia
Peter Craig	Australia	Chris Mooers	USA
Wolfgang Rosenthal	Germany	Yoshiaki Toba	Japan
Vladimir Gryanick	Russia	Jurgen Battjes	The Netherlands
S. Shetye	India	I. A. Maiza	Egypt

Funding from NASA has been secured for the first meeting of this working group which has been delayed during a 1997 sabbatical leave for Dr. Huang. It is expected that this meeting will take place in 1998.

2.3 Committees and Panels

2.3.1 Editorial Panel for the Ocean Modelling Newsletter

The Executive Director noted that this newsletter was established in 1976 by WG 49 (Mathematical Modelling of Oceanic Processes). Since then 113 issues have been published. However, its future was in serious doubt as the traditional financial support from the U.S. Office of Naval Research was due to expire at the end of 1997. Electronic publication on the WWW has been proposed by the editor, Peter Killworth. The Executive Committee expressed its gratitude to the editors for a valuable contribution to the field of ocean modelling.

2.3.2 Joint Global Ocean Flux Study Scientific Steering Committee (with IOC)

The President invited Vice-President S. Krishnaswami to take over as Chair of the Executive Committee meeting in order that he (Field) might present the report from the Scientific Steering Committee for the Joint Global Ocean Flux Study (JGOFS), in his capacity as outgoing Chair of JGOFS. Field reported that he expected to hand over the chairmanship of the JGOFS program to Michael Fasham (UK) in about a month's time, if this was acceptable to SCOR and IGBP. He noted, briefly, that this was a crucial time for the JGOFS program as it moved from the field phase into a period of data analysis, modelling, integration and synthesis of the results obtained during the first eight years of the program.

The Executive Committee reporter for JGOFS, Bjorn Sundby, introduced the written report submitted to SCOR by the JGOFS International Project Office in Bergen (see Annex 6). He noted that a recent bibliography produced by the office demonstrated that more than 1,400 publications have resulted from JGOFS research.

Field presented a more detailed report, noting that the JGOFS process studies in various ocean basins have now been completed. Each area of study was selected for a different scientific reason. For example, the North Atlantic Bloom Experiment was designed for a region of deep water formation and large seasonal variability; the Equatorial Pacific is a large oceanic source of CO_2 to the atmosphere, has interannual variability (related to El Niño) which exceeds the seasonal variability, and a large unused nutrient pool; the Arabian Sea has an intense and predictable period of productivity associated with the monsoon: and, the Southern Ocean is an area where the carbon fluxes may represent a significant component of the global carbon cycle and are likely to be very sensitive to climate change. Several scientific highlights resulting from the JGOFS program in the 1996-97 period are described in Annex 6.

As a first step in JGOFS' preparations for its "synthesis phase", the first JGOFS Synthesis and Modelling Symposium was successfully organized in Oban (May 1997). The Symposium attracted a large number of international participants and provided a productive forum on modelling ocean biogeochemical processes. Biogeochemical model design, development, interpretation and validation concerns were major priorities of the symposium. Moreover, the members of the JGOFS Global Synthesis and Modelling Task Team and other symposium participants engaged in discussions with IGBP GAIM (Global Analysis, Interpretation and Modelling) participants on merging biogeochemical process models with large-scale General Circulation Models.

Following the symposium, the JGOFS SSC met at the Dunstaffnage Marine Laboratory, near Oban. It agreed upon a restructuring of the SSC and of the various regional planning groups so as to provide better leadership as the program shifts from a period of intensive field observations to one of data assembly, modelling and synthesis of a global view of oceanic carbon fluxes. Essentially, the SSC will be reduced in size by attrition over a three year period to six "at large" members appointed jointly by SCOR and IGBP. The Chair of the SSC will be nominated from among these "at large" members. In addition, the Chairs of the various JGOFS subsidiary groups (regional Planning Groups and scientific Task Teams) will serve as *ex officio* members of the SSC. Over the next year, the regional Planning Groups will be restructured to take on the tasks of synthesis, feeding into the global synthesis effort. Other groups will be disbanded as their tasks are completed. The overall result will be a considerably smaller JGOFS SSC providing leadership for the synthesis phase.

The Executive Committee approved the membership proposals put forward by the Chair of JGOFS; these proposals were immediately forwarded to the IGBP for consideration at its Officers' meeting. Firstly Michael Fasham (UK) was nominated to be the new Chair, taking over from Field in late 1997. Field would remain on the SSC for one year as Past-Chair. Secondly, in addition to Fasham and Field, five nominations, approved by SCOR

were forwarded to the IGBP for membership on the JGOFS SSC. As a result of the decisions by SCOR and IGBP, the following individuals were to be invited to join the JGOFS SSC as of January 1 1998: K.K. Liu (China - Taipei) - appointed for a second term; Karin Lochte (Germany) - appointed for a second term; Huasheng Hong (China); Renato Quinones (Chile). The complete 1998 membership of the JGOFS SSC is given in Annex 6.

2.3.3 SCOR/IGBP/IOC Committee on Global Ocean Ecosystem Dynamics

A note from Vere Shannon (Executive Committee reporter for GLOBEC) was introduced by Cintia Piccolo. In addition, a report from the Chair of GLOBEC SSC, Roger Harris, is found in Annex 7. Shannon's report highlighted a few points:

The GLOBEC Science Plan, was published in 1997 as IGBP Report No.40, and GLOBEC Report No. 9. This provides a blueprint for the continued development and functioning of GLOBEC.

Secondly, and a matter of some concern to the Executive Committee, a GLOBEC International Project Office (IPO) had still not been established, and the delay of the hoped-for financial support from NERC (UK) placed an untenable burden on Harris and on the SCOR Secretariat which is trying to provide as much interim assistance as possible to the GLOBEC Chair. This state of affairs required urgent resolution by SCOR-IOC-IGBP.

Thirdly, the GLOBEC Implementation Plan was starting to take shape (the main function of the SSC during 1997) and would be presented as a draft at the First Open Science Meeting of GLOBEC at IOC in Paris in March 1998.

Brian Rothschild presented a brief overview of the current status of the GLOBEC program, and, in particular, of the four scientific foci which form the basis of the Implementation Plan currently being drafted:

Focus 1: Retrospective Analyses in the Context of Large-Scale Climatic Changes

Activity 1.1 Analyses of Existing Historical Data
Activity 1.2 Creation of new, Historical, Data sets
Activity 1.3 Support for ongoing, and development of new, data sets for future comparisons

Focus 2: Conduct Process Studies organized around the Themes of (1) Research and modelling of Ecosystems and Trophodynamics, (2) Identification and Understanding of Mesoscale Physical-Biological Interactions and (3) Research on Forced Responses in Ecosystems.

Activity 2.1 Ecosystem and Trophodynamics
Activity 2.2 Multiscale Physical-Biological Interactions
Activity 2.3 Ecosystem Response to Forcing
Activity 2.4 Global Integration and Cross-links to Other Foci, e.g. Process Modelling

Focus 3: Develop Modeling and Predictive Capabilities with Interdisciplinary, Coupled Modeling-Observational Systems

Activity 3.1 Review Relevant Sampling and Observational System Capabilities
Activity 3.2 Review Relevant Modeling Capabilities
Activity 3.3 Review Relevant Coupled Modeling-Observational Capabilities and Applications

Focus 4. Cooperate with other Ocean, Atmosphere, Terrestrial and Social global change research efforts to estimate Feedbacks from Changes in Marine Ecosystem Structure to the Global Earth System.

Activity 4.1 Climate Interaction on Multiple Scales and its Consequences for basic Biological Processes.
Activity 4.2 The Interaction between Phytoplankton and the Zooplankton-Fish System.
Activity 4.3 Ecosystem Effects on Higher Trophic Levels.
Activity 4.4 Relations to International Programmes.

Rothschild also noted that the Numerical Modelling Working Group of GLOBEC is being re-structured in order to make it more responsive to the needs of the other components of the GLOBEC program. He noted the important influence of the international program as evidenced by the continuing establishment of new national programs as well as a Euro-GLOBEC program in the early planning stages.

Two members of the GLOBEC SSC were due to rotate off the committee at the end of 1997. In addition, one unexpected resignation, and one vacancy left a total of four positions to be filled on the GLOBEC SSC. The SCOR Officers were charged to assess the various nominations received and to forward proposals to IOC and IGBP for their consideration and approval. As a result of this consultation, four new members were invited to joint the GLOBEC SSC for three year terms, effective January 1 1998: Nadia Pinardi (Italy), Serge Poulet (France), Francois Carlotti (France), and Suam Kim (Republic of Korea). The complete membership of the GLOBEC SSC for 1998 is given in Annex 7.

2.3.4 SCOR/IGBP Task Force on a Surface Ocean - Lower Atmosphere Study

The Executive Committee had before it a report from the Chair of a meeting of a SOLAS task group meeting in London in January 1997. S. Krishnaswami reviewed this report and introduced the report of the London meeting which had been considered by both the IGBP and SCOR Officers in the months following. Their comments were taken into account and a revised version of the SOLAS document was published in the IGBP Newsletter in September 1997 (see Annex 8). The concerns of the SCOR Officers related to the need to involve physical oceanographers in the development of the SOLAS program, and the need for a clearly-stated overarching goal for the program.

The goal of a future SOLAS effort, as stated in the document prepared by Andrew Watson (UK) would be: "To address key interactions among the marine biogeochemical system, the atmosphere and climate, and how this system affects and is affected by past and future climate and environmental changes."

This goal will be attained by:

- formulating and testing hypotheses about these key interactions,
- quantifying cause and effect in these interactions, and
- incorporating this new understanding into models

In order to advance these plans, Watson requested approval from SCOR and IGBP for a much larger workshop in 1998. The recommendation of the SCOR Executive Committee meeting was that, before such a workshop, meaningful interactions needed to be established between the advocates of SOLAS and the atmospheric sciences, climate, physical and biological oceanography communities. In order to facilitate this, it was agreed that SCOR and IGBP should each provide a small amount of funding for travel by the SOLAS proponents, Andrew Watson, Peter Liss and Robert Duce, during 1998 to lay the groundwork for a SOLAS workshop in 1999.

2.4 Proposals for New Working Groups

The following proposals were circulated to all national committees for comments in advance of the Executive Committee meeting.

2.4.1 Influence of Submarine Groundwater Discharge on Coastal Oceanographic Processes

This proposal was introduced and summarized by Bjorn Sundby who stated that a number of coastal chemistry phenomena are difficult to explain unless there is a large source of fresh water to the coastal ocean besides rivers. The likelihood that this additional source of freshwater comes from direct groundwater input through the sea bottom to the coastal zone has recently been recognized. It may come from underwater springs, seepage through the sediments, and so on. Some geochemical budgets are impossible to balance without this groundwater input being taken into account. However, the marine science and groundwater science communities do not interact and often come to different conclusions about these phenomena and the underlying mechanisms.

A recent international workshop in Moscow sponsored by the Land-Ocean Interactions in the Coastal Zone (LOICZ) program of IGBP had focused on these issues. This working group proposal, which was endorsed by LOICZ, was formulated to take advantage of the interest fostered by this workshop and to focus on the key problems it identified.

The proposal in its entirety, with the title and terms of reference as modified and approved by the Executive Committee meeting, and the final membership list, is given in Annex 9.

The meeting agreed to accept this proposal, but revised the terms of reference to reflect the need to assess the magnitude of the groundwater input to the coastal ocean before considering its impacts. The WG will be entitled "Magnitude of Submarine Groundwater Discharge and its Influence on Coastal Oceanographic Processes", and will be cosponsored by LOICZ which will share in the costs of its meetings.

2.4.2 Asian Monsoon Evolution in Marine Records: Comparison Between Indian and East Asian Subsystems

Nick McCave presented this proposal which had been submitted to SCOR by Pinxian Wang and was endorsed by the Chinese SCOR Committee and the IMAGES Scientific Committee. The Asian monsoon system is one of the most significant features of the climate dynamics of Earth and it exerts climatic control over some of the most populated areas of the globe. Its two subsystems, the Indian monsoon and the East Asian monsoon, are linked atmospherically, but have important differences controlled by the different regional land-ocean distributions. The proposal calls for a comparative study of the evolution of these two subsystems as seen in the marine sediment record. According to McCave, the capability to make long cores of marine sediments makes this feasible. Pinxian Wang pointed out that while the Ocean Drilling Program has meant that the Indian monsoon evolution is better studied, most work on the history of the East Asian subsystem has been done on land.

Other members of the Executive Committee made a number of comments and suggestions as to the proposed terms of reference and membership. These are reflected in the revised proposal which is presented in Annex 10. The establishment of this working group (as WG 113) under the chairmanship of Wang Pinxian, was approved. It will be co-sponsored and supported by the IMAGES program (International Marine Global Changes) of PAGES/IGBP.

2.4.3 International Exchange of Biological Samples from Hydrothermal Vents

Nick McCave also reviewed this proposal which was received from the InterRidge program. It called for SCOR to take the lead in developing a set of protocols for the exchange of biological samples from deep sea hydrothermal vent communities. The proposal was motivated by the fact that the remote nature of deep-sea vent environments and the geographic sampling focus of individual nations have led to a situation in which individual scientists do not have access to critical samples with which to address scientific problems on the global scale. International exchange of these samples would extend the use of these samples beyond restricted groups of senior scientists in a few major laboratories to a much wider user group and would facilitate many more comparative studies. InterRidge felt that such scientific breakthroughs are not likely to occur in the absence of an international sample exchange agreement and that SCOR should take the lead on this effort.

The Executive Committee was unanimous in its opinion that this was not an appropriate topic for a SCOR working group. It is not a scientific question, but rather a logistical and political one that required intergovernmental action. SCOR thought this was a laudable initiative, however, and that InterRidge should be encouraged to pursue it. SCOR could assist with contacts in organizations such as the IOC and the Ocean Drilling Program. It was agreed that Nick McCave would respond to InterRidge after discussing the problem with the President of IABO who was not present for the meeting.

2.4.4 Limits to Predictability

A proposal on this topic was submitted by John Woods on behalf of the UK SCOR Committee and was presented by Ian Jones. It was based on the belief that a major constraint on the development of operational oceanography is a lack of understanding of the limits to predictability of ocean variability, "especially those aspects that impact on the skill of forecasts for paying customers". The concept of limits to predictability, part of the theory of non-linear systems, commonly called "chaos theory". The theory explains why it is impossible to forecast the weather for more than a week or so into the future, and it provides a framework for designing observing systems and model integrations, including ensemble forecasts. It is widely believed that similar laws of error growth will be a feature of models designed to forecast the ocean, and that the error growth curve will be modified

by the fluxes between the ocean and atmosphere in coupled models used for operational ocean forecasting and climate research. However, the literature on limits to predictability for ocean forecasting is very sparse at present. It deserves greater attention. Indeed it is becoming an urgent matter as the time comes closer to formally seek investment in the Global Ocean Observing System.

The meeting agreed that this proposal needed to be developed in more detail so as to clarify the relationship of such a group to the activities of the CLIVAR program, to add a focus on coupled ocean-atmosphere models, and to define the time scales to be addressed. In addition, a potential leader for this activity needs to be identified and specific preliminary membership proposals were required. It was agreed that a revised proposal on this topic could be considered at the General Meeting in 1998.

2.4.5 Inclusion of Management of Coastal Ecosystem in SCOR Activities

This proposal was received from the Pakistani SCOR Committee too late to be circulated to national committees for comments prior to the meeting. Accordingly it could only be discussed in a preliminary way, and was briefly reviewed by the Executive Director. The idea for this proposal arose, in part, from an IOC workshop on Integrated Coastal Zone Management which took place in Pakistan and identified several urgent coastal zone problems such as non-sustainable use of natural resources, uncontrolled effluent discharges, the impacts of agricultural practices such as river diversions for irrigation, salt water intrusion into aquifers and coastal erosion. It was proposed that a SCOR working group could take the lead in such activities as information and data archiving and dissemination, provision of information for policy makers, development of a comprehensive network for coastal zone information exchange and so on.

The Executive Committee agreed that this was much too broad a task for a typical SCOR scientific working group. There was a significant degree of overlap with the coastal activities of the IOC, the Group of Experts on the Scientific Aspects of Marine Environmental Protection (GESAMP), the Land-Ocean Interactions in the Coastal Zone (LOICZ) program of the IGBP. Neither SCOR nor the LOICZ program have the expertise in management and policy formulation that this proposal seemed to assume to be available.

At the same time, several participants welcomed the fact that this proposal came from a SCOR Committee in a developing country like Pakistan and felt that SCOR should respond to this national committee encouraging it to submit more specific scientific proposals in the future. In addition, information on relevant IOC, GESAMP and LOICZ activities should be sent to the Chair of the Pakistani SCOR Committee.

2.5 Affiliated Programs

Reports were received from each of these Affiliated Programs accepted by the SCOR General Meeting in 1996. These reports were primarily for information since it was agreed that Affiliated Programs would be reviewed in detail biennially at General Meetings and not at Executive Committee meetings.

2.5.1 Acoustic Thermometry of Ocean Climate (ATOC)

As noted in the report submitted by David Farmer, ATOC Chair, (see Annex 11) the goal of this program is to develop an international collaborative program to use long range sound transmissions to monitor ocean climate. Several scientific highlights are featured in the report. In particular, the method has proved to be even more precise than expected and it appears that temperature changes of as little as 0.001°C can be detected. ATOC measurements in the Arctic Ocean basin indicate significantly warmer intermediate layer water than seen in historical data sets. This observation was verified with *in situ* measurements. Plans for expansion of the ATOC program in the Pacific and for an Indian Ocean program are also reviewed in the report.

The only matter that required action by SCOR was to approve the recommendation by David Farmer that he step down and that a new ATOC Chair be identified at the meeting in Goa in October 1997. He also proposed to restructure the ATOC Committee (which to this time has consisted of all the members of former SCOR WG 96), to have a minimum of three members. Any active member of the program (defined as someone who has attended two or more previous ATOC meetings) would be eligible to serve as a committee member. The Chair would serve for a period of two years, to be replaced by a nominee identified by the Committee. The Committee members would

serve for three years. The primary goal here is (a) to ensure an open and nonexclusive membership and (b) to encourage a strong international participation. The Executive Committee approved this plan.

2.5.2 International Marine Global Change (IMAGES - with PAGES/IGBP)

The IMAGES program has been initiated to respond to the challenge of understanding the mechanisms and consequences of climatic changes using oceanic sedimentary records. Individual research is no longer sufficient to resolve this problem because the acquisition of the required, long sediment cores in high sedimentation rate areas is expensive, and the proper study of such cores demands the use of multiple tools and large numbers of measurements. IMAGES has been developed as an international effort for the marine sediment research of PAGES-IGBP, with the sponsorship of SCOR. A brief report of a very recent IMAGES Scientific Committee meeting was introduced by Nick McCave. He noted that Russia, Denmark and Sweden have joined the program. The membership structure proposed by IGBP/PAGES and SCOR has been accepted by the Scientific Committee. More information on IMAGES goals, membership, scientific activities and so on can be found on the WWW at http://www.images.cnrs-gif.fr/. The following scientific working groups have been established by IMAGES to address issues relating to the collection of giant cores, their study and the interpretation of data:

Ultra High Resolution in the North Atlantic
Western Pacific Margins
Asian Monsoon Evolution (with SCOR, see item 2.4.2 above)
Western Margins of the Americas
Workshop on the re-evaluation of the 18,000 year oceanic SST map
Data Base Standing Committee
New Technologies For Sediment Imaging

IMAGES will have a special session at the PAGES Open Science Meeting in London in April 1998, and will hold its next Scientific Committee meeting at the International Paleoceanography Congress in Lisbon in August 1998.

SCOR national committees were urged to encourage the establishment of national committees for the IMAGES programs, or at least to develop a strong collaboration between appropriate institutions and funding agencies with the goal of developing strong ties to the international effort.

2.5.3 International Antarctic Zone (iAnZone)

On behalf of Vere Shannon, Cintia Piccolo made the following points: iAnZone is alive and well under the capable joint leadership of Arnold Gordon (USA) and Eberhart Fahrbach (Germany). Its fist meeting as an Affiliated Program was planned to be a joint one with SCAR-GLOCHANT's ASPeCt (Antarctic Sea-Ice Processes, Ecosystems and Climate) and to take place in Arizona during the first week of December 1997. The output will be a blueprint for future iAnZone activities and coordination with ASPeCt and CLIVAR (Note: The Chair of ASPeCt is Steven Ackley who is also Chair of SCOR WG 86). The membership of iAnZone is now truly international and complies with SCOR requirements. The role of SCOR in iAnZone is being actively promoted by the Co-Chairs who have also kept the SCOR Reporter (Shannon) informed about developments on an ongoing basis. iAnZone has a homepage at http://www.Ideo.Columbia.edu/physocean/ianzone/. The current membership of iAnZone is:

A. Gordon	(USA) Co-chair	E. Fahrbach	(Germany) Co-chair
R. Muench	(USA)	K. Heywood	(UK)
A. Piola	(Argentina)	J. Launiainen	(Finland)
P. Schlosser	(USA)	M. Garcia	(Spain)
M. Wakatsuchi	(Japan)	A. Klepikov	(Russia)
C. Garcia	(Brazil)	G. Spezie	(Italy)
N. Bindoff	(Australia)	H. Hellmer	(Germany)

2.5.4 InterRidge (International Ridge Studies)

A comprehensive report on current InterRidge activities was presented by Nick McCave and is given in Annex 12. InterRidge is an international and interdisciplinary initiative concerned with all aspects of ridges. The

objectives of the three principal InterRidge themes, Global Studies, Meso-scale Studies and Active Processes, are to: acquire a balanced set of global-scale data on the entire mid-ocean ridge system, including the high latitudes; observe, measure and monitor active processes at individual ridge sites in order to begin to quantify the fluxes of mass and energy involved and their biological consequences; investigate the interplay of mantle processes at various temporal and spatial scales, and; understand the evolution, reproduction strategies and dispersion paths of hydrothermal vent biota and determine their relationships with physical, chemical, and geological processes at the ridge-crest. No specific action by SCOR was needed with respect to InterRidge.

In addition, two programs have made preliminary enquiries about an affiliation with SCOR:

2.5.5 The International Ocean Colour Coordinating Group (IOCCG)

The Committee on Earth Observing Satellites (CEOS) is a high-level international group which brings together representatives of national space agencies with a mandate to ensure *inter-alia* the scheduling of satellite missions so as to ensure continuity of observations, the coordination of sensor requirements, etc. CEOS and the IOC jointly established the IOCCG to deal with many issues relating to ocean color observations from space. The IOCCG is chaired by Trevor Plant (Canada), past-chair of JGOFS.

The contribution of the IOC as a cosponsor of the IOCCG during its first year of operation was to provide staff support for this activity and to provide a financial mechanism (through the IOC Trust Fund) for the space agencies to contribute to the support of the group. These arrangements proved to be insufficiently flexible to meet the needs of the group. Problems in accessing the funds held at IOC in a timely way and in agreeing on appropriate representation of the IOCCG at meetings of related bodies led to a reconsideration of these organizational arrangements.

As a result, recognizing that SCOR has a "minimum of red tape", the IOCCG Executive turned to SCOR with a request that it provide administrative support to the group, primarily by holding funds in trust from the space agencies and dispensing them in accordance with a budget approved by the IOCCG Executive. The Executive Secretary of IOC agreed with this solution.

The SCOR officers present in Baltimore enthusiastically approved this request. The Strategic Review Meeting had emphasized the need for enhancing the visibility of SCOR and for broadening the funding base for the organization. They agreed that this proposal would expose SCOR to a completely new community (the space agencies and the remote sensing scientists), and that SCOR should be seen to be responsive to a stated need with good scientific merit. Since the IOCCG has a sizeable annual budget, a small amount of income to SCOR could result from interest accrued on the funds held in trust for the IOCCG (about $150,000 per year). IOCCG funds will be held in a separate bank account and will not be co-mingled with SCOR funds.

To further solidify these arrangements, the officers agreed that, at the Executive Committee meeting serious consideration should be given to a formal request from the IOCCG for Affiliated Program status, providing that all of the criteria for this category of SCOR programs (as discussed at SCOR meetings in Cape Town/1995 and Southampton/1996) are met. This request had not been received since the IOCCG Executive had not met prior to the SCOR meeting, but it was expected to be forthcoming. The meeting agreed that when the formal request is received, it should be approved, if appropriate, by the Officers in correspondence.

2.5.6 Sir Alister Hardy Foundation for Ocean Science

A letter from the Director of SAHFOS, which operates the Continuous Plankton Recorder Survey transmitted a preliminary enquiry about Affiliated Program status. In response the Executive Director sent information on the criteria for the Affiliated Program. No further response was received and the matter was not considered by the Executive Committee.

3.0 ORGANIZATION AND FINANCE

3.1 Membership

The following changes in SCOR membership since September 1996 had been reported to the Secretariat:

BANGLADESH:	M.M. Miah succeeds Monirul Hoque as one of Bangladesh's nominated members.
CANADA:	Kenneth Lee will serve as the third nominated member for Canada joining L. Hobson and Bjorn Sundby.
DENMARK:	Erik Buch joins Drs. Bjornsen and Larsen as Denmark's third nominated member.
EGYPT:	Egypt has three new nominated members selected in 1997, they are Drs.Badawi, Beltagy and Emara.
INDONESIA:	K. Sumadhiharga has been appointed as a second nominated member to SCOR from Indonesia.
MEXICO:	The three new Nominated Members from Mexico are Antionio Peña Diaz, Mario M. Garcia and Clara Morán succeeding Adem, Alvarez-Borrego and Ayala-Castañares.
NETHERLANDS:	W. Mook has retired as a Nominated Member and Hein de Baar replaces him.
POLAND:	Profs. Korzeniewski and Wolowicz's successors to SCOR as Nominated Members are C. Druet and J.Weslawski joining A. Zielinski.
SOUTH AFRICA:	G. W.Bailey and L. V. Shannon join John Field as South Africa's Nominated Members.
SWEDEN:	David Turner of Goteborg has been appointed to serve as the third Nominated Member from Sweden.
THAILAND:	Thailand has appointed Kamol Jittjumnong and Suvit Vibulsresth to serve as Nominated Members and they join Manuwadi Hungspreugs as Thailand's three Nominated Members.
TURKEY:	Dr. Cemal Saydam is the new third Nominated Member from Turkey.
UK:	R. Dickson replaces M. Whitfield as the UK's newly appointed Nominated Member.
USA:	Carl Friehe and John Magnuson join Robert Knox as the USA's three Nominated Members, succeeding Arthur Nowell and Brian Rothschild .

The following changes should be noted for representative members of other ICSU Bodies:

IUGG:	Robert A. Duce and L. Vere Shannon replace D. Lal
IUGS:	E. Bonatti of Bologna, Italy has been appointed by the Bureau of the IUGS replacing Y. Lancelot.
SCOPE:	H. Postma has been replaced by Venugopalan Ittekkot of Hamburg, Germany.

The Membership Officer, S. Krishnaswami, reported that, while no new national committees have been added to SCOR in 1997, he was hopeful that Portugal and Tunisia may join SCOR in the near future.

3.2 Publications Arising from SCOR Activities

The Publications Officer, Bjorn Sundby, and the Executive Director presented a report on the following publications arising from SCOR activities since September 1996:

GLOBEC Publications

GLOBEC Special Contribution No. 2. An Advanced Modeling/Observation System (AMOS) for Physical-Biological-Chemical Ecosystem Research and Monitoring (Concepts and Methodology). By GLOBEC International Working Groups on Numerical Modeling and Sampling Observational Systems.

Interdisciplinary Model Formulation and Parameterization. Report of the Second Meeting of the International GLOBEC Numerical Modeling Working Group. Nantes, France, July 17-20, 1995.

GLOBEC International Newsletter. Vol. 3., No. 1. Editor: Roger Harris. April 1997

Global Ocean Ecosystem Dynamics (GLOBEC) Science Plan. GLOBEC Report No. 9 & IGBP Report 40.

JGOFS Publications

First Report of the JGOFS/LOICZ Continental Margins Task Team. JGOFS Report No 21. October 1996.

Report on the International Workshop on Continental Shelf Fluxes of Carbon, Nitrogen and Phosphorous. JGOFS Report No 22. 1996.

One-Dimensional Models of Water Column Biogeochemistry. JGOFS Report No 23. Report of a Workshop held in Toulouse, France, Geoffrey T. Evans and Veronique C. Garcon, eds. February 1997.

Publications Arising from SCOR Working Groups

S.W. Jeffrey, R.F.C. Mantoura and S.W. Wright (eds) 1997. Phytoplankton Pigments in Oceanography: Guidelines to Modern Methods. UNESCO Publishing, Paris, 661pp. The results of methodological workshops organized by SCOR WG 78.

SCOR Working Group 99 & Bridge Research Results. Abstracts. 2-Day Science Meeting, Southampton Oceanography Centre, UK. September 18th and 19th 1996. Edited by L.M. Parson & M. Sinha. Southampton Oceanography Centre Report No 3.

SCOR Working Group 95: Sediment Suspension and Sea Bed Properties. A Special Section in *Journal of Marine Systems,* Vol 11, Nos 3-4. Includes seven papers by the members of WG 95. June 1997.

Publications Arising from Other SCOR Activities

SCOR Proceedings No. 32. Report of the XXIII General Meeting of SCOR. Southampton Oceanography Centre, Empress Dock, Southampton, UK. September 16-20 1996.

Ocean Modelling Newsletter. Issues 111, 112 and 113 were published during the period since the XXIII General Meeting.

Journal of Marine Systems. Vol 7 - Nos.2-4. Special Issue: The Coastal Ocean in a Global Change Perspective. Edited by S. Djenidi. February 1996. The Proceedings of the 26th International Liège Colloquium on Ocean Hydrodynamics, May 1994. The Colloquium was co-sponsored by SCOR.

Caribbean Journal of Science. Vol. 32, Number 3. September 1996. Guest Editor, Frank J. Millero. The Proceedings of the First International Meeting on Carbon Dioxide in the Oceans, January 1996, Puerto Rico. The meeting was organized by members of the JGOFS/IOC CO_2 Advisory Panel and co-sponsored by SCOR.

General Bathymetric Chart of the Oceans. GEBCO-97. The Second Release of the GEBCO Digital Atlas. British Oceanographic Data Centre. March 1997. The package includes a CD-ROM and supporting documentation. SCOR co-sponsors the GEBCO Panel.

VIII International Conference on Harmful Algae. Vigo, Spain. June 25-29 1997. Book of Abstracts. The Conference was co-sponsored by SCOR.

M.A. Donelan, W.H. Hui and W.J. Plant (eds) 1996. The Air Sea Interface: Radio and Acoustic Sensing, Turbulence and Wave Dynamics. University of Toronto Press. 789pp. The proceedings of a Symposium with the same title which took place in Marseilles in June 1993 and was co-sponsored by SCOR.

Sundby reported that he had agreed at the Officers Meeting to assist in the production of a SCOR newsletter, but that this had been impossible in the intervening time. He hoped to take this up, however, and some suggestions were made about diversifying the SCOR distribution list for the newsletter by obtaining lists from other organizations like IAPSO and IGBP, and by including libraries on the list - all as means of making the newsletter available to a wider audience.

3.3 Finance

The *ad hoc* Finance Committee and the Executive Director reviewed the state of SCOR finances for the past and current fiscal years, meeting twice during the Executive Committee meeting. The *ad hoc* Finance Committee also drew up a budget for 1998 and made recommendations regarding the levels of membership contributions to SCOR for 1999. The final financial statement for 1996 and the budget for the year are presented in Annex 13.

In his report to the meeting, the Chair of the *ad hoc* Finance Committee, Wolfgang Fennel, pointed out that the income for 1996 was about $36,000 less than anticipated in the budget, primarily due to smaller than expected grants and contracts from IGBP and IOC. The favorable cash balance at the beginning of the year compensated for this lost income. In addition, two postponements and economically advantageous venues for working groups meetings meant that most of them cost somewhat less than expected in 1996. Finally, administrative costs were kept well below budget. The result was a very healthy cash balance of $129,000 at the end of the year. It must be pointed out, however, that of this, $60,000 is accounted for by unpaid membership dues - much of this debt to SCOR was owed by a single country. While it was expected that most of these arrears would be collected in 1997, failure to do so will put a serious financial burden on SCOR.

Turning to the current financial year (1997), Fennel requested the Executive Committee to accept various revisions to the budget which had been approved by the General Meeting in 1996. For example, a grant from IGBP for JGOFS has now been transferred directly to the JGOFS office in Bergen for administration. As noted in the discussions of working groups, at least three meetings have been moved to very early in 1998, so these funds must be moved out of the 1997 budget. At the same time, funds for the WG 106 meeting approved by the 1996 General Meeting were inadvertently omitted from the budget and have had to be inserted. Additional funds in the GLOBEC expense line were matched by additional income for GLOBEC. A computer failure in the Secretariat resulted in an unexpected expense for office equipment. The anticipated cash balance, while considerably reduced, was still expected to be a reasonable one with which to continue operations into 1998.

The budget for 1998 which was drafted by the committee took account of all the requests made by working groups and the needs for other SCOR activities. These had totaled more than the available funds and several means of saving funds were suggested. Referring to the discussion of the working group on Wave Breaking (WG 103), the *ad hoc* Finance Committee specifically suggested that no funds be allocated to this group in 1998. Rather, the members who are attending the April symposium in Baltimore should take the opportunity to meet informally and to prepare a short paper with a detailed justification for the continuation of the group. A total of $85,000 was allocated for working group meetings in 1998, including some funds for the new group on Asian Monsoons which was expected to meet in April 1998. Fennel requested that the new group on Groundwater Discharge should be given first priority should any changes in plans mean that funds may not be used by other groups and if it is organized quickly enough to meet in 1998. The committee strongly recommended that $12,000 be allocated for part-time help for the SCOR Secretariat in accordance with the findings of the Strategic Review Committee (see item 3.5). This draft budget for 1998 ends with a year end cash balance of only $60,000 which is the minimum acceptable amount.

Finally, Fennel's report recommended an increase of 3% in SCOR membership fees effective January 1 1999 in order to balance increased expenses due to inflation. The 1996 General Meeting had already approved a similar increase for 1998.

The report of the *ad hoc* Finance Committee was accepted as presented. Concern was once again expressed about the continuing inability of the Bangladesh SCOR Committee to pay its membership dues and the requirement for its membership to be suspended after five years of non-payment. Accordingly, the Executive Committee agreed to waive the unpaid Bangladesh dues for 1992 in recognition of the severe economic hardships faced by that country. This procedure may be used again in 1998, but a very special effort will be made to have Bangladeshi scientists participate in the Executive Committee meeting when it is held in Goa, India in 1999 in order that they may see the value of SCOR membership for their oceanographic community.

3.4 Establishment of a Nominations Committee in Preparation for Elections at 1998 General Meeting

The two year terms of the Secretary and all three Vice-Presidents of SCOR will expire at the General Meeting in 1998. The current Secretary (Bjorn Sundby, Canada) and one Vice-President (Sergei Lappo, Russia) are eligible to be re-elected. Two Vice-Presidents (S. Krishnaswami, India and Wang Pinxian, China) are not eligible for re-election since they will have served for four years by the time of the XXIV General Meeting. A Nominations Committee was appointed in preparation for elections at the XXIV General Meeting. It will be convened by Brian Rothschild and two former members of the SCOR Executive Committee, Su Jilan (China) and Gerold Siedler (Germany) will be invited to join the committee.

3.5 Other Organizational Issues

3.5.1 Strategic Review of SCOR

The report of a meeting convened to review SCOR's role in the international scientific arena, and its modes of operation, was circulated to all SCOR national committees and individual SCOR members. Nick McCave, who had chaired the meeting, led the lengthy discussion of this report which is presented in its entirety in Annex 14. He proceeded through the report, discussing the series of questions which the Strategic Review Panel had addressed.

*1. **The role, mission and mandate of SCOR. Is there a need for SCOR at all?***

The discussion focused on the issue of science for policy. The consensus was that SCOR's best service to decision makers would be to work on science that is policy relevant and to improve efforts to present the outputs of its scientific activities to policy makers in a form that they can readily understand, but to leave the interpretation vis à vis specific policy development up to them. Working groups should be encouraged to highlight scientific issues that are relevant to society in their reports to SCOR. This could be included in the terms of reference of future working groups.

*2. **The position of SCOR among marine science and related organizations: IOC, ICES, PICES, IGBP, SCOPE, etc. Should one organization provide a larger focus; should there be an International Union of Ocean Sciences IUOS?***

It was generally agreed that the present structure of SCOR allows it to be flexible and free-ranging in comparison to the unions of ICSU. At the same time, it was the view of the Strategic Review Panel that ICSU does not adequately recognize the international stature of some of its Scientific Committees like SCOR. There was also broad agreement with the content of the report regarding relations with IOC and other organizations.

*3. **Is the modus operandi of SCOR appropriate to needs of the next 20 years (SCOR is now 40)? Subsidiary to this, are the mechanisms whereby SCOR receives and considers proposals for new W.G.'s likely to yield the hottest, most pressing topics? How are priorities established? What topics has SCOR missed?***

This question was paraphrased by McCave as "has SCOR been bumbling away while really hot topics have been missed?" The discussion centered around means to improve communications in both directions between SCOR and its national committees and the process of generating and considering proposals for new working groups.

The Brazilian SCOR Committee was held up as a model national committee, one which is "representative, communicative and responsive" in the words of the report. Field reported that the South African national committee used the Strategic Review Report as a basis for re-examining its own effectiveness. Recognizing, however, that many national committees do not fully understand the operations of SCOR and their own rights and responsibilities as members, several participants suggested that information on these issues should be made available via the SCOR Home Page and Newsletter, when it is published. Perhaps an Executive Committee member could be assigned to advise a national committee which does not appear to be functioning effectively.

With regard to working group proposals, the meeting approved the suggestion that each proposal, as it arrives in the SCOR Secretariat, should be assigned to a member of the Executive Committee who would cooperate with its author(s) to guide it through the process, ensuring that the proposal meets SCOR criteria and that it is, in

fact, ready for consideration at a SCOR meeting. The process should be initiated earlier in the year so that proposals could be circulated to national committees further in advance of the annual SCOR meeting. SCOR could also put out a "call for proposals" of topics for new working groups which could then be screened, with the best ones being developed into detailed working group proposals in collaboration between a member of the executive Committee and the originator of the idea.

4. Should SCOR return to the organization of large all-embracing conferences, or any conferences at all? If not will SCOR become increasingly invisible?

The consensus of the Strategic Review Meeting was that there is an unmet international need for a large, interdisciplinary conference for marine science. It would need to planned with a careful eye on the timing and themes of other meetings, and should be fairly infrequent. A dissenting view was expressed by many participants at the Executive Committee meeting, namely that such conferences should be an opportunity for the presentation of very recent results and should, therefore, have only two or three narrow themes rather than trying to deal with the whole field of ocean science. The Executive Committee meeting agreed with the view that SCOR should not undertake to reinstate a large meeting like the former Joint Oceanographic Assemblies, but that advantage should be taken of the opportunities presented by other international meetings.

5. Is the way in which SCOR is comprised of members nominated by National Committees militating against young (sub 40) oceanographers in its deliberations? They are rarely among officers or nominated members but some are on W.G.'s. Is this a matter of concern? What about female scientists? Oceanographers from developing countries? Is affirmative action required or desirable?

This part of the report of the Strategic Review meeting was accepted by all participants who agreed that the first priority must always be given to excellent science.

6. Involvement of the global community of marine scientists in SCOR has been held to be a problem (too low). Is it?

The Executive Committee agreed with the suggestion that more advantage should be taken of the category of Invited Member as defined in the SCOR Constitution in order to establish SCOR contacts in those countries which are not currently SCOR members. Noting that his letters to various countries in Southeast Asia and Arabic countries had not generated any responses, Krishnaswami warned against indiscriminate use of this option.

7. Is the balance of disciplines represented, and topics treated by SCOR, appropriate to modern needs of the science (Phys/Chem/Biol/Geol), deep ocean vs coastal, pure vs applied etc?

The meeting agreed with the conclusion of the report that there is good balance of the scientific disciplines of oceanography in the current range of SCOR activities.

8. Is the secretariat (1 Executive Director, 1 Executive Assistant) adequate to service the demands placed upon it now and for the next 5-10 years? If not; more funds?, offload work?, contract staff/tasks.

The President described the space and working conditions in the SCOR Secretariat which he has visited on two occasions during 1997 and which he found to be of less than desirable quality. McCave stressed the need to lighten the workload of the Secretariat staff and suggested that there should be "position descriptions" defining the responsibilities of the various members of the Executive Committee. In general, Executive Committee reporters need to better fulfill their obligations to communicate with WG chairs as described in the "Objectives and Procedures for Working Groups" in the *SCOR Handbook*. This includes transmitting the decisions of Executive Committee and General Meetings to the WG chairs, and maintaining good contacts with them at all times.

3.5.2 Constitutional Review

At the XXIII General Meeting, a group was established to draft a set of procedures for the nomination and election process. Ian Jones presented the preliminary report of this group. It had concluded that the SCOR Constitution is not in need of major revision in order to deal with the election process and that a set of rules of procedure could simply be appended to it. He presented a preliminary draft for these procedures which was discussed and generally approved, although it needed further editing. This was to be concluded in correspondence after the meeting and disseminated to all national committees with the next call for nominations. These new procedures will be used on a trial basis for the election process at the General Meeting in 1998. At that time they

will be submitted for formal approval by the General Meeting. These draft procedures are:

1. A call for nominations must be issued more than 6 months before the General Meeting. Nominations should include a suggestion of the position for which the candidate is being proposed, and a brief *curriculum vitae*.

2. A Nominating Committee of three SCOR members will be appointed by the Executive Committee meeting prior to each General Meeting at which an election will take place. The Nominating Committee will normally include the Past-President as its Chairperson.

3. Nominations will not be accepted later than 4 months before the General Meeting except as provided for in clause 4.

4. Between 3 and 4 months before the General Meeting, the Nominating Committee, after scrutinizing the nominations received, may seek additional nominations for specific positions through direct consultations with national committees and/or affiliated organizations. This process may be needed in order to maintain the appropriate disciplinary and geographic balance on the Executive Committee.

5. The Nominating Committee will prepare a final slate of candidates, one per position, and will confirm that the members of this slate are willing to serve.

6. Three months before the General Meeting the Nominating Committee will announce its proposed slate and send it, along with all nominations received, to all voting members of SCOR as defined in Clause 21 of the SCOR Constitution (Nominated Members and Representative Members of Affiliated Organizations). Nominations received as a result of action taken under clause 4 will be identified.

7. Clause 21 of the SCOR Constitution states that when elections are held "only one Nominated Member from each Committee for Oceanic Research shall have a vote. One Representative Member from each Affiliated Organization may also vote."

8. No further nominations be allowed.

9. If notice is given not less than 2 weeks before the start of the General Meeting by any 3 national committees requesting that a formal vote take place, it will be held on the last day of the General Meeting.

10. If no vote is requested the slate proposed by the Nominating Committee will be declared elected at the end of the General Meeting.

4.0 RELATIONS WITH INTERGOVERNMENTAL ORGANIZATIONS

4.1 Intergovernmental Oceanographic Commission (IOC)

In the absence of an IOC representative at this meeting, the IOC Executive Secretary sent a written report on the status of several areas in which SCOR and IOC have joint activities; this is given in Annex 15. The President and Executive Director of SCOR represented SCOR on the occasion of the IOC Assembly in July 1997. Several resolutions of that meeting referred specifically to SCOR.

The first of these (IOC Resolution XIX-3) on Ocean Mapping recognizes the SCOR working group on ocean bathymetry for its contributions "towards the preparation of a well co-ordinated and comprehensive plan for the coming decade". Another (IOC Resolution XIX 12) called upon SCOR, and other bodies, to cooperate with the IOC Regional Committee for the Southern Ocean in the implementation of its projects. Two others required more extensive discussion by the SCOR meeting.

IOC Resolution XIX-1 accepted the recommendations of the fourth session of the IOC Intergovernmental Panel on Harmful Algal Blooms (HAB). Among these was a request for SCOR to assist in the development of a "science agenda" for the IOC HAB program with a focus on the ecology and oceanography of harmful algal blooms. This was also reiterated in a letter from the Executive Secretary of IOC. Coincident with this request from IOC, SCOR also received a document (Annex 16) from the chair of WG 97 on Harmful Algal Blooms, Don Anderson, who is also leading the development of a scientific initiative on harmful algal blooms in the United States, and from the relevant program managers at the National Science Foundation and the National Oceanic and Atmospheric Administration. The document from these individuals requests SCOR to assist in the development of an international effort along the same lines as the US ECOHAB (Ecology and Oceanography of Harmful Algal Blooms) program.

These concurrent requests from IOC and ECOHAB were very well received by the Executive Meeting as this was seen to be an area in which SCOR could provide leadership. Rather than immediately setting up a working group, as suggested in the letter from the IOC Executive Secretary, the meeting suggested that SCOR and IOC should jointly convene an international workshop (as had been done in order to begin planning for the international JGOFS and GLOBEC programs, for example) so as to get an international consensus on priorities for a potential international HAB science program. Bjorn Sundby accepted the responsibility of developing this concept in cooperation with Don Anderson.

The other major new initiative with IOC is referenced in IOC Resolution XIX-17. This calls for an IOC "assessment an analysis of the state of marine science, in particular regarding our scientific capability to understand ocean processes and to use such understanding for the sustainable development of Member States". The resolution calls upon SCOR and SCOPE to "contribute to this assessment in their respective fields of competence and to establish with IOC a joint advisory group of up to six members to assist in the assessment and analysis". This request for SCOR advice was welcomed by the Executive Committee which designated Brian Rothschild to take the lead on behalf of SCOR in this effort.

4.2 World Meteorological Organization (WMO)

A written report briefly described items of mutual interest especially with respect to data buoys and the Integrated Global Ocean Service System (IGOSS). The Drifting Buoy Cooperation Panel of IOC and WMO is increasingly involved in efforts to persuade meteorologists and oceanographers to collaborate on combined meteorological and oceanographic drifting buoys. The panel also now convenes a scientific/technical workshop with its annual session. The 1997 workshop was expected to be on the applications of drifter data in the southern hemisphere. IGOSS has responded to the termination of the TOGA and WOCE research program with the formalization of an operational Ship of opportunity (SOO) programme. It has established an international coordination and management mechanism for the long-term operational maintenance of a ship-of-opportunity XBT network in support of GCOS, GOOS and the WCRP. A complete and detailed survey of existing and projected SOOP resources was compiled. This resource survey is being used by the IGOSS Ship-of-opportunity Programme Implementation Panel (SOOPIP) and the Ocean Observations Panel for Climate (OOPC) as part of an ongoing dialogue to determine the most scientifically effective way of using the available resources to monitor upper ocean heat content in support of global climate studies. A complete and detailed survey of existing and projected SOOP resources was compiled in order to determine the most scientifically effective way of using the available resources to monitor upper ocean heat content in support of global climate studies.

4.3 International Council for the Exploration of the Sea (ICES)

Brian Rothschild introduced the report from ICES (see Annex 17) which highlights the reorganization of that organization as well as some areas of joint activities, especially GLOBEC, and forthcoming ICES scientific meetings. SCOR sponsorship was requested in a letter from the Secretary-General of ICES in relation to one of these; "Ecosystem Effects of Fishing" to be held in Montpellier, France in March 1999. The Executive Committee readily approved this request since this meeting is being organized by WG 105 on the Impacts of World Fisheries on the Stability and Diversity of Marine Ecosystems.

4.4 North Pacific Marine Science Organization (PICES)

A written report describing items of mutual interest (Annex 18) was presented by the PICES representative to the SCOR meeting, Shizuo Tsunogai. In particular he noted strong cooperation between SCOR and PICES in respect to WG 105 (Impacts of World Fisheries on the Stability and Diversity of Marine Ecosystems), on the Climate Change and Carrying Capacity component of the GLOBEC program, and on the JGOFS North Pacific Task Team. SCOR was to be represented at the next PICES meetings (October 1997 in Pusan, South Korea) by Tsunogai and by Ian Perry, a member of the GLOBEC SSC.

4.5 Commission on the Conservation of Antarctic Marine Living Resources (CCAMLR)

The Executive Director informed the meeting of the increasing interest of CCAMLR in the Southern Ocean component of GLOBEC. There was no other recent information from CCAMLR.

4.6 Others

Bob Duce, who is a member of the Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection (GESAMP), also represented SCOR at its last meeting. The Group of Experts is known, in part, for its periodic assessments of the health of the ocean and has recently begun a new two to three year effort to produce a new report on the Health if the Ocean.

5.0 RELATIONS WITH NON-GOVERNMENTAL ORGANIZATIONS

5.1 International Council of Scientific Unions

Nick McCave reviewed the recommendations contained in the report of the Panel on the Assessment of ICSU which might have an impact on SCOR and other Scientific Committees of ICSU. The implementation of the recommendations of the Assessment Panel resulted in many proposed revisions to the ICSU Statutes and Rules of Procedure and will be the subject of an Extraordinary General Assembly of ICSU on April 25 1998.

McCave noted, for example, the creation of a new position of ICSU "Vice-President for Scientific Planning and Review" to chair the Committee on Scientific Planning and Review which will be responsible, among other things, for the periodic review of Scientific Committees. The proposal to introduce "sunset clauses" for Scientific Committees evoked a very negative reaction within SCOR and other, well-established interdisciplinary bodies of ICSU, and this has been communicated to ICSU on more than one occasion. The revised definitions for ICSU interdisciplinary bodies seemed inadequate to many of their members. The review of these bodies might become more frequent (as often as triennial - for every ICSU General Assembly) and the mechanisms for these reviews have not been explained at all. A response from SCOR to the proposals of the Assessment Panel should be sent to ICSU in time for its Executive Board meeting in October 1997. Nick McCave agreed to represent SCOR at the Extraordinary General Assembly of ICSU.

In an unrelated decision, ICSU had agreed to initiate a review of SCOR to be conducted during 1997. The SCOR Officers who met in Baltimore in April 1997 agreed that this new ICSU review of SCOR would be inappropriate, following so soon after the last one which was concluded in 1992. This was especially true since exactly the same questions were being posed in this review process as in the last one; questions which SCOR criticized when they originally appeared in 1991, but to which the SCOR community nevertheless responded in full. In fact, the 1992 report of the last SCOR review panel, chaired by Olof Tandberg, was well received by SCOR and SCOR reacted to most, if not all, of its significant recommendations. However, it seemed unlikely that using the same questions a second time, just five years later, would be a productive use of the time of the panel members or of the oceanographers who are asked to respond to them. While SCOR did not wish to cooperate with the ICSU review under these circumstances, ICSU was also informed that the SCOR Executive would be pleased to collaborate with ICSU in developing new guidelines for the periodic review of ICSU's interdisciplinary committees. The ICSU Executive Board accepted this point of view and delayed the review of SCOR until after the process for such reviews has been redesigned.

5.2 ICSU Unions and Committees

Reports were requested from all of the ICSU bodies which have representatives to SCOR.

5.2.1 International Geosphere-Biosphere Program

SCOR-IGBP interactions had already been discussed in relation to JGOFS, GLOBEC, SOLAS and LOICZ. The Deputy Executive Director of IGBP, Neil Swanberg, informed the meeting of plans to integrate and synthesize the results of the IGBP program, beginning with the outputs of the more mature IGBP program elements such as JGOFS and others. He particularly noted plans for the meeting of the IGBP Scientific Advisory Council and a Global Change Policy Forum in Nairobi in September 1998, and for a second IGBP Congress in early 1999 at which there would be a special emphasis on science synthesis.

5.2.2 World Climate Research Program

An extensive written report from WCRP summarizing the current status of WOCE, CLIVAR and other WCRP activities of considerable interest to SCOR was tabled without discussion since there was no representative of the WCRP at the meeting and no particular action by SCOR was requested. It is given in Annex 19.

A request from Worth Nowlin, Chair of the US WOCE Steering Committee for SCOR action to encourage submission of WOCE data internationally was sympathetically received. The meeting agreed that it should be forwarded to SCOR national committees and to the JGOFS International Project Office which should draw it to the attention of the international JGOFS community.

5.2.3 Scientific Committee on Problems of the Environment (SCOPE)

The main area of cooperation between SCOR and SCOPE during the past year had been an attempt to clarify the status of, and relationships between, a number of assessments of the oceans currently underway or planned (IOC, GESAMP, GIWA, etc.). The most relevant of these, from the point of view of ICSU science interests, seemed to be the IOC Assessment. This was discussed in detail under agenda item 4.1.

5.2.4 Others

Committee on Space Research (COSPAR)

A letter from the President of COSPAR requested SCOR's sponsorship of the COSPAR Scientific Assembly and Associated Events in Nagoya, Japan in July 1998, and support for some participants from developing countries. As usual, there were a number of scientific sessions on topics relating to ocean remote sensing planned and the Executive Committee agreed to this request.

International Union of Pure and Applied Chemistry (IUPAC)

A brief report summarized activities of interest to SCOR:

IUPAC Commission V.6 (Equilibrium Chemistry): The project entitled "Influence of pressure on chemical equilibria in aqueous solutions, with particular reference to sea water", described in IUPAC's report to the XXIII General Meeting of SCOR, is nearing completion. The written report is expected to be submitted for review within IUPAC during autumn 1997.

IUPAC Commission V.8 (Solubility Data): An outline of the proposed project on Solubility of Oceanic Salts was presented to the XXIII General Meeting of SCOR, which requested a more formal and detailed proposal before financial support could be considered. Uncertainties concerning the Commission's publication series have, however, made it impossible to present such a proposal in 1997.

IUPAC Commission VI.1 (Fundamental Environmental Chemistry): The joint IUPAC/SCOR project (SCOR WG 109) is covered elsewhere [see item 2.2.11]. Two other projects relevant to marine sciences are in the planning stage: "In situ measurements in water and sediments", and "Transport processes" (working title). The latter project is in the early stages of planning, and will focus on the transport of chemical species to the water/organism interface, the organisation and structure of the relevant membranes, and the nature of the initial uptake process.

Both projects are expected to lead to books published in the IUPAC series "Analytical and Physical Chemistry of Environmental Systems"

5.3 Affiliated Organizations

International Association for Biological Oceanography (IABO)

Neither the President nor the Secretary of IABO was able to attend the SCOR meeting, but a written report was tabled.

On the organizational side, IABO has devoted much time and effort to updating the list of National Correspondents who have hitherto constituted the only formal contact with the international community of biological oceanographers. Where this was not successful within a reasonable period of time, direct approaches were made to individuals who, in the opinion of the President and Secretary, would be appropriate for the role. The current list of Correspondents is available from the Executive Director, or directly from IABO. All of these Correspondents were contacted about their availability to carry out duties related to IABO within their own countries and in liaison with the executive. The question of widening the membership of IABO to include individual biological oceanographers has been considered but action awaits further discussion on the future role of IABO.

On the scientific front, IABO has continued to place top priority on Marine Biodiversity. The wide endorsement by the international scientific community of DIVERSITAS as an international programme of biodiversity science is extremely encouraging . The Programme has been approved by IUBS, SCOPE, UNESCO, ICSU, IGBP-GCTE, and IMS, and the President has worked hard to ensure the inclusion of a Programme Element on Marine Biodiversity. The marine research components outlined in the Operational Plan of DIVERSITAS are:

1. Ecosystem functioning and its effects on marine biodiversity,
2. Origins and maintenance of biodiversity in marine ecosystems,
3. Systematics and monitoring of marine organisms,
4. Marine microbial biodiversity.

At the special session of 4th International Marine Biotechnological Conference on Marine Biodiversity, which was to be jointly chaired by the President and Secretary of IABO, plans called for marine biological diversity to be discussed in the context of:

1. Current status of research,
2. Potential for collaborative research and expanded research opportunities,
3. Potential for commercial applications and research results,
4. Policy implications of the proposed research.

The goal of the meeting will be to forge the framework of an International Marine Biodiversity Programme under DIVERSITAS. Emphasis will be placed on the development of an international network of marine laboratories and field stations to share information and to conduct parallel experiments to test common hypotheses. It is intended to prepare a publication summarizing results from the IMBC Biodiversity Workshop and outlining future directions for research.

Future plans include a joint meeting with IAPSO in the year 2001. These plans were still at a very early stage, but it will address the question of interdependency between physical and biological oceanography in the context of current international programmes such as GLOBEC.

International Association for Meteorology and Atmospheric Sciences (IAMAS)

Bob Duce, the President of IAMAS, reported that one of the primary efforts undertaken by IAMAS during the past year was related to the Joint General Assembly of IAMAS and IAPSO, which was held in Melbourne, Australia from 1-9 July 1997. The overall theme of this conference was Earth-Ocean-Atmosphere, Forces for Change, which reflected the present challenge facing the world's scientific community to respond to the pressure to provide relevant knowledge and solutions to a public that is increasingly concerned about changes to

the natural environment. Symposia on the role of the ocean in climate, on air/sea exchange, and other areas related to interactions between the ocean and atmosphere were featured. The total attendance was over 1100, and the General Assembly was considered a great success. The next General Assembly of IAMAS will be held in 2001.

IAMAS also devoted a significant amount of time during the 1997 to the development of "ACT", the WMO-IUGG "Alliance for Capacity Transfer" in meteorology and the atmosphere-related sciences, including hydrology and oceanography. The University Corporation for Atmospheric Research will also be a founding IUGG partner in ACT which has also been approved by the World Meteorological Organization's Executive Committee, the IAMAS Executive Committee and IAPSO.

The goal of ACT is to stimulate and expand voluntary collaboration and exchange of information and data, within and across the boundaries between the National Meteorological and Hydrological Services (NMHSs), the university community, and the scientific community at large through the use of the Internet.

Specific Objectives of ACT are:

- To provide close links between operations and research, between individual scientists and Universities, and meteorological and hydrological services;
- To facilitate interactive research between developing and developed countries;
- To facilitate access and exchange of meteorological and related data within the context of Resolution 40 of WMO Cg-XII, when applicable;
- To facilitate cooperation within regions or scale- or subject-related groups;
- To facilitate application of newly developed scientific insights and technologies;
- To provide and exchange software for operations, data processing, synthesis and modelling;
- To develop new approaches to education and training; and
- To create international "Discussion", "Support" and "Help" Bulletin Boards and other means for discussion and collaboration through the Internet.

Within the Alliance for Capacity Transfer, "Capacity" is defined as the knowledge, experience and capabilities of the individual meteorologists and scientists and their institutions. "Capacity" includes ways of doing things as well as products, i.e. procedures, technologies, data processing, conceptual and numerical modelling, theoretical approaches, results and interpretations of data, data itself, and software. "Capacity" applies to operations, observations, and measurements in general, but also to management of services and projects as well as educational and training aspects. It further includes knowledge of equipment of all kinds used in pursuing the goals and objectives. ACT will consist of a loose and flexible framework which will make use of currently available Internet Web sites relating to Meteorology, Hydrology and Oceanography. These sites represent the availability of a large pool of dedicated scientists, often retired and willing to volunteer as resource persons, collaborators and advisors. ACT will provide fast links to and between groups most knowledgeable about specific problems and solutions within certain regions or groups of similar interests. It will be concerned with aspects of local, regional or global scale issues. Generally, there will be no charges involved. The Alliance will rely heavily on the use of the Internet, an inexpensive and effective means of communication among large numbers of people and institutions. Participating organizations would be responsible for the funding of their own tasks; there will be no transfer of funds necessary.

Duce reviewed the time line for the implementation of ACT. He sought formal SCOR endorsement of this concept in order that a grant proposal could be made to ICSU, noting that IUGG had already indicated its approval. The Executive Committee endorsed the request and asked to be kept informed about the progress of ACT.

International Association for the Physical Sciences of the Ocean (IAPSO)

The representative of IAPSO, Cintia Piccolo, also noted the success of the joint IAMAS/IAPSO Assembly in Melbourne, as reported by Bod Duce. She reported that IAPSO has prepared proposals for IAPSO symposia and joint symposia, IAPSO sponsored Union symposia, and possible Union lecturers at the upcoming IUGG General Assembly in 1999. Finally, interest has been expressed concerning a possible Joint Assembly between IAPSO and

the International Association for Biological Oceanography in 2001. IAPSO was considering possible sites for 2001. Efforts are also being made to involve IABO in joint symposia at the IUGG General Assembly in 1999.

The SCOR meeting welcomed this interdisciplinary cooperation between IAPSO and IABO and agreed in principle to support their planned joint symposium in 2001. More information on this will likely be available in time for the General Meeting in 1998.

5.4 Corresponding Organizations

Reports were received from the following organizations.

Arctic Ocean Sciences Board (AOSB)

A report was received too late to be tabled at the meeting, but is included (in part) here for information.

The AOSB held its Sixteenth Session in Sopot, Poland at the invitation of the Institute for Oceanology. The following were among the major results of AOSB-XVI:

- The AOSB is proceeding with planning for an international multi-disciplinary circum-Arctic riverine discharge research program (APARD) to quantify and characterize present river discharge and its change over time.
- Planning is also underway, in cooperation with SCOR, to convene a NATO advanced study workshop, to bring together experts in all aspects of freshwater inflow to the Arctic to develop a definitive picture of freshwater input and output and to develop recommendations for future research.
- Research has been initiated on the oceanographic and meteorological processes responsible for the generation and maintenance of the North Water polynya, especially the gradient in latent/sensible heat.
- The AOSB is also considering the needs and opportunities in other areas such as coordination/integration of climate related research in the North and South Atlantic; dense water plumes research.

The Board regularly tracks relevant developments in Arctic Ocean research and technology, including remote sensing and data management. The Board's next Meeting (AOSB-XVII) was tentatively scheduled for late March 1998 in Oslo.

Engineering Committee on Oceanic Resources (ECOR)

The first issue of ECOR's journal, *Oceanic Engineering International,* (joint with Memorial University) has been published and circulated. The second issue was planned for fall 1997.

Confederation Mondiale des Activités Subaquatiques (CMAS - Scientific Committee)

The objective of the CMAS Scientific Committee is promote the cause of scientific diving and to make regulators aware of the distinction between this pursuit and commercial diving activities (e.g. in the offshore oil and gas industry) which are potentially much more dangerous. The Committee has commissions and working groups on Archaeology, Biology and Conservation, Geology, and Amateur/Professional. CMAS has instituted the Grand Prix International de l'Environnement Marin 1997, to be awarded to a work providing a major contribution to the conservation of the marine environment. The award was expected to me made in mid-January 1998.

The Scientific Committee has a number of projects with UNESCO such as the development of an international law on the protection of "submerged cultural heritage". In collaboration with the European Union, it organized a Symposium on Scientific Diving in 1997. The Committee offers courses in scientific diving and certifies professional scientists as "Scientific Divers". A second edition of *Scientific Diving: A General Code of Practice* by Nic Flemming and M. Max has been published.

5.5 Other Organizations

The Oceanography Society(TOS)

The General Meeting in 1996 approved the request from TOS to cosponsor its next Scientific Meeting on the theme of "Coastal and Marginal Seas" in Paris in June 1998. It is being organized in cooperation with the IOC.

In his capacity as President of TOS, Bob Duce reviewed the daily themes of the meeting on coastal processes at various scales. He requested that SCOR provide some funds for travel by participants from developing countries, Eastern Europe and Russia. This has been the traditional component of the SCOR cosponsorship of all TOS Scientific Meetings to date.

6.0 FUTURE MEETINGS

6.1 Future meetings of SCOR

XXIV General Meeting

There was a detailed discussion of the plans for this meeting and for the associated Scientific Symposium on the Biogeochemistry of Iron in Seawater (see item 2.2.11) to be organized by WG 109 and the Royal Dutch Academy of Sciences. Hein de Baar, Chair of the Netherlands SCOR Committee, presented plans for a seven day schedule (including arrivals and departures) for these meetings to be held at the Academy in Amsterdam with a one day scientific excursion to the Netherlands Institute for Sea Research on the island of Texel. There will be a half day review session of the Iron Symposium which will be open to all the participants in the General Meeting. The Executive Committee thanked de Baar for undertaking these arrangements and for the opportunity for SCOR to meet in The Netherlands. [The dates were later confirmed as November 1-5 1998.]

Thirty-fourth Executive Committee Meeting

An invitation had been received for SCOR to hold its next Executive Committee meeting at the National Institute of Oceanography in Goa, India These plans were confirmed and S. Krishnaswami pointed out that, if possible this meeting should take place in late October or early November in order to avoid the bad weather associated with the monsoon. The precise dates were to be decided in consultation with the local hosts and have since been established as October 25-29 1999.

6.2 International Oceanography Meeting

Since the General Meeting of SCOR in late 1996, there have been discussions between IABO and IAPSO about the desirability of organizing and international, interdisciplinary meeting in oceanography in the year 2001. This idea has been endorsed by the two organizations, since it was felt that a well structured and focused meeting, together with the biological oceanographic and fisheries science communities would be a valuable mechanism for promoting interdisciplinary cooperation in marine science. It was also suggested that a Joint IAPSO-IABO Assembly might be of interest to SCOR, The Oceanography Society and other organizations which might wish to co-sponsor the meeting or one or more of the symposia. IAPSO and IABO have separately considered whether the proposed joint meeting should be expanded into a Joint Oceanographic Assembly, but neither Association was in favor of this approach out of concern that the meeting might become too unwieldy, be difficult to organize, and lose focus. IAPSO and IABO tend to favor a meeting where the symposia can address interdisciplinary issues of the type that are not well catered for in other forums, and in particular to promote ongoing dialogue between IAPSO and IABO. Although no decision had yet been made about the venue yet, suggestions include Canada (Rimouski), Argentina (Buenos Aires) and South Africa (Cape Town) inter alia. With respect to a date the meeting would probably be in mid-2001 but timed so as not to clash with the IAMAS Assembly.

These decisions agreed well with the results of the discussion on a similar topic in the report of the SCOR Strategic Review Meeting (see item 3.5). Namely that SCOR should not independently undertake the organization of large meetings. If IABO and IAPSO proceed with these plans, SCOR involvement may indeed be appropriate. This should be discussed at the General Meeting in 1998.

6.3 Other meetings of interest to SCOR

The Executive Director presented a list of international meetings of interest to SCOR during the next two years. In some cases, she sought decisions on requests for SCOR cosponsorship and/or support of these events. The results of these discussions are indicated below.

Meetings for which SCOR cosponsorship was authorized by the General Meeting in 1996:

September 22-24 1997	ICES International Symposium. Recruitment Dynamics of Exploited Marine Populations: Physical-Biological Interactions. The Johns Hopkins University, Baltimore, USA.
October 15-181997	A Symposium on Ocean Data for Scientists: Management and Exchange of Information for Scientific Use. Dublin, Ireland.
May 18-22 1998	Oceanic Fronts and Related Phenomena. Konstantin Fedorov Memorial Symposium. Sankt-Petersburg, Russia. A request for a substantial financial contribution was received after cosponsorship had been granted, but was not approved by the Executive Committee meeting, except for the use of some funds from the NSF grant to assist scientists from Russia and developing countries to participate. It was agreed that if the new WG on Groundwater did not seem likely to need any of the funds allocated to new working groups, a small contribution could be made from general SCOR funds.
May 24-29 1998	Ocean Circulation and Climate: The Conference of the World Ocean Circulation Experiment. Halifax, N.S., Canada. A request for assistance with the travel expenses of speakers from developing countries, Eastern Europe and Russia was approved.
June 1-4 1998	The Oceanography Society and IOC Meeting on "Coastal and Marginal Seas". UNESCO Headquarters, Paris, France. Discussed under item 5.5.
August 17-211998	International Conference on Satellites, Oceanography and Society. EXPO '98, Lisbon, Portugal. This was discussed under the next agenda item.

Requests for SCOR sponsorship were received for the following meetings:

November 10-16 1997	Marine Benthic Habitats and Their Living Resources: Monitoring, Management and Application to Pacific Island Countries. Noumea, New Caledonia. SCOR sponsorship was approved without any commitment of funds.
November 17-19 1997	Marine Analytical Chemistry for Monitoring and Oceanographic Research. Brest, France. A preliminary enquiry about SCOR sponsorship had not been followed by a formal request. Concern was expressed that this meeting did not appear to be sufficiently international to warrant support from SCOR.
April 19-25 1998	Third International Seagrass Biology Workshop. Marine Science Institute, University of the Philippines. This request was accompanied by a draft budget which seemed to be out of proportion for the size of the meeting being planned and did not include any provision for travel assistance to needy scientists. It was felt that the meeting should be largely self financing and that many savings could be made in the projected expenditures. It was not endorsed by SCOR.
August 15-20 1998	Sixth International Conference on the History of Oceanography, Qingdao, China. This series of meetings has traditionally been cosponsored by SCOR and it was agreed that this meeting should be supported.
August 23-28 1998	6th International Conference on Paleoceanography. Reconstructing Ocean History: A Window into the Future. Lisbon, Portugal. The cosponsorship of this meeting should not be linked to the question of Portuguese membership in SCOR. It should be cosponsored, not only because the IMAGES Scientific Committee will meet in conjunction with this event.

The following meetings may be of interest to SCOR members. Information about any of them (past or future meetings) may be obtained from the Secretariat:

October 10-13 1997	Global Change Science in the Coastal Zone. LOICZ. Noordwijkerhout, The Netherlands.
October 27-29 1997	Bordomer 97. Coastal Environment Management and Conversation. Bordeaux Convention Center, France.
November 24-28 1997	Marine Cyanobacteria and Related Organisms. Marseilles, France.
December 4-5 1997	XX Symposium on Polar Biology. National Institute of Polar Research, Tokyo, Japan.
March 17-20 1998	GLOBEC Open Science Meeting. Paris, France.
April 19-23 1998	1st IGBP PAGES Open Science Meeting. Past Global Changes and their Significance for the Future. Royal Holloway College, University of London.
August 24-28 1998	SCAR - International Symposium on Polar Aspects of Global Change, Tromsø, Norway.
September 5-9 1998	Sixth International Symposium on Antarctic Glaciology (ISAG-6), Lanzhou, China.

6.4 International Conference on Satellites, Oceanography and Society (ICSOS)

The sponsorship and provision of administrative support to this meeting (Lisbon, Expo '98, August 17-21 1998) is a major contribution of SCOR to the events marking the International Year of the Ocean. Information on the status of planning was provided by the Executive Director and in a report from the ICSOS Chair, David Halpern. Commitments of sponsorship and financial support have been obtained from various space agencies (NASA, NASDA, ESA and CNES) and from NOAA, IOC and WCRP in addition to the provision of space and some services by the Expo '98 organization. An Executive Council has been established as well as a Scientific Organizing Committee. Planning for the program was well advanced at the time of the SCOR meeting and it includes the following major themes: Weather and Waves Prediction; Geophysical Exploration; Living Resources Assessment and Prediction; Seasonal-to-Interannual Climate Prediction, and; Decadal Climate Prediction.

7.0 OTHER BUSINESS

7.1 Regional Graduate Education in Oceanography in Developing Countries

Ian Jones presented a proposal to SCOR which arose from his experience in teaching during a graduate training program in oceanography at the University of Concepcion in Chile which may be unique in its regional approach. Students come from a number of countries in the South American region. The objective of this program is to offer Master's and Doctoral degrees comparable in quality to those offered in the developed world. In part this is achieved by concentrating the effort in one location and by inviting leading scientists from industrialized nations to become visiting faculty members at Concepcion and to teach short (3-4 weeks), intensive courses in their fields of specialization. A number of SCOR members, including past and current Presidents, in addition to Jones, have been visiting faculty members. The coordinator of this program, José Stuardo (also a SCOR member) asked Jones to propose that SCOR lead an effort to study its applicability in other developing regions of the world.

This concept was discussed in some detail during the visit of the Executive Director of the Third World Academy of Sciences, Mohammed Hassan, to the SCOR meeting. In general, he endorsed the concept of such a regional approach and he offered to search the TWAS data base to identify oceanographic institutions in the member countries of TWAS. Cintia Piccolo (Argentina) enthusiastically endorsed the proposal from Stuardo and Jones and noted a prior IAPSO interest in this concept.

It was agreed that this proposal should be developed by Stuardo and Jones, with assistance from the Executive Director, and submitted to the Rockefeller Foundation for support for a small meeting to be held at their Bellagio Conference Center. This meeting would develop the concept of regional graduate education in marine science in much more detail. TWAS should also be kept involved in this process.

CLOSURE OF THE MEETING

The President of SCOR formally closed the 33rd Executive Committee meeting, extending his gratitude on behalf of all members of the Committee to the Brazilian SCOR Committee for its enthusiasm, for the extensive participation of its members in the meeting and for all the information on their scientific activities that had been presented during the week. Field thanked especially the local organizers, Izabel Gurgel and Fred Herms as well as their students who had provided so much help during the meeting. The extent to which these students and the international participants in the Executive Meeting had been able to interact, both scientifically and socially was especially rewarding for everyone. The experience of Brazilian culture, the ambiance of the city of Rio de Janeiro and the field trip planned for the following day would provide special memories for all of the visitors to Brazil. Once again, he thanked all those involved and declared the meeting adjourned.

ANNEX 1 - List of Participants
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Rio de Janeiro, Brazil - September 8-12 1997

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ANNEX 2 - Agenda

33rd EXECUTIVE COMMITTEE MEETING OF SCOR

Luxor Hotel Regente
Rio de Janeiro, Brazil

September 8-12 1997

1.0 OPENING

1.1 Opening Remarks and Administrative Arrangements

1.2 Approval of the Agenda
Additions or modifications to the Draft Agenda as distributed may be suggested prior to approval of the final version.

1.3 Report of the President of SCOR
The President will briefly review activities since the XXIII General Meeting (September 1996).

1.4 Appointment of an *ad hoc* Finance Committee
The Constitution requires that a Finance Committee be appointed at every SCOR meeting. It reviews the administration of SCOR finances during the previous fiscal year and the current year. It also works with the Executive Director to draw up a budget for the next year's activities based on the decisions taken during the meeting. The Committee will report under agenda item 3.3.

2.0 SUBSIDIARY BODIES

2.1 Arising from Former Working Groups

2.1.1 ***WG 78 Determination of Photosynthesis Pigments in Seawater***
The monograph on pigment methods has been published by UNESCO. *[Gross]*

2.1.2 ***WG 80 Role of Phase Transfer Processes in the Cycling of Trace Metals in Estuaries***
Progress with the final report. *[Gross]*

2.1.3 ***WG 89 Sea Level and Erosion of the World's Coastlines***
Progress with final report and plans for its publication. *[McCave]*

2.1.4 ***WG 93 Pelagic Biogeography***
Progress with the publication of the Proceedings of the International Conference on Pelagic Biogeography, Amsterdam, July 1995. Recommendations for future SCOR activity in the field of biogeography. *[Rothschild]*

2.1.5 ***WG 95 Sediment Suspension and Sea Bed Properties***
Presentation of final report, and publication of a collection of articles in Volume 11, *Journal of Marine Systems. [Krishnaswami]*

2.1.6 ***WG 97 Physiological Ecology of Harmful Algal Blooms (with IOC)***
Progress with publication arising from the NATO ASI (May 1996). *[Sundby]*

2.1.7 ***WG 101 Influence of Sea State on the Atmospheric Drag Coefficient***
Progress with a monograph on "Drag over the Ocean". *[Duce, Jones]*

2.2 Current Working Groups

2.2.1 ***WG 86 Ecology of Sea Ice***
Report on the Gordon Conference on "The Ecology of Sea Ice Biota" (March 1997) and progress with final publication, a book on Sea Ice Ecology. *[Gross]*

2.2.2 ***WG 98 Worldwide Large-scale Fluctuations of Sardine and Anchovy Populations***
Plans for final meeting in October 1997, and merging of this activity with the GLOBEC effort on Small Pelagics and Climate Change. *[Field]*

2.2.3 ***WG 99 Linked Mass and Energy Fluxes at Ridge Crests***
Progress with the preparation of a "booklet" on ridge processes and fluxes. Publication of the abstracts of the papers presented at the Symposium on Mid-Ocean Ridges held at the SCOR General Meeting in 1996. *[McCave]*

2.2.4 ***WG 102 Comparative Salinity and Density of the Atlantic and Pacific Ocean Basins***
Chief reviewer's comments on the paper by the working group. Suggestions for follow-up action from Shannon and Clarke. The meeting must decide how to finalize and disseminate this report. *[Piccolo for Shannon]*

2.2.5 ***WG 103 The Role of Wave Breaking on Upper Ocean Dynamics***
Plans for a second meeting in late 1997 have been postponed until April 1998. *[Jones]*

2.2.6 ***WG 104 Coral Reefs Responses to Global Change: The Role of Adaptation (with LOICZ)***
Plans for a meeting in January 1998 and a session at the Conference of the Society for Comparative and Integrative Biology. Other WG 104 activities. *[Sundby]*

2.2.7 ***WG 105 The Impact of World Fisheries Harvests on the Stability and Diversity of Marine Ecosystems (with PICES)***
Report of the first meeting (November 1996). Plans for second meeting in early 1998. *[Rothschild]*

2.2.8 ***WG 106 Relative Sea Level and Muddy Coasts of the World***
Report on the preparation of a publication by WG 106. The final meeting of WG 106 will take place September 1-5. An effort will be made to get a report in time for consideration at the Executive Committee meeting. *[McCave]*

2.2.9 ***WG 107 Improved Global Bathymetry***
Report of the first meeting of WG 107 (November 1996). Plans for a second meeting in Baltimore (October 1997). Links to IOC effort on bathymetry. *[Piccolo for Shannon]*

2.2.10 ***WG 108 Double Diffusion***
Report of the first meeting of WG 108 (May 1997). Plans for future activities. *[Jones]*

2.2.11 ***WG 109 Biogeochemistry of Iron in Seawater (with IUPAC)***
Progress with the establishment of WG 109 - discussions with IUPAC. Preliminary work is to be by correspondence. Future activities. *[Duce]*

2.2.12 ***WG 110 Intercomparison and Validation of Ocean Atmosphere Fluxes (with WCRP)***
Report on the establishment of WG 110. Plans for first meeting in October 1997. Future activities. *[Lappo]*

2.2.13 WG 111 Coupling of Waves, Currents and Winds in Coastal Models
Report on the establishment of WG 111. Plans for preliminary activities and a first meeting - an application for support has been sent to NASA. *[Jones]*

2.3 Committees and Panels

2.3.1 Editorial Panel for the Ocean Modelling Newsletter
The latest issue published is No 113. The future of publishing this Newsletter in the traditional way is in doubt after funding expires at the end of 1997. *[Gross]*

2.3.2 Joint Global Ocean Flux Study Scientific Steering Committee
The outgoing Chair of JGOFS will present this report. Activities in 1997 and plans for 1998. Transition to synthesis and modeling phase of JGOFS as field activities are concluded. Re-structuring of the JGOFS SSC. Nominations for new SSC members. Proposed changes to JGOFS/IOC Carbon Dioxide Panel terms of reference and membership. Other JGOFS business. *[Sundby, Field]*

2.3.3 SCOR/IGBP/IOC Committee on Global Ocean Ecosystems Dynamics
Publication of the GLOBEC Science Plan. Report on first and second meetings of reconstituted GLOBEC SSC. Development of GLOBEC Implementation Plan. Plans for GLOBEC Open Science Meeting (Paris, March 1998). Nominations for new SSC members. Other GLOBEC business. *[Piccolo for Shannon, Rothschild, Field, Gross and Swanberg]*

2.3.4 SCOR/IGBP Task Force on a Surface Ocean - Lower Atmosphere Study
Report (and comments from SCOR Officers) of a task group meeting held in London (January 1997). Proposal for a major workshop in late 1998/99. The Executive Committee must discuss plans for the further development of SOLAS and make recommendations for joint action by SCOR and IGBP. *[Krishnaswami, Duce, Field]*

2.4 Proposals for New Working Groups
The following proposals are being circulated to all national committees for comments:

2.4.1 Influence of Submarine Groundwater Discharge on Coastal Oceanographie Processes
A proposal for a Working Group to be co-sponsored by the LOICZ program of IGBP. *[Presenter to be determined]*

2.4.2 Asian Monsoon Evolution in Marine Records: Comparison Between Indian and East Asian Subsystems
A proposal arising from the IMAGES program. *[Wang]*

2.4.3 International Exchange of Biological Samples from Hydrothermal Vents
A proposal arising from the InterRidge program. *[McCave]*

2.4.4 Limits to Predictability
A proposal from the UK SCOR Working Group. *[Jones]*

2.4.5 Inclusion of Management of Coastal Ecosystem in SCOR Activities
This proposal was received from the Pakistani SCOR Committee too late to be circulated to national committees for comments prior to the meeting. Accordingly it should only be discussed in a preliminary way. *[Gross]*

2.5 Affiliated Programs

Reports have been received from each of these Affiliated Programs accepted by the SCOR General Meeting in 1996. These reports are primarily for information since it was agreed that Affiliated Programs would be reviewed biennially at General Meetings.

2.5.1 ***Acoustic Thermometry of Ocean Climate (ATOC)*** *[Piccolo for Shannon]*
Scientific highlights and development of the ATOC program. Request for advice from SCOR Executive on membership issues for action at ATOC meeting in India, October 1997. *[Piccolo for Shannon]*

2.5.2 ***International Marine Aspects of Global Change (IMAGES - with PAGES/IGBP)***
Report from IMAGES Scientific Committee meeting, Stockholm, August 18-20, to be transmitted. *[McCave]*

2.5.3 ***International Antarctic Zone (iAnZone)***
Plans for iAnZone meeting at Biosphere 2, December 1997. *[Piccolo for Shannon]*

2.5.4 ***InterRidge (International Ridge Studies)***
Report from InterRidge. *[McCave]*

In addition, two programs have made preliminary enquiries about an affiliation with SCOR:

2.5.5 ***The International Ocean Colour Coordinating Group (IOCCG)***
At their meeting in Baltimore in April, the SCOR Officers approved a request for the SCOR Secretariat to assume responsibility for financial administration on behalf of the IOCCG. Information on IOCCG will be presented and the current arrangement will be reviewed. The IOCCG Executive meets on October 7 and may request a more formal relationship as an Affiliated Program of SCOR. *[Gross, Field]*

2.5.6 ***Sir Alister Hardy Foundation for Ocean Science***
A letter from the Director of SAHFOS, which operates the Continuous Plankton Recorder Survey transmits a preliminary enquiry. In response the Executive Director sent information on the criteria for the Affiliated Program status on August 11. If a formal request is received prior to the meeting, it should be discussed. *[Gross]*

3.0 ORGANIZATION AND FINANCE

3.1 Membership

The Membership Officer and the Executive Director will report on changes in SCOR membership since September 1996. Other membership issues. *[Krishnaswami, Gross]*

3.2 Publications Arising from SCOR Activities

The Publications Officer and the Executive Director will present a report on publications arising from SCOR activities since September 1996. Publication of a SCOR Newsletter. *[Sundby, Gross]*

3.3 Finance

The *ad hoc* Finance Committee and the Executive Director will review the state of SCOR finances for the past and current fiscal years. The *ad hoc* Finance Committee will report to the Executive Committee Meeting on this review and will present a budget for 1998 activities and recommendations regarding the levels of membership contributions to SCOR for 1999. *[Finance Committee, Gross]*

3.4 Establishment of a Nominations Committee in Preparation for Elections at 1998 General Meeting
The two year terms of the Secretary and all three Vice-Presidents of SCOR will expire at the General Meeting in 1998. The current Secretary (Bjorn Sundby, Canada) and one Vice-President (Sergei Lappo, Russia) are eligible to be re-elected. Two Vice-Presidents (S. Krishnaswami, India and Wang Pinxian, China) are not eligible for re-election since they will have served for four years by the time of the XXIV General Meeting.
A Nominations Committee will be established in preparation for elections at the XXIV General Meeting. See also item 3.5.2 below. *[Field]*

3.5 Other Organizational Issues

3.5.1 Strategic Review of SCOR
The report of a meeting convened to review SCOR's role in the international scientific arena, and its modes of operation, was circulated to all SCOR national committees and individual SCOR members. The implications of this report will be discussed. *[Field]*

3.5.2 Constitutional Review
At the XXIII General Meeting, a group was established to draft a set of procedures for the nomination and election process. The preliminary report of this group will be discussed by the Executive Committee Meeting prior to circulation to national committees for approval and implementation as part of the election process for the General Meeting in 1998. *[Jones, Gross]*

4.0 RELATIONS WITH INTERGOVERNMENTAL ORGANIZATIONS

Reports have been requested from the following organizations with which SCOR has joint interests:

4.1 Intergovernmental Oceanographie Commission (IOC)
The report covers a number of items of mutual interest; the Global Ocean Observing System, Harmful Algal Blooms, etc. Items arising from the IOC Assembly attended by the President and Executive Director of SCOR. International Marine Science Newsletter, Global Bathymetry, an Ocean Science Assessment. Request from IOC for SCOR to contribute to development of a science program on harmful algal blooms. Other IOC business. *[Field, Gross]*

4.2 World Meteorological Organization (WMO)
A written report briefly describes items of mutual interest

4.3 International Council for the Exploration of the Sea (ICES)
Report from ICES on joint activities and others of mutual interest. Request to SCOR to be "co-publisher" of a zooplankton methodology manual. Request for SCOR to be a "co-organiser" of an ICES Symposium on the Ecosystem Effects of Fishing to be held in 1999. This meeting will, in part, be the final activity of WG 105. Other ICES matters. *[Rothschild]*

4.4 North Pacific Marine Science Organization (PICES)
A written report briefly describes items of mutual interest. SCOR will be represented at the forthcoming meeting of PICES (Pusan, South Korea) by Shizuo Tsunogai and Ian Perry, a member of the GLOBEC SSC.

4.5 Commission on the Conservation of Antarctic Marine Living Resources (CCAMLR)
No report had been received as this agenda was prepared. CCAMLR has expressed interest in a number of SCOR activities related to marine ecosystems. *[Gross]*

4.6 Others

Report from the SCOR representative to a meeting of the Joint Group of Experts on the Scientific Aspects of Marine Pollution (GESAMP) which is undertaking a new study of the Health of the Ocean. *[Duce]*

5.0 RELATIONS WITH NON-GOVERNMENTAL ORGANIZATIONS

5.1 International Council of Scientific Unions

Response from SCOR to the Report of the Assessment of ICSU. The implementation of the many recommendations of the Assessment Panel will be the subject of an Extraordinary General Assembly of ICSU on April 25 1998. Additional input has been sought from all ICSU bodies and will be discussed by the meeting. Should SCOR be represented at the Extraordinary General Assembly? *[McCave]*

Status of the ICSU review of SCOR to be conducted during 1997. The ICSU Officers have agreed to postpone this review following a protest from SCOR and have sought input from SCOR as they consider how to improve the review process. Comments will be sought from participants. *[Field et al.]*

5.2 ICSU Unions and Committees

Reports have been requested from the following ICSU bodies which have representatives to SCOR. Matters of interest will be brought to the attention of the meeting.

5.2.1 International Geosphere-Biosphere Program

SCOR-IGBP interactions will be discussed in relation to JGOFS, GLOBEC, SOLAS and LOICZ. The Deputy Executive Director of IGBP will bring other IGBP issues to the attention of the meeting as needed. *[Swanberg]*

5.2.2 World Climate Research Program

A written report summarizes the current status of WOCE, CLIVAR and other WCRP activities relevant to SCOR. Request from US WOCE for SCOR action to encourage submission of WOCE data internationally. *[Jones]*

5.2.3 Scientific Committee on Problems of the Environment (SCOPE)

The role of SCOPE and SCOR in relation to a number of assessments of the oceans currently underway or planned (IOC, GESAMP, GIWA, etc.). *[Gross]*

5.2.4 Others [Gross]

Scientific Committee on Antarctic Research (SCAR)
Committee on Space Research (COSPAR)
International Union of Pure and Applied Chemistry (IUPAC)
International Union of Pure and Applied Physics (IUPAP)
International Union of Theoretical and Applied Mathematics (IUTAM)
etc.

5.3 Affiliated Organizations

Reports have been requested from the following organizations and matters of interest will be brought to the attention of the General Meeting. The Presidents may also present verbal reports as *ex officio* members of the Executive Committee.

International Association for Biological Oceanography [written report only]
International Association for Meteorology and Atmospheric Sciences
Proposal for an ALLIANCE between the national meteorological and hydrological services (through the WMO), the world's university system (through UCAR) and the scientists at large (through IUGG (IAMAS). Other IAMAS issues. *[Duce]*

International Association for the Physical Sciences of the Ocean
Proposal for a joint effort with IABO to organize and international, interdisciplinary oceanographic meeting in 2001. See also item 6.2. Other IAPSO issues. *[Piccolo]*

5.4 Corresponding Organizations
Reports have been requested from the following organizations and matters of interest will be brought to the attention of the meeting.

Arctic Ocean Sciences Board
Engineering Committee on Oceanic Resources
Confederation Mondiale des Activités Subaquatiques (Scientific Committee)

5.5 Other Organizations

The Oceanography Society
Request to SCOR to co-sponsor the TOS Scientific Meeting on the theme of Coastal and Marginal Seas", Paris, June 1998. Other TOS matters. *[Duce]*

6.0 FUTURE MEETINGS

6.1 Future meetings of SCOR
The ***XXIV General Meeting*** will take place in Texel, The Netherlands, in September 1998. The representative of the Dutch SCOR Committee will present information on the plans for this meeting and for an associated scientific event. *[de Baar]*

The ***Thirty-fourth Executive Committee Meeting*** of SCOR will take place in India in 1999. Preliminary arrangements for this meeting will be discussed. *[Krishnaswami]*

6.2 International Oceanography Meeting
There have been discussions between IABO and IAPSO about the desirability of organizing and international, interdisciplinary meeting in oceanography in the year 2001. The SCOR Strategic Review Meeting (see item 3.5.1) also considered this matter and the possibility of involving SCOR, and perhaps The Oceanography Society, in this effort has been considered. The Executive Committee meeting should decide whether SCOR should move forward with this suggestion. *[Field]*

6.3 Other meetings of interest to SCOR
The Executive Director will present a list of international meetings of interest to SCOR during the next two years. In some cases the meeting will be asked to decide on requests for SCOR cosponsorship and/or support of these events. *[Gross]*

6.4 International Conference on Satellites, Oceanography and Society
The sponsorship and provision of administrative support to this meeting (Lisbon, Expo '98, August 17-21 1998) is a major contribution of SCOR to the events marking the International Year of the Ocean. Information on the status of planning will be presented for discussion. *[Gross]*

7.0 OTHER BUSINESS

7.1 A Regional Approach to Graduate Education in Oceanography in Developing Countries
A proposal to be introduced by Ian Jones.

CLOSURE OF MEETING

ANNEX 3 - Final Report - Sediment Suspension and Sea Bed Properties

The abstracts of the articles which appeared in the *Journal of Marine Systems*, Vol 11, No. 3-4, 1997 are reprinted with the permission of the publisher, Elsevier Science.

SCOR Working Group 95
SEDIMENT SUSPENSION AND SEA BED PROPERTIES
FINAL REPORT

1. INTRODUCTION

In the late 1980s interactions between pelagic and benthic systems were mainly investigated with special focus on vertical sedimentation of particles from the productive euphotic zone in the ocean or the release of dissolved matter from the seafloor into the water-column. It was well known that close to the seafloor turbidity or nepheloidal zones with increased concentration of suspended matter do exist. indicating the relevance of physical sediment resuspension. However, the processes of their formation were only poorly understood. Especially, since radionuclide measurements in the nepheloidal layers in the deep-sea suggested a surprisingly short residence time for particles in the near bottom water. Additionally, it became more evident, that animals influence the particle exchange between near bottom water and the sediments strongly.

Constructing a realistic budget for a sedimentary system, e.g. for carbon, requires the knowledge of various processes, which influence the particle dynamics above and below the sediment-water-interface. Thus this budget should include vertical sedimentation and biodeposition, physical resuspension and bioentrainment. lateral advection. the sediment mixing and burial rate. Individual particles can be maintained in a resuspension loop for many years, in the deep-sea for several thousand years. The extension of This resuspension loop extends from the bioturbation depth in the sediment to the particle mid water minimum in the water-column and is influenced by all above mentioned processes.

In this loop a particle experiences a wide variety of chemical conditions. Well oxygenated conditions in the nepheloid layer, anoxic pore water in the sediment and various types of digestive regimes in animal guts. In recent years it was shown that aggregate formation is an important process close to the seafloor and that microbial colonisation and modification of these particles is of great importance.

Apart from the advancement in knowledge in an important but rather neglected field, systematic analyses of these processes could guide to identify and predict potential modem burial sites of anthropogenic carbon and marine pollutants like xenobiotics and heavy metals. For these reasons the XX General Meeting of SCOR at Warnemünde, FRG, approved the establishment of Working Group 95 on "Sediment Suspension and Sea Bed Properties" and defined the following Terms of Reference:

1) To review and summarise the information available on the changes that occur to suspended material in the region of resuspension close to the sea bed.
2) To identify the conflicts shown by the data and propose approaches for their resolution.
3) To assess the impact of these processes and changes on the properties of the sea bed.
4) To prepare and convene a symposium to present the working group 5 result and current research in the field.

The following members contributed to the work of WG 95

Blackburn	Denmark	Nyffeler	Switzerland
Boudreau	Canada	Rosenberg	Sweden
Brattegard	Norway	Rutgers van der Loeff	Germany
Graf (Chairman)	Germany	Wainright	USA
Kontar	Russia		

From the expertise of the group members it is obvious that the biological and geochemical part of the resuspension loop was the main focus which was strengthened by the contribution of a physicist and a modeller.

2. ACTIVITIES OF WG 95

The first meeting of WG 95 was held in Mel, September 14 to 16, 1992. After a first discussion of the terms of references it was decided to organize the review task as follows:

1) Mathematical modelling of resuspension and sediment mixing
2) Tracers in the study of resuspension
3) Inorganic chemical chan~es in the nepheloid layer.
4) Animals in the BNL
5) Microbial processes in the BNL
6) Biodeposition and Bioresuspension
7) Geological/ecological monitoring of the near-bottom layer (technical equipment and methodology)

A more detailed report of the meeting was added to our annual report in 1993. It was decided to prepare these reviews as articles in a scientific journal and to discuss the first drafts of these papers during a second meeting.

he second meeting was held at the University of Neuchatel, Switzerland, from May 21 to *25,* 1994, hosted by F. Nyffeler. The main purposes of this meeting were to finish the review task, to discuss the identified gaps in our knowledge and to assess the impact of these processes on the sea bed (see terms of references 2 and 3).

The review articles were finished in the spring of 1995 and sent to the peer reviewed Journal of Marine Systems. Unfortunately the publishing process took another two years (see section 3 in this report). The second part of the meeting was used to compile a list of open questions which are presented in detail in section 4.

The final topic of our terms of references was to organize or to contribute to a symposium on the current research in the field. The first plan to organize a special session at the meeting of the IASWI (International Association of Sediment Water Interaction) failed and it was decided to join the International Symposium on "Computerized Modelling of Sedimentary Systems" which was held in Güstrow, 8.-1 1.10.1996.93 scientists from 20 countries participated. This meeting was funded by the German Science Foundation and cosponsored by SCOR. 4 members of WG 95 contributed with talks and posters and the group used the occasion for a final meeting. Selected talks of this meeting will be published as a book. published by Springer-Verlag. At this meeting the presentations of WG 95 were highly appreciated by the participants and stimulated fruitful discussions.

3. PUBLICATIONS

The terms of references proposed to review the existing knowledge in the field, to identify gaps and to assess the impact of the most important identified processes on sea bed properties. The results of this discussion were published in a special section of the Journal of Marine Systems vol.11: 267 - 386. First of all the prepared articles review the existing knowledge and by this a lot of open questions became apparent. Especially our second meeting stimulated the members to apply and to modify their existing models to the resuspension problem. The review of the existing mathematical models revealed that there was no model available which describes the entire resuspension loop. Most models deal with either the upper half of the cycle in the water or with the lower one in the sediment, assuming the sediment-water interface as a boundary condition. By allowing a non-local mixing between the two half cycles a first step towards a new model was presented, which subsequently was applied to the modelling of radio tracer distribution and investigating the dissolution processes of opal and calcite in the benthic nepheloid layer (BNL) The first results Suggest, that in contrast to the sediments, where resuspension has little effect on the nutrient cycling, in the BNL the nutrient dynamics may be majorly influenced.. Animals are responsible for the non-local exchange of panicles. A topic which is very difficult to be described in quantitative terms.

BIORESUSPENSION AND BIODEPOSITION: A REVIEW

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Abstract
The present Literature on biologically mediated fluxes from the benthic nepheloid layer (BNL) across the sediment-water interface into the sediment and vice versa is reviewed. The processes involved are categorised according to direct bioresuspension and biodeposition, i.e. direct interception of the animal with particles, and those effects, which are indirectly created by benthic Organisms e.g. changes of physical properties in the sediments, constructions like tubes and pits and the Corresponding changes in hydrodynamic conditions. It is concluded that benthic organisms significantly increase the flux of particles across the interface and that the physically created fluxes are easily modified by a factor of 2 and more.

A ONE-DIMENSIONAL MODEL FOR BED-BOUNDARY LAYER PARTICLE EXCHANGE

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Abstract
This paper discusses the coupling between transport processes in fine-grained sediment beds and those in the overlying boundary layer. A review of currently available, separate bed and boundary layer models indicates that they do not constitute a basis for a complete description of these couplings. Consequently, new boundary conditions and nonlocal transports terms for resuspension arc proposed in order to obtain satisfactory coupling between suspended and bottom sediments. The nonlocal transport can account both for resuspension from a finite surficial zone of sediment and its redistribution in the boundary layer. Profiles of total suspended matter generated with this new mode! resemble those observed in marine environments. Application to a suspended matter profile from the Oregon Shelf suggests that this sediment is resuspended at a mean rate of about 0.4% per day to a mean height of about 3 cm. This material is then redistributed by eddy mixing to produce a classic profile that decreases with height above the bed.

THE EFFECT OF RESUSPENSION ON CHEMICAL EXCHANGES AT THE SEDIMENT WATER INTERFACE IN THE DEEP SEA. A MODELLING AND NATURAL RADIOTRACER APPROACH.

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Abstract
We review the processes responsible for the formation of vertical gradients in the chemical composition of suspended particles across the benthic nepheloid layer. Such gradients have usually been explained by resuspension of surface sediments, but it is shown here that these gradients can only be understood as part of a dynamic exchange between the water column and the sediments. A coupled model, developed in a companion paper, is expanded to include chemical reactions above and below the sediment-water interface. Three cases are discussed: A tracer with first order decay (Model 1), the dissolution of a major constituent (Model 2), and a particle-reactive tracer with first-order decay and production in the water column (Model 3). Using typical parameter values for a well-developed benthic nepheloid layer, the three models reproduce typical distributions of C_{org} (organic carbon), opal. and ^{234}Th, respectively, on particles above and below the sediment-water interface. Sensitivity analyses illustrate how bioturbation can cause the large discrepancy observed between suspended and surface sediment C_{org}

values (Model 1). The model also reconciles this observed discrepancy with observations that the major part of the decomposition takes place within the sediment. For opal (Model 2), the influence of resuspension on the burial rate of opal is shown to be negligible, as long as dissolution follows first order kinetics and is not enhanced by turbulence in the suspended phase. The modelling of ^{234}Th (Model 3) successfully links the depletion of ^{234}Th in bottom waters with the distribution of excess ^{234}Th in surface sediments and on resuspended particles. ^{234}Th is a powerful example of the tools supplied by the radioactive daughters of the natural U and Th decay series in studying fluxes and exchange rates of solutes and particles across the sediment-water interface. A short review is given of these tools, and it is shown how they can be used to obtain rate information required to apply and calibrate specific resuspension models.

RELEASE OF NITROGEN COMPOUNDS FOLLOWING RESUSPENSION OF SEDIMENT: MODEL PREDICTIONS

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Abstract

Simulation models were used to predict the concentrations of dissolved organic nitrogen (DON), ammonium and nitrate in sediment pore waters, under various conditions. The quantity of particulate organic matter (POM) undergoing decomposition varied from 5 - 85 mmol C $m^{-2}d^{-1}$; this POM had C:N ratios of 5 or 10, and was distributed in three different ways. The POM was either located close to the sediment surface, or decreased linearly from the surface. or was completely mixed into the sediment. The effect of resuspending the sediment to various depths, for this suite of profiles, was determined. The different distributions gave unique patterns, but it was concluded that sediment must be resuspended to considerable depth before any major contribution was made to the overlying water. Thus, at the highest POM degradation rate, in order to get a liberation of ΣN of 5 mmol m^{-2} it was necessary to resuspend the top, linear and mixed distributions to depths of 2.4, 1.2 and 0.8 cm respectively. The model predicted that after mixing of the latter to 2.4 cm, profiles of ammonium and other molecules had returned to pre-mixing values after ~5 h. It was predicted that resuspension would not increase the quantity of nitrogen molecules exported ro the overlying water, but it would affect the timing.

EFFECTS OF SEDIMENT RESUSPENSION ON ORGANIC MATTER PROCESSING IN COASTAL ENVIRONMENTS: A SIMULATION MODEL

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Abstract

A model, constructed using STELLA™ was used to simulate changes in standing stocks and flows of organic matter resulting from resuspension in shallow coastal environments. Previous studies suggested that resuspension may determine the sites and rates of organic matter mineralization in shallow environments (Hopkinson, 1985, 1987). Those studies predicted that resuspended organic material could exert an enhanced demand on dissolved oxygen. Our model results support this hypothesis. Total system metabolism receives increasing contributions from the water column as settling rates decreases. Water column respiration also increases relative to benthic respiration as the frequency and intensity of resuspension events increases. This is driven by higher specific degradation rates in the water column than in the benthic environment. Furthermore, overall respiration (benthic+pelagic) increases in response to resuspension.

ON THE BENTHIC BOUNDARY LAYER'S DYNAMICS

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Abstract

The Shirshov Institute of Oceanology in cooperation with other specialized Russian institutions has developed autonomous self-contained instruments (ADS) for long-term investigations of the benthic boundary layer (BBL) of the ocean. This paper is an analysis of the experience of ADS' S application for long-term investigations of the BBL's dynamics based upon direct measurements of velocity components 2.5 - 25 m above the bottom, simultaneous observation of benthic water temperature and concurrent measurements of local seismicity of the sea floor, as recorded by ADSs, which were deployed more than 50 times at depths ranging from 730 -6125 m on the bottom of the Atlantic and Pacific Oceans and the Mediterranean Sea.

4. GAPS AND OPEN QUESTIONS

1) How do deep-water circulation and bottom topography affect BNLs?

Deep water circulation in the ocean is much less understood than surface current Systems. Especially the temporal and spatial scale of so called deep-sea Storms is unknown. Therefore, the prediction of major resuspension events based on circulation models in the deep-sea is not yet possible. At present the existing data base of near bottom current measurements both with appropriate fine scale resolution and long term records is insufficient. The effect of seamounts and mid-ocean ridges on resuspension is almost not investigated, even though it may be of high regional relevance.

A special emphasis should be given to resuspension and sediment transport on continental margins. In many areas intermediate nepheloid layers INL's were observed. Only in very few cases their occurrence is predictable. In polar regions, where cooling increases the density of shelf water, low density turbidity currents with appreciable down slope velocities and concentrations of suspended matter have been observed in the field as well as predicted by numerical simulations. Furthermore, more attention should be given to the effects of contour-currents, the braking of internal waves on the slope, and tides on the near bed particle dynamics.

2) Is resuspended carbon a missing carbon source?

The BNL may affect mass balances by serving as an intermediary reservoir between the sediments and the water column during lateral sediment transport. Depending on the transport processes involved (e.g. bedload vs suspended load) and the properties of the sedimentary material (settling velocity, density, biogeochemical composition, reactivity) resuspended material may or may not settle in the same area as its source. It may be physically sorted with associated size dependent fates of particles. It may also be subject to feeding (perhaps selective) and re-packaging of the organic material by consumers feeding within the BNL. To the extent that these processes are known or not known, the susceptibility of material within the BNL to lateral advection may lead to inaccuracies of mass balances of constituents of interest.

Lateral advection may also provide an explanation for enhanced secondary production of benthic animals, which in many cases can not be explained by food supply from vertical sedimentation alone. Field measurements and flume experiments, however, are very rare, especially for environments in greater water depths. In most cases the amount of carbon once settled and subsequently redistributed after resuspension is unknown. If lateral transport of organic matter is a missing carbon source, export areas, where less organic matter is consumed, have to be identified.

Concentrations of dissolved organic matter (DOM) in pore-waters are significantly higher than in the BNL. An efflux of DOM from the sediments into the BNL may be one reason for the increased microbial activity observed on near bottom aggregates.

3) Which biological and chemical reactions are stimulated or inhibited during resuspension?
Microbial activity in and on aggregates in the surface waters turned out to be relatively low. Closer to the sea floor in the first meter of the BNL the increased turbulence seems to stimulate microbial activity and to provide an enhanced flux of DOM towards bacterial cells, associated with larger aggregates. (>30 μm)

Biological and chemical reactions depend on the supply rate of reactants and the removal rate of reaction products. These in turn depend both on the composition of the surrounding water and on the hydrodynamic regime. The benthic boundary layer in the deep-sea is homogeneous in temperature. and gradients of solute concentrations (e.g. oxygen and nutrients) are also small. To a first approximation, particles at the sediment surface have therefore usually been considered to be surrounded by bottom water. In this view, resuspension would not change the chemical environment of the particles and as a consequence modelled reaction rates would not be affected by resuspension.

We know now, that gradients exist across the diffusive boundary layer above the sediment. Even the uppermost particles are surrounded by water affected by oxic diagenesis, with lowered oxygen concentration and pH, and enhanced nitrate and silicate. We have to expect that similar gradients exist in dissolved trace metals and organic constituents. Foraminifera living at the sediment surface from calcite with an isotopic signal which is different from bottom water. This implies that resuspension does change the chemical environment of particles to a composition less affected by early diagenesis, with e.g. higher oxygen and lower nutrient contents.

Moreover, turbulence may enhance the exchange of solutes between particle surfaces and surrounding water above the molecular diffusion rate. In small particles, molecular diffusion is predominant even in suspension, but for larger particles the supply of reactants is improved by turbulence. Similar to the process described for bacteria on aggregates chemical exchange rates with surfaces of small particles may increase when they are attached to larger particles.

Thus, both equilibria and kinetics of early diagenetic reactions are expected to be affected by resuspension. Whether the change is significant, depends on the ratio between reaction rates at particle surfaces and diffusion rates. Reactions related to the early decomposition of labile organic material, with release of dissolved organic matter, exoenzymes, uptake of oxygen, and lowering of pH, are likely to be affected. This includes many bacterial activities and the dissolution of calcite. Slower reactions will be less affected. Published values for the dissolution rate of opal in surface sediments imply that the dissolution is surface-reaction-controlled and that the silicate undersaturation at the interface is only little different from that in the overlying water. As a consequence, the effect of resuspension must be small, except if turbulence would tend to enhance the dissolution rate in a yet unknown way.

The question of what reactions are stimulated or inhibited by resuspension can be approached by high-resolution measurements of microgradients of dissolved constituents at the sediment-water interface combined with modelling. Transport terms in the required transport-reaction models can be calibrated with data from the distribution of natural radiotracers. ^{234}Th (24.1 days half-life) has already been used for this purpose, but as it turns out that the residence time of particles in suspension is often too long to be observed with this tracer the potential of other nuclides like ^{210}Po (138 days) and ^{228}Th (1.9 years half-life) has to be explored. While existing data already allow some qualitative predictions to be made, microgradients of many constituents and/or experimental studies on the effect of turbulence on reaction rates are needed to make these estimates more quantitative and extend them to a wider range of reactions.

4) How important are processes in the BNL for mass balances?
The BNL is, by definition, a water mass containing relatively high concentrations of particles which overlies the benthos. As such there is the potential for enhanced particle-to-particle interactions, including collisions, and feeding interactions within the BNL. To the extent that the particles within the BNL are derived from sediments,

there is the potential for enhanced biotic activity in the BNL compared with source sediments. To what extent such a stimulation of biotic activity occurs is most likely dependent on the differences in biogeochemical properties in the sediment and in the BNL. the chemical properties of the organic matter and the degradative capabilities of the consumers. Simply moving organic matter from a sedimentary site to the overlying water may expose the material to electron acceptors like O_2 the supply of which may limit mineralisation within the sediment. Weight-specific degradation rates of organic matter may be at least 10-fold higher in the water column compared with aerobic rates in sedimentary environments. Physical disturbance to sediment communities, even without resuspension is sufficient to generate a stimulatory effect on the mineralisation rate.

1. Shallow water vs deep-sea

The differences in the above effects between deep-sea and shallow water environments would likely be the result of different biogeochemical properties of the sediment and BNL, e.g. amount and lability of organic matter, rather than an effect of depth per se.

2. Oxic vs anoxic conditions

The effect of oxic vs anoxic conditions on the role of the BNL in mass balances of organic matter may be summarised with 3 scenarios, assuming that oxic mineralisation is more rapid than in anoxic environments.

a. Resuspension of organic matter from anoxic sediments into aerobic BNL: There is likely to be a rapid consumption of dissolved oxygen within the BNL via a combination of abiotic and biotic uptake. CO_2 production will also be enhanced, primarily due to mineralisation. The respiratory quotient would likely be greater than I. Other biotically-mediated fluxes would likely proceed at rates related to O_2 and CO_2 fluxes according to the elemental composition of the organic material being degraded.

b. Resuspension of organic matter from aerobic sediments into aerobic BNL: The effect on fluxes would be expected to be smaller than (1) because of mineralization in aerobic sediments is faster than in anaerobic sediments in the first place. (2)The imbalance between CO_2 production and O2 consumption might be smaller because of the dominance of aerobic mineralization with an RQ close to 1.

c. Resuspension of organic matter from anoxic sediments into anoxic BNL: The expected outcome would be a stimulation to anaerobic organic matter processing, with corresponding increases in fluxes of CO_2 and other reduced inorganic or low weight organic substances.

5) How many and what type of particles are produced or destroyed in the BNL?

Although the techniques for the in situ particle size determination has significantly improved there are only few investigations that were carried out in the BNL and few which cover the full range of possible size classes. Particle collision due to turbulence or differential settling will modify the size classes and thus change settling velocities. Although these processes can be modeller data in the BNL are lacking in order to evaluate the models. The enhanced microbial activity close to the sea floor will increase the stickiness of particles and thus aggregate formation. Moreover shear will destroy aggregates creating smaller particles. This bottom near cycle of particle formation and destruction will significantly modify settling velocity and thus residence time. The extent to which production of organisms itself and their feeding activity i.e. clearance rate and pellet production, modifies the particle production in the BNL is almost unknown. According to their high biomasses e.g. on continental slopes, it may be enormous.

6) What is the role of benthic and bentho-pelagic organisms in exchange of matter between the mixed layer in the sediment and the BNL?

While bentho-pelagic organisms may increase the flux from the BNL to the sediment surface, epi- and infauna are responsible for the reverse process of non local exchange between sediments and BNL. Quantitative data, however, are very rare, and mainly consider the problem of biodeposition. Most suspension feeding benthic animals seem to be specialised to feed on small particles. How they deal with aggregates and if special adaptations to larger particles evolved remains to be seen. Bioresuspension, the biologically mediated flux from the sediment into the BNL is one of the most open questions in this context.

Animals do also effect the fluxes indirectly. While small organisms may consolidate the sediment surface with biofilms, modifying the critical shear stress, larger animals affect the exchange across the sediment surface with constructions like tubes, pits and other sorts of biogenic structures. Detailed knowledge on these topics is needed, to develop realistic models to describe the dynamics of suspended matter in the BNL.

7) Is a multidimensional, coupled model needed for the description of sediment - suspended matter interactions?

1. Can a coupled theory (like the one presented by Boudreau) find experimental / observational verification? Can the parameters be estimated simply from a given data set? What tracers can be used to obtain rate data and for which parameters in the model? If the classic equilibrium boundary condition near the sediment-water interface is valid, should there be an effort to discourage its use?
2. The coupled model is currently one-dimensional. Should it be made multidimensional? If not, are lateral processes important and how should they be included in a 1-D model? Will "bursting", and other turbulent motions in the benthic boundary layer that have a lateral component, show up as non-local transports in a properly formulated 1-D model? How could one solve the resulting model?
3. How important is biologically-driven resuspension, and what are the rates of this process? Is this predominantly a boundary flux or a non-local transport? What are the modes of biological resuspension? What data must exist to correctly identify these modes in a given environment, if it matters?
4. Should physical entrainment be formulated to depend on the particle (solid) volume-fraction of the sediments? (Current theories do not do this.) What are the typical rates of this process in oceanic environments, particularly in the deep-sea?
5. Is recognition of particle size-classes important to accurate model predictions of suspended matter and/or tracer distributions? Would continuum models be better descriptions?

ANNEX 4 - Coral Reef Responses to Global Change

SCOR WG 104 - Coral Reef Responses to Global Change: the Role of Adaptation
Report to SCOR Executive Committee – September 1997
Submitted by R. W. Buddemeier, chair, 4 August 1997

Activities since the previous report may be divided into two major categories.

Symposium organization: During late 1996 and early 1997, considerable effort was expended obtaining approval and co-sponsorship for the scientific symposium that will precede the final meeting of WG-104. Those efforts were successful; Appendix A of this report is a copy of the description of arrangements and solicitation of participation that was distributed via the NOAA coral reef list-server and other avenues.

Development of scientific content of the symposium has been the primary focus of activities for the past six months. Invitations to participate in the symposium were initially structured to address all of the terms of reference of WG-104, where necessary drawing on expertise from outside the membership of the group. Since that time substantial effort has gone into coordinating the topics and approaches of the various authors to ensure the maximum possible conceptual and terminological consistency and mutual relevance among the various presentations. This has been accomplished largely by e-mail, augmented by meetings of opportunity among various participants. Appendix B of this report give the current status of the program for the symposium.

American Zoologist will publish the refereed proceedings of the symposium. As indicated in the previous report, a final (see comments below) WG-104 meeting will be held in Boston for approximately three days immediately following the SICB meeting and symposium. The primary focus of this meeting will be the internal review and coordination of the draft symposium papers to produce a coherent and well-integrated overview of the topic rather than a collection of disparate papers. I have invited non-WG symposium participants to contribute to the meeting at their own expense, and I continue to seek additional funding to support those participants who are making major contributions.

Notes and Comments: We have continued the efforts initiated early in the existence of the WG to include and appeal to the broader community of those interested. Not only by drawing other invited speakers into the symposium, but also by achieving a high visibility, co-sponsorship by several organizations, and providing opportunities for contributed paper and poster sessions on related themes, we expect to make the meeting (and proceedings) a milestone in reef research.

I also note that our overall approach and products will fit extremely well with the SCOR initiative to develop a greater presence in policy-oriented matters. This meeting will occur at the conclusion of the International Year of the Reef, and the topics addressed, although very fundamental science, will be clearly and specifically relevant to the concerns of policy makers at all levels. As an example of the context for our contribution, see the recent publication in *Science* (Pennisi, 1997).

I have previously reported on the co-sponsorship of WG-104 by the LOICZ core project of IGBP. This has included a commitment of funds without which the Symposium could not have been organized. Overlapping interests are also demonstrated by the fact that a number of symposium participants will be attending and presenting talks at the LOICZ Open Science Meeting to be held this October.

Further testimony to the success of this collaboration may be found in the proposal for joint sponsorship of a working group on coastal groundwater effects. In a recent development, Prof. H. Faure of INQUA has contacted me and WG-104 member Jean-Pierre Gattuso with a request to organize a Working Group of the "INQUA Commission on Terrestrial Carbon" devoted to "Reef Carbon". Although this effort will have only marginal overlap in time with the SCOR-LOICZ WG, it will provide an opportunity for continued development of some of

the ideas and findings arising from our present work (the significance of which the invitation tacitly acknowledges).

Scientific progress: It is premature to detail our accomplishments while they are still in the abstract stage, but I am confident that we are in the process of producing an unprecedented synthesis which will include specific formulations that will alter fundamental paradigms.
Corresponding member S. V. Smith recently circulated a review and summary of draft abstract submissions that sums up both our challenge and our probable contribution: "Most of what we know (or think we know) about coral reefs is based on studies of well-developed coral reef communities. These features are probably atypical over geological time, in that the communities being studied have developed in habitats created by a rapid rise of sea level over about 10,000 years, followed by about 3,000 years of relatively stable conditions. There is further reason to suggest that the geographic and environmental distributions of many (perhaps most) reef organisms extend well beyond the environmental limits which encompass most reefs which have been studied. Furthermore, most ecological and physiological studies of reef organisms have involved a relatively limited range of reef organisms--most prominently the scleractinian corals and their contained endosymbiotic algae. We must therefore view our knowledge of reefs as being remarkably biased. An encouraging aspect of the present session is the recognition of these various biases and the attempts to 'see beyond them'. As two examples, let me cite the reflection about modern reef ecology within the context of the geological record, and the use of environmental models to define the "hyperspace" occupied by coral reefs. Another point I would like to raise at the outset is the recognition that ecologists increasingly recognize that "change" includes measures of frequency and variance, as well as mean."

Members of the Working Group and the other Symposium participants have continued to publish relevant papers; one commentary that was derived from and inspired by WG-104 discussions and goals was that by Buddemeier, 1997 (note that because of Nature's stringent format and space limitations I wasn't able to use the standard acknowledgment, but did succeed in citing SCOR as reference 2).

Acknowledgments: I particularly want to recognize the very substantial contributions of two people who are not members of WG-104. One is Dr. Howard Lasker, co-organizer of the symposium; it is no exaggeration to say that this could not have happened without him. The other is Dr. John Benzie of the Australian Institute of Marine Science. In addition to bringing to our efforts an area of expertise (evolutionary genetics) that was badly needed and not originally represented, he has consistently taken a leadership role in helping to organize people and ideas, both at the original meetings and workshop in Panama, and in preparation for the symposium. I think it is appropriate to recognize his contributions by designating him a corresponding member of WG-104.

On a related issue, the Proceedings will meet the basic commitment of WG-104. It seems clear that one further stage of integration and publication is both possible and desirable -- development of the individual papers into a single, integrated book or monograph. This would presumably involve a smaller subset of key authors/editors, at least one more writing/editorial workshop, and a publishing outlet. I am not requesting support for this from SCOR, but I do ask for any comments, suggestions, or possible assistance in developing the necessary support for this additional product that would further extend the impact and recognition of the results.

References

Buddemeier, R. W., 1997, Symbiosis: Making light work of adaptation: Nature, v. 388, no. 6639, p. 229-230.
Pennisi, E., 1997, Brighter prospects for the world's coral reefs?: Science, v. 277, no. 5325, p. 491-493.

Appendix A, WG-104 Report: Announcement/release materials

CORAL REEF SYMPOSIUM AND MEETINGS

Coral reef issues and programs will be a major focus of the joint annual meeting of the Society for Integrative and Comparative Biology (SICB) and its associated societies*, the International Society for Reef Studies (ISRS), and

the Ecological Society of America (ESA), which will be held at the Boston Marriott Hotel -- Copley Place, January 3-7, 1998. SICB is organizing both meeting and program.

The scientific meeting will feature a major emphasis on coral reef science, including an invited Symposium Jan. 6-7 on CORAL REEFS AND ENVIRONMENTAL CHANGE -- ADAPTATION, ACCLIMATION, OR EXTINCTION? Contributed paper and poster sessions, special events, and society meetings will also take place. Invited Symposium speakers include: A.B. Pittock, B. N. Opdyke, J. Pandolfi, R. A. Kinzie III, R. Gates, K.Yamazato, B. Carlson, H. Lasker, J. Benzie, D. Potts, R. Rowan, R. P. M. Bak, T. Done, R. Karlson, J. Kleypas, T. Done, J.-P. Gattuso, B. Hatcher, S. V. Smith, and R. W. Buddemeier.

Included in the presentations will be the initial versions of the final report of Scientific Committee on Oceanic Research (SCOR) Working Group 104. This group, co-sponsored by the Land-Ocean Interactions in the Coastal Zone (LOICZ) Core Project of the International Geosphere-Biosphere Programme (IGBP), has as its charge a review and report on the topic Coral Reef Responses to Global Change: The Role of Adaptation. In addition to SCOR and LOICZ, the symposium is being sponsored by SICB, ISRS, ESA, and the New England Aquarium.

Robert W. Buddemeier and Howard R. Lasker, Symposium organizers.

SICB/SCOR CORAL REEF SYMPOSIUM -- Revision/update as of 03 August 1997

Note -- some titles and the exact order of presentations are preliminary and subject to change.

Tuesday , 6 January 1998 -- am, chair: H. Lasker, co-chair: D. Potts

8:00. BUDDEMEIER, R.W.*, Univ. of Kansas, Lawrence. A most ingenious paradox -- Introduction and overview.

8:40. HATCHER, B.*, A. HATCHER. Dalhousie Univ., Halifax, Canada. Scaling coral reef responses to global change: Can we identify the key processes a priori?

9:20. PITTOCK, A. B.*, CSIRO Division of Atmospheric Research, Aspendale, Victoria, Australia. Coral reefs and environmental change: Adaptation to what?

10:20. OPDYKE, B.N.*, Australian National University, Canberra, J.KLEYPAS, Nat. Center for Atmos. Research, Boulder. Climatic, bathymetrie and geochemical constraints on the distribution andrelative accumulation rates of coral-algal communities for the last 150,000 years.

11:00. PANDOLFI, J. M.*, National Museum of Natural History, Washington, D. C. Understanding ecosystem response to environmental change in modern coral reefs: clues from the Pleistocene fossil record.

Tues pm -- chair: T. Done, co-chair: S. Smith

1:00. KINZIE, R.A. III*, Univ. of Hawaii, Honolulu. Reproduction, symbiosis, and the fossil record: do geologists care about sex?

1:40. GATES, R.*, P. J. EDMUNDS, Univ. of California, Los Angeles, and Calif State Univ., Northridge. The physiological mechanisms of acclimatization in tropical reef corals

2:20. YAMAZATO, K.* Meio University, Okinawa, Japan. Coral and reef responses in marginal environments: effects on reproduction.

3:20. CARLSON, B.*, Waikfki Aquarium, Honolulu. Organism responses to rapid change: what aquaria tell us about nature.

4:00. LASKER, H.R.*, SUNY, Univ. at Buffalo. Life history traits of corals and their resilience to environmental perturbation.

4:40. BENZIE, J.*, Australian Inst. of Marine Science, Townsville. Genetic structure of coral reef organisms: Ghosts of dispersal past.

Wednesday January 7 -- am, chair: J. Benzie, cochair: J. Pandolfi

8:00. POTTS, D.*, Univ. of California, Santa Cruz. Environment and ecology -- the Porites perspective.

8:40. ROWAN, R.*, Marine Lab., Univ. of Guam, Mangilao. Endosymbiotic algae as adaptive agents.
9:20. BAK, R.P.M*, E.H. MEESTERS, Netherlands Inst. of Sea Research, Texel. Population structure as adaptive response of coral communities to global change.

10:20. DONE, T.*, L.M. DEVANTIER, K.E. FABRICIUS, L. MCCOOK, and E. TURAK Australian Inst. of Marine Science, Townsville. Coral reef community adaptability to environmental change at the scales of regions, reefs and reef zones.
11:00. KARLSON, R.*, H.V. CORNELL. Univ. of Delaware, Newark. Integration of local and regional perspectives on the species richness of coral assemblages.

Wed. pm -- Chair: J. Ware, co-chair: D. Fautin
1:00. KLEYPAS, J.* Nat. Center for Atmos. Research, Boulder. Habitat and habitat change -- a global model.
1:40. GATTUSO, J.P.*, D. ALLEMAND and M. FRANKIGNOULLE. European Oceanologic Observatory, Monaco, and University of Liege, Belgium: Interactions between the carbon and carbonate cycles at organism and community levels in coral reefs.
2:20. SMITH, S.V.* Univ. of Hawaii, Honolulu. Large-scale implications of coral reef structure and function to global environmental change.

3:20. BUDDEMEIER, R.W.*, ET AL. Univ. of Kansas, Lawrence. Overview, summary, and products.
4:00. SYMPOSIUM PARTICIPANTS and AUDIENCE. Moderated discussion on synthesis and implications of symposium results.

ANNEX 5 - Impact of World Fisheries Harvests on Marine Ecosystems

The Impact of World Fisheries Harvests on the Stability and Diversity of Marine Ecosystems
SCOR Working Group 105

Report of First Meeting Halifax, Nova Scotia, Canada
5-7 November 1997

Introduction to the Meeting

Mike Sinclair opened the meeting with some introductory remarks. The principle aim of the meeting was to develop a work plan to fulfill the terms of reference within about three years (end of 1999). The terms of reference and list of members are attached (Annex 1, 2). SCOR Working Group 105 reports to John Field the new President of SCOR. The role of working groups is to summarize the state of knowledge in a particular subject area of marine science, and to identify key issues for future research. It was noted that there is potentially some overlap of our working group with both WG 93 (Pelagic Biogeography) and WG 98 (Worldwide Large-scale Fluctuations of Sardine and Anchovy Populations). Steps will be taken to ensure that there is no duplication of effort and that the results of these WGS (which are near completion) are taken into consideration. The end product of the Working Group is to be a publication. The SCOR publication policy is attached as Annex 3.

The issue of ecosystem effects of fishing is becoming increasingly topical. Two examples from a Nova Scotia perspective were mentioned. A recent application for an experimental kill fishery in the Gulf of Maine area and on the Scotian Shelf off Nova Scotia is being resisted by many stakeholders, due to the intuitive expectation that fishing at lower trophic levels will result in disruptive ecosystem effects involving commercially important species and marine mammals at higher levels of the food chain. The scientific advice infers that a restricted fishery should not be a concern from an ecosystem perspective. Atlantic cod, haddock and halibut have recently been placed on the red list by the Species Survival Commission of the World Conservation Council (IUCN). The list identifies species that are threatened by extinction. Canada has questioned the criteria that are being used due to the dynamic nature of marine ecosystems and the life history features of the species in question. These two recent local examples provide a context for the importance of our work at the policy and operational level of ocean management

A recent book review of *Betrayal of Science and Reason* (Paul and Anne Ehrlich), in the journal *Science*, highlights the need for peer review and consensus by the scientific community with respect to environmental issues. The book tackles the backlash against "green" policies by some scientists. This reaction is coined "brownlash". The reviewer states:

> "At the heart of the brownlash movement they see a range of ideologically and economically motivated journalists, politicians, charlatans, and congenitally iconoclastic scientists who misrepresent the state of scientific knowledge about the environment in order to minimize, or even discount entirely, the challenges facing humanity in the next century... The stated goal of the book is to set the scientific record straight. (emphasis added)

The final sentence of the quote captures the challenge of our Working Group, i.e. to set the scientific record straight with respect to the ecosystem effects of fishing.

The agenda for the meeting was then reviewed and some modification noted. Steve Murawski and Jake Rice were not able to participate due to work conflicts. It was hoped that aspects of their presentation on the conceptual framework for the evaluation of ecosystem effects would be covered by, respectively, Henrick Gislason and Steve Hall. A presentation by Jill Casey and Ram Myers on the effects of fishing on fish community structure of the southern Grand Banks and St. Pierre Bank (off Newfoundland) was added. The final agenda is attached as

Annex 4. The structure of this first meeting was designed to facilitate a discussion of the full range of issues involved in ecosystem effects of fishing during the presentations made in the first two days. Subsequently, during the third day we could focus in on what can usefully be achieved by 1999 given the expertise and interests of the members.

Points from the Discussion of the Presentations

Presentation #1 (Platt): The paper provided perspective on the degree to which annual fishing harvests at present levels may be a concern from a trophic dynamic perspective. The methodology for estimating primary production within "Longhurst Areas" was reviewed. Given technological developments involving remote sensing, and good conceptual understanding of production processes, we now have the capability to estimate primary production at a wide range of spatial and temporal scales. Three problems were identified New production", that component which supports fisheries yields cannot be readily estimated without empirical observations on nitrate fluxes or proxies for this process. Also, it is difficult to aggregate global fisheries yields by biogeographical zones of interest for ecosystem analysis, due to constraints of the Systems of fisheries statistics. Finally, the "Longhurst Areas", although sensible from an ocean physics perspective, are rather large for many shelf seas and semi-enclosed seas within which most of the fisheries are prosecuted. This mismatch in spatial scales needs to be addressed.

Presentation #2 (Pauly): A methodology for the analysis of fisheries removals within a trophic dynamic context was presented (ECOPATH). Work is being carried out in many parts of the world using the ECOPATH methodology, which is itself evolving over time. It was proposed that a synthesis of the results of these studies be brought together as part of the publication of the Working Group in 1999. The timing of the ECOPATH studies and the deadline for our synthesis appear to be consistent. It was stressed that the "Longhurst Areas" used for estimates of primary production are the preferred starting point for the trophic dynamic aspect of ecosystem effects of fishing. These areas, however, can be sub-divided where appropriate. Main Fonteneau (ORSTOM, France) is presently using the "Longhurst Areas" in his global analysis of tuna fisheries. There was again a discussion of the feasibility of using the FAO data base on fisheries landings. This issue will be followed up. The model results suggest that for some geographic areas annual carbon removals by fisheries account for up to 30% of primary production. Should society be concerned if a particular percentage of primary production is being removed by fishing? From a theoretical perspective little work has been done on this question. In general terms, however, the trophic dynamic modelling approach allows an analysis of the competing roles of fishing and other components of the marine community such as marine mammals. It has been estimated that the latter consume annually three times the removals by fishing. The energetics approach also provides a tool within which to evaluate the removal of production from intermediate trophic levels (such as krill and small pelagics). Gaps in knowledge, such as that in meso-pelagics and sea-bird abundances were noted. Although there was some concern that the trophic dynamic approach generates results that are difficult to interpret within an ecosystem effects context, there was a general consensus that the approach provides important insights to energetics constraints within marine ecosystems.

Presentation #3 (Reid): The continuous Plankton Recorder Program (CPR) has been running since 1947. The presentation provided a flavour of the scope of the data set, both geographically and temporally. Can this information on plankton species composition and abundance be used to evaluate the degree to which fishing practices in the North Atlantic have impacted on pelagic zone community structure? The trophic cascade hypothesis developed within north temperate lakes, and the key predator hypothesis based predominantly on intertidal experiments, infer that reduction in abundance of higher trophic level species can result in substantive changes in community structure at lower levels. The one study using the CPR data for the North Sea (by Koslow in the early 1980s) did not provide support for these hypotheses. However, a systematic evaluation of the CPR data from a perspective of ecosystem effects of fishing has not been made. It was suggested that an analysis of the patterns of fishing effort over time and space would provide background for the CPR data analysis. It was cautioned that due to the parallel impacts of pollution and climate variability it may be difficult to extract the degree to which fishing has had an impact (particularly in the coastal waters). The increase in the abundance of echinoderm larvae in the North Sea over several decades was one observation that suggested that the benthos in

this area may have been impacted due to trawling. Although there was some concern that the plankton community is irrelevant to the ecosystem effects issue, it was recognized that this data set provides one of the few descriptions of marine communities on time and space scales of relevance to the fishing impacts issue. It was generally felt that a judicious analysis of the CPR data set should provide conclusions on impacts on this restricted, yet central, component of the marine ecosystem.

Presentation #4 (Quinones): A site specific study on the Jack mackerel fishery in the southeast Pacific Ocean off Chile introduced the issues involved in small pelagics fisheries of eastern boundary currents. Around 4.4 million tonnes of this species was removed from the waters off Chile in 1995. The estimations available of the total biomass of Jack mackerel in the southern Pacific point at a value of approximately 17,000,000 tonnes (1+). According to the consumption rates of euphausiids by Jack mackerel estimated in the Chilean economic zone, the (1+) biomass in the southern Pacific can consume around 122 million tonnes of euphausiids per year. It was estimated that the portion of the population complex that is being extracted in the Chile-Peru current would have removed around 34 million tonnes of zooplankton per year. The channeling of this zooplankton biomass otherwise unavailable through the trophic web is an interesting impact of fishing on the ecosystem. The scale of this particular fishery (perhaps the largest single fishery during the early 1990s) provided perspective on the high productivity of eastern boundary currents and the roll of large-scale migration on energy fluxes between systems. There was general consensus that a comparative study of ecosystem impacts of fisheries within eastern boundary currents should be included within our work plan. It was noted that the CalCOFI data set provides a time series of zooplankton changes over several decades. There is also a good data set on zooplankton trends for the Chilean part of the eastern boundary current off South America.

Presentation #5 (Caddy): Temporal trends in the annual fisheries yield per km^2 for all parts of the globe were estimated using the FAO statistics on reported landings. The patterns provided perspective on which areas have already peaked in terms of landings, and thus a rough index of the degree of potential impact of fishing on the diverse ecosystems. The aggregate North Atlantic fisheries landings, for example, peaked early. Thus one might expect that the modifications in community structure have been occurring for a longer time period, and potentially be more dramatic. The analysis may provide a taxonomy on the degree of overfishing on a global scale and a framework to select representative case histories to ensure a balanced global synthesis. Most of the discussion was on the reasons for certain anomalies (e.g. the southwest of Africa shelf sea production) and on the deficiencies in the FAO data base for subdividing landings by biogeographic areas defined by physical oceanographic parameters.

Presentation #6 (Beckett): The implications of recent international conventions on ecosystem considerations for fisheries management was summarized. The CITES categories and the IUCN Redlist, both of which identify species which are threatened with extinction, are based on criteria applicable to both terrestrial and marine systems. This may cause problems during their application. The code of conduct for responsible fishing and the straddling stocks convention identify ecosystem considerations, as does the recent Convention on Biodiversity at Rio. It was considered important to fully understand the diverse technical statements in these texts, and where necessary, to translate them into operational terms. The discussion was very animated, but there was a general consensus that the new conventions provide powerful legal or institutional frameworks for the consideration of the ecosystem aspects of fisheries management. There was debate on a number of issues:

- the degree to which principles from terrestrial ecology can be applied to marine systems;
- to what degree is the loss of populations of a species, due to overfishing, a threat to genetic diversity and long term persistence of species?;
- do keystone species exist in the oceans, and if so, are they being reduced in abundance in a detrimental manner for community structure;
- does the loss of larger fish within a population result in less extensive migrations, and thus less adaptability of exploited species to climate variability?;
- what is habitat diversity for different ecosystems, and what proportion should remain pristine?;
- how can the precautionary approach be made operational?;

- should we include the role of aquaculture escapees as an ecosystem effects issue for fisheries?; and,
- are the eco-certification discussions relevant to our deliberations?

A consensus point from the wide-ranging discussion was that the ecosystem implications of the conventions need to be translated into operational terms, and that this is an issue that the Working Group should address.

Presentation #7 (Sinclair/Mohn): From one perspective the effect of fishing on recruitment potential of the target species falls outside of our subject area. From another perspective, however, these studies may be relevant. Two points were addressed. The loss of spawning components due to overfishing may lead to spatial changes in fish community structure (e.g. a coastal ecosystem may lose a species within the management unit even though the overall abundance for the target species is at moderate levels). Two examples of loss of spawning components for gadoids were provided. The second point is that studies of recruitment overfishing may provide increases in understanding about the regulation of abundance of non-commercial marine species with similar life history features. As such, the narrowing of theory may prove to be helpful in providing guidelines or "listing" criteria for endangered species. A model to evaluate the spatial dynamics of a population complex to fishing pressure was described. Much of the discussion focused on the functional relationships of the model rather than on the usefulness of incorporating spatial complexity into the modelling of population persistence. The approach may be helpful in the analysis of the importance of leakage between populations for the persistence of small populations.

Presentation #8 (Hall): The lack of long-term monitoring of the benthos on the European Shelf seas makes it difficult to evaluate the impact of trawling on this component of the ecosystem. There are only two long-term monitoring locations - the Kattegat and off Northumberland. A second constraint is the limited data on fishing effort. A general conclusion of the European studies is that climate variability has had a greater impact than trawling, and that the changes over time have been minimal. It was recommended that historical data sets (such as fish stomach collections) be mined to evaluate whether changes in the benthos occurred prior to the initiation of benthic monitoring. An additional approach to evaluating impacts is the study of changes in the benthos within MPAs where trawling is prohibited. It was pointed out that the North Sea is a relatively featureless area and perhaps resistant to fishing. There is a need to quantify the vulnerability of benthic species, and some approaches developed by John Pope were summarized. Length frequencies for benthic species are contrasted with expected length frequencies without fishing mortality. Much of the discussion focused on the degree to which major change predated our descriptions of benthic communities and the representativeness of the North Sea and Irish Seas as study areas.

Presentation #9 (Gordon): An experimental study of the impacts of trawling on the benthos community off the Grand Banks was described. The design of the experiment, as well as the advanced technology used to sample the habitat, should allow firm conclusions to be drawn. Initial results are available for the epifauna only. The abundance of some taxa declined significantly subsequent to trawling, while others were unaffected. Changes in benthic production will be estimated. The area chosen has not been fished for some years, and there was a discussion on the degree to which the experimental site is representative of fishing areas. It would be useful to compare the benthic community of a heavily fished area of similar habitat features to the experimental site that has been repeatedly trawled. There is a need to quantity the impacts at the level of the population (a scale of the bank), as well as to evaluate the degree to which impacts on the benthos influence other components of the demersal food chain (including commercially important species). The video presentation on the sampling methodology was impressive. The discussion was truncated due to time constraints. The two presentations on benthos impacts provided a framework for discussion of how best to carry out a synthesis.

Presentation #10 (Gislason): The trawl survey data for the North Sea provide data on trends for 146 species. There has been little change in the non-commercial component of the fish community off Scotland between the 1950s and 1990s. Recent work has addressed approaches to integrate the information using community level indices of diversity and size composition. The size spectrum of the North Sea fish community has changed, with the slope

becoming steeper and the intercept higher. Analysis of the diversity at size changes were less clear (non-linear). The response of the indices to fishing pressure were modeled, and the empirical observations on size spectra fit well with the model results. During the discussion it was concluded that these methods should be applied to comparable data sets from other parts of the world. The North Sea results infer structural changes in fish communities due to overfishing. There was no discussion on whether such size composition changes generate functional modifications. Much of the discussion addressed the meaning of various diversity indices. There was a general consensus that in contrast to the size composition such indices are not particularly helpful in quantifying the impacts of fishing on community structure. The evidence for "extinction" of larger length categories of the fish community in the North Sea, and the progress in modelling size composition responses to fishing intensity, generated several ideas for future work.

Presentation #11 (Zwanenburg/Howell): The trawl survey study data from Cape Hatteras to the northern tip of Labrador has been put on GIS to facilitate large scale analysis of fish community structure in response to changes in the environment and in patterns of fishing effort. The analysis suggests that although community structure is weak, it has been stable during the 1975 to 1994 time period. There have, however, been geographical displacements in locations of biogeographic discontinuities in response to cooling in the north and warming in the south during the 1990s. The overall results infer that environmental variability modifies geographical distributions of species and latitudinal shifts in fish communities, but that the fish community composition has been relatively persistent over several decades. Overfishing has impacted populations, but perhaps not the fish communities. An analysis of cod abundance and bottom temperature for several management units was presented to illustrate methods to separate out fishing and environmental impacts. The results suggest that large-scale changes in bottom temperatures have modified the habitat characteristics and suitability of certain areas for cod. Above 10^0C and below 2^0C cod tend to move to respectively contiguous cooler and warmer areas. The dynamic range of adaptability to temperature appears to be stock specific. The discussion digressed on the causes of the cod collapses in the northwest Atlantic rather than on the utility of trawl surveys to evaluate ecosystem effects of fishing.

Presentation #12 (Sainsbury): The research on the ecosystem effects of fishing in Australian waters was summarized within three categories: case histories; experimental studies; and, comparative studies (meta-analysis). For the shelf southeast trawl fishery there have been clear changes in species composition during the latter part of steam trawling (1940s and 1950s). For the more recent deeper water slope fishery in the same area several species have declined significantly since fishing began in 1976. There have also been marked changes in community structure within the Gulf of Carpentaria. In contrast, the diverse Great Barrier Reef prawn fishery studies have generated equivocal results (closed area similar to open area, before/after differences not significant) although repeated trawling has been shown to effect epibenthic habitats. The experimental management of gear types in the northwest Australian demersal fishery illustrates that benthic community impacts of trawling are reversible. Trawling had modified the structural complexity of the benthos in this area with associated change in commercial fish species mix. Removal of trawling resulted in a return to original species rank order. An emphasis was put on the need to study the pelagic ecosystem. For example, the Pacific tuna fishery results in a 250,000 t by-catch of sharks. what are the impacts of the removal of top predators? A by-catch of seabirds is also taken, but there is little information available of the effect on these populations in the ecosystem. The Australian "experience" with ecosystem impacts provided an excellent conceptual framework for the working group activities. It also appears as if the impacts on the ecosystem by fishing off Australia have been more dramatic than is the case of north temperate shelf seas, but it was also pointed out that Australian fisheries are more recent with several examples of research survey information on the unfished state. There was further discussion on the desirability of including ecosystem management considerations within our terms of reference.

Presentation #13 (Bianchi): The presentation began with a discussion of the constraints of the data sets in topical groundfish fisheries. Until recently there have been good taxonomic descriptions at the species level, thus much of the earlier trawl survey data describes distributions at the genus or family level. As a result extinction of species, if it has occurred, may not be possible to evaluate. The global coverage of trawl surveys by the Norwegian research vessel *(Nansen)* was summarized. "The results from a study based on the data collected by this vessel in three

oceans, showed that tropical continental shelves display a wide variety of fish assemblages, often separated by clear environmental boundaries such as the thermocline or the oxycline. These differences are reflected in the species composition, diversity and size spectrum. The vulnerability of these communities to fishing may also differ. Therefore, it was recommended that studies on the impact of fishing on species composition and size spectra should be preceded by an identification of main communities (or habitats) in the areas under study". There are some areas that have been surveyed more than once using the same methodology. The size spectrum method of Henrik Gislason was applied to several surveys and the initial results look promising. The need for an inventory of trawl surveys in topical waters was discussed. Some approaches to describing species diversity in topical environments were reviewed. The discussion focused mostly on the degree to which there is data available for topical groundfish fisheries that will allow generalizations to be made concerning ecosystem impacts. This is an area to follow-up upon. There was general consensus that similar methods could be used to characterize changes in groundfish communities in diverse ecosystems.

Presentation #14 (Casey): Trawl survey data from the 1950s for the southern Grand Banks and St. Pierre Bank have been recently added to the results of standard surveys conducted since the 1970s. The longer time frame allows conclusions to be drawn concerning the impacts of the European distant water fleet activity in the northwest Atlantic during the 1960s and early 1970s. There have been major changes in relative abundance of categories of species. The gadoids declined dramatically whilst the flatfish species increased in absolute abundance as well as proportionally. Barndoor skate has become very rare. The study highlighted the value of including data sets prior to the onset of modem industrial trawling. The discussion was cut short because of a shortage of time at the end of day 2.

Presentation #15 (McManus): A slide presentation of the dramatic effects of intensive fishing on coral reefs provided a reality check on the scope of the problem in heavily populated tropical coastal areas. The concept of "Malthusian overfishing" (resulting from overcrowding, poverty and lack of alternate livelihoods) was particularly helpful for focusing on the coastal fringe impacts which had not been covered in previous presentations. A conceptual framework involving raising of the cost curve of the Gordon-Schaefer bio-economic model through restrictions on fishing methods was suggested as the only management method applicable to artisinal high participation, open access systems (the Schumacher "Small is Beautiful" approach to development of the early 1970s). A site specific study in the Philippines on the impacts of fishing on both habitat and species diversity was described. The study illustrated some methods for dealing with statistical descriptions of community structure. It was concluded that present fishery practices could well lead to extinction of the species level, which until recently had not been considered a serious threat for wide ranging marine fish species having complex life histories (relatively high dispersal capability and fecundity). The discussion ended with the need for indices of ecosystem health to compliment species and population indices of overfishing. As was the case of several of the other presentations, the issue of multiple causes of changes in ecosystems was discussed (climate variability, pollution, overfishing). For many topical coastal zone ecosystems it may not be possible to tease out the fishing impacts from others.

Discussion of Work plan

Mike Sinclair briefly explained that SCOR and ICES will co-sponsor a symposium on "The Ecosystem Effects of Fishing" to be held in 1999 with Sinclair and Gislason as co-conveners. ICES will help with the organization.

The framework of the symposium was discussed and it was decided to aim for a three to four day symposium comparable in structure to the symposia organized by the British Ecological Society. This means that the presentations will be restricted to invited keynote papers, giving the authors more than the usual 20 minutes to present their results. The papers should all be subject to peer-review before the symposium. Additional contributions will be as posters presenting specific case studies.

The aim of the symposium will be to provide a global synthesis of what is known about the impact of fishing

on marine ecosystems, report on new methods for quantifying the impact at the ecosystem level and provide a forum for discussions on how these methods can provide the basis for formulations of management strategies. In order for the symposium to be successful it was felt important to investigate the scope of other symposia planned for the intervening period so that undue overlap could be avoided. It was also noted that representation from all areas of the globe would be encouraged. Representatives from environmental NGOs (e.g. WWF) and other environmental organizations (e.g. IUCN) should be invited to present viewpoints on fisheries impacts and environmental quality objectives. In view of the very broad scope of the symposium it was decided to form a number of groups responsible for providing the input is required.

It was decided that the symposium should consist of the following themes:

a) Case histories - documenting investigations of fisheries impacts on the local scale or presenting new methods for the study of ecosystem effects of fishing. These contributions should be presented in the form of posters;

b) Ecosystem synthesis - presenting overviews of fisheries impacts on particular ecosystems;

- Coastal and estuarine fisheries: Sainsbury will contact Blaber (CSIRO) and a group will be formed including, if possible, Yanez-Arancibia (Mexico) and Omar Defeo (Uruguay);
- Coral reefs: McManus will form a group;
- Eastern boundary currents: Quinones will form a group and make contact wit SCOR WG 98 and the SCIOS project of ORSTOM and,
- Continental shelves:
  - Demersal fish: Bianchi, Hall, Gislason, Sainsbury and Zwanenburg;
  - Benthos: Hall will form a group including Gordon, Poiner (Australia), Collie (US) and Juan Carlos Castilla (Chile). The group should contact T. Pitcher regarding a synthesis of benthos responses in areas closed to fishing;
  - Pelagic ecosystem: Reid will form a group including Andy Bakun (US) and Alain Fonteneau (France). The group will cover zooplankton, tunas, small pelagics, sharks and possibly also marine mammals and seabirds; and,
  - Semi-enclosed seas: Caddy will form a group.

c) Cross-ecosystem comparisons:

- Trophodynamics: Pauly will organize a group. Work is in progress to construct a model of global fluxes in the marine environment based on the ECOPATH approach. A series of workshops has already been planned and it is expected that a preliminary synthesis of the model results will be available in 1999.
- Community structure: Sainsbury will organize a group including Rice, Bianchi and McManus.
- Vulnerability: Gislason will contact John Pope (UK) and ask him whether he will be interested in forming a group on the quantification of species vulnerability to fishing. The group will include Mohn.
- Genetic diversity: Sinclair will find someone the lead the group. The group may include Robert Ward (Australia) and Ricardo Galleguillos (Chile).

d) Ecosystem Quality Indices (Sustainable development indices:. Gislason will contact Niels Daan (The Netherlands). The group will include Tundi Agardy (WWF), Sainsbury and McManus.

There was some discussion about the possibility of including habitat changes due to fishing as a special item in either b or c, but it was concluded that this topic should be dealt with under each of the separate items in b.

Most of the work will have to be done through networking, but the groups should also have a possibility to meet at least once in order to prepare the input for the symposium.

To advertise the SCOR Working Group, and the Symposium, it was decided to make a Home-page on the Internet and to make a folder with the SCOR logo containing a two-page synthesis of what the group is trying to achieve and a work plan. Members of the group should provide Mike Sinclair with suggestions on whom to send it to. The folder would be helpful in raising additional funds for the symposium and for the costs associated with the meetings of the groups.

The time and venue of the symposium were briefly discussed and it was suggested to have the symposium in March 1999. Rome was suggested as a convenient place, provided FAO was willing to help with the organization.

The SCOR working group should meet again for two days in approximately one year's time in order for the members to report on progress. It was suggested to have the meeting in Copenhagen in connection with the meeting of the ICES Working Group on Ecosystem Effects of Fishing in November 1997 (dates yet to be fixed by ICES).

Based on the work plan discussion Henrik Gislason expanded upon the symposium outline. During the meeting at least 12 invited presentations for the symposium were identified. Assuming the symposium to last for about four days and having three one-hour presentations during the morning session and four in the afternoon we would have plenty of room for additional contributions. Among the areas not sufficiently covered at present are marine mammals and seabirds, which would provide two additional presentations. A special presentation would be needed on sharks, tunas and other highly migratory top predators (separating them from the plankton issues). Also small pelagics on continental shelves deserve a special presentation, as does the impact of fishing on the Arctic/Antarctic ecosystem (involving if possible CCAMLR). The continental slope and the deep sea could be treated in a special session. We should also try to present something on sustainable management strategies. ACFM of ICES is now moving towards including the precautionary approach and ecosystem considerations into their advisory framework. The chairman of ACFM could be invited to provide a paper on the advances they have made so far.

An outline of an expanded programme could therefore be:

Ecosystem synthesis:
- Coastal and estuarine fisheries
- Coral reefs
- Semi-enclosed seas
- Continental shelves:
  - Demersal fish
  - Small pelagics (new)
  - Benthos
- Continental slopes and the deep sea (new)
- Arctic and Antarctic ecosystems (new)
- Eastern boundary currents
- Pelagic ecosystem (top down effects on plankton) (modified)
- Sharks, tunas and other highly migratory species (new)
- Seabirds (new)
- Marine mammals (new)

Cross-ecosystem comparisons (methods for quantifying the impact of the ecosystem level)
- Trophodynamics
- Community structure
- Quantifying species vulnerability
- Genetic diversity

Separating natural and fisheries-generated changes in recruitment

Ecosystem quality indices (sustainable development indices)
The scientist's view (N. Daan)
The view of environmental NGOs (Tundi Agardy)

Management strategies (new)
Options for sustainable development? (A. Garcia?)
Integrating fisheries and ecosystem management (J.J. Maguire?)

This would provide us with a total of 22 presentations. Additional presentations could be generated by subdividing the continental shelves into say boreal, temperate and tropical systems or by having more contributions for the two last sessions. Another possibility would be to include a panel discussion at the end of the Management Strategies session; thus providing WWF, IUCN and others a forum for providing input to the Symposium.

ANNEX 6 - Joint Global Ocean Flux Study

Progress Report (1997)
Joint Global Ocean Flux Study (JGOFS)
International Project Office
University of Bergen, Bergen, Norway

Contributed by:
Roger B. Hanson, Executive Officer, JGOFS International Project Office
John G. Field, Chairman, JGOFS Scientific Steering Committee

Introduction

In this report, we will review JGOFS achievements and scientific activities from 1 July 1996 through 31 June 1997, Scientific Steering Committee reorganization, the proposed 1998 JGOFS SSC structure, and identify upcoming JGOFS activities through 31 December 1997. Finally, we will highlight planned JGOFS subsidiary activities for 1997/98.

International Scientific Highlights

Ocean-Atmosphere CO_2 Exchange.

One step in the eventual understanding of the dynamics of *THE* global carbon cycle is estimating the distribution of ocean dissolved inorganic carbon and partial pressures of CO_2. In recent years, JGOFS scientists have made major advances to improve the assessments of the exchange and balance of pCO2 between the atmosphere and the upper ocean, and whether this exchange leads to changes in ocean processing, sinks, and sources. Takahashi and colleagues (in press) have now provided new estimates of the global atmospheric and oceanic pCO_2 balance, which is defined by systematic variations in the air-sea differences in the partial pressures of CO_2. These estimates are based on seasonal pCO_2 data combined with surface flows obtained from ocean circulation models. *THE* Annual composite indicates that temperate oceans act as an atmospheric CO_2 sink and equatorial oceans act as a source (Takahashi, T., Feely, R. A., Weiss, R., Wanninkhof, R. H., Chipman, D. W., Sutherland, S. C. and Takahashi, T. T. *Global air-sea flux of CO2: an estimate based on measurements of sea-air pCO2 difference*. Proceedings of the National Academy of Science, volume 94).

Regional CO_2 Drawdown and Particulate Carbon Export in Ocean regions with very different ways of processing carbon.

In temperate North Atlantic latitudes, results show that seasonal biological activity allows considerable drawdown of atmospheric carbon dioxide and export of particulate carbon to the deep ocean and sediments. In the Arabian Sea, where upwelling fuels surface production so prodigiously, a large export of particulate carbon occurs after southwest monsoons and fuels the midwater oxygen depleted zone. An issue that remains to be addressed in the Arabian Sea, is the balance between the export of particulate carbon from surface waters on one hand and its remineralization at depth, and its eventual return as CO_2 through upwelling on the other. The pattern that is emerging is that seasonality, whether in the tropics or temperate latitudes, provides a mechanism by which biogenic carbon can be exported from the surface waters to the deep ocean. In the equatorial Pacific, ocean data suggest intense carbon recycling in surface waters, resulting in little export of surface particulate carbon to the deep ocean but a source oceanic CO_2 to the atmosphere. In the Southern Ocean (see U.S. JGOFS AESOPS below), another pattern unfolds.

U.S. JGOFS Antarctic Ecosystem Southern Ocean Process Study (AESOPS).

The U.S. JGOFS Process Study in the Southern Ocean has two components. The first is in the Ross Sea, concentrating on the southern polynya region near the Ice Shelf, with cruises on RVIB NATHANIEL B. PALMER from August 1996 - April 1998. The next component is a study of the Antarctic Polar Front Zone along longitude 170 West, aboard the RV ROGER RAVELLE, beginning in Oct. 1997 and continuing through March 1998. During the past year in the Ross Sea, the U.S. completed a successful mooring deployment, benthic survey, and three

process cruises in October, January and April. These activities span the entire seasonal progression from initial stages through the peak of the bloom to the winter cessation of net production. Preliminary analyses of ocean data indicate that the Ross Sea *Phaeocystis* bloom (and thus nitrate uptake and atmospheric CO_2 drawdown) becomes iron limited because the bloom strips the water of available iron that is followed by vertical export to the deep sea.

International Publication Achievements

Special Journal Issues *(1993-present)*

JGOFS: The North Atlantic Bloom Experiment. Guest Editors H.W. Ducklow and R.P. Harris. ***Deep-Sea Research*** Part II. Topical Studies in Oceanography, Volume **40**, No. 1-2, 1993.

Biogeochemical Cycling in the Northwestern Indian Ocean. Guest Editors P.H. Burkill, R.F.C. Mantoura and N.J.P. Owens. ***Deep-Sea Research*** Part II. Topical Studies in Oceanography, Volume **40**, No. 3, 1993.

A U.S. JGOFS Process Study in the Equatorial Pacific. Guest Editor J.W. Murray. ***Deep-Sea Research*** Part II. Topical Studies in Oceanography, Volume **42**, No. 2-3, 1995.

Southern Ocean JGOFS: The U.K. "Sterna" Study in the Bellingshausen Sea. Guest Editors D. Turner, N. Owens and J. Priddle. ***Deep-Sea Research*** Part II. Topical Studies in Oceanography, Volume 42, No. 4-5, 1995.

Special Section: EUMELI Program. ***Deep-Sea Research*** Part I. Oceanographic Research Papers, Volume **43**, No. 8, 1996.

Ocean Time-Series: Results from the Hawaii and Bermuda Research Programs. Editors D.M. Karl and A.F. Michaels. ***Deep-Sea Research*** Part II. Topical Studies in Oceanography, Volume **43**, No. 2-3, 1996.

A U.S. JGOFS Process Study in the Equatorial Pacific. Editor J.W. Murray. ***Deep-Sea Research*** Part II. Topical Studies in Oceanography. Volume **43**, No. 4-6, 1996.

Special Section: JGOFS (India). Editors S. Krishnaswami and R.R. Nair. **Current Science**, Volume **71**, No. 11, 831-905, 1996.

Ecology and Biogeochemistry of the Antarctic Circumpolar Current during Austral Spring: Southern Ocean JGOFS Cruise ANT X/6 of R.V. Polarstern. Editors V. Smetacek, H.J.W. de Baar, U.V. Bathmann, K. Lochte, and M.M. Rutgers van der Loeff. ***Deep-Sea Research*** Part II. Topical Studies in Oceanography, Volume **44**, No. 1-2, 1997.

Special Section: The ANTARES Program. ***Deep-Sea Research*** Part I. Oceanographic Research Papers, Volume **44**, No. 5, 951-1196, 1997.

CD ROM Productions (1994-present)

Biogeochemical Ocean Flux Study (BOFS) North Atlantic Data Set. Oceanographic data collected during the North Atlantic cruises of the NERC Biogeochemical Ocean Flux Study (1989-1991): a UK contribution to JGOFS. British Oceanographic Data Centre, Bidston Observatory, Birkenhead, Merseyside L43 7RA, UK

Netherlands Indian Ocean Program (1990-1995). Oceanographic data collected during the field phase of the Netherlands IOP from May 1992 until February 1993. A Netherlands contribution to JGOFS. NIOZ Marine Research Facilities, PO Box 59, NL-1790 AB Den Burg Texel, NL

The Arabian Sea CTD Data Set (in preparation). This CD-ROM contains CTD data collected during the Arabian Sea JGOFS cruises from 1994-1997. Institut für Mereeskunde, Marine Planktologie, Düsternbrooker Weg 20, 24105 Kiel, Germany

The U.S. Arabian Sea Process Studies Data Set (in preparation). This CD-ROM contains all U.S. JGOFS Arabian Sea data collected during cruises from 1994-1996. U.S. JGOFS Planning and Implementation Office, Woods Hole Oceanographic Institution, Woods Hole, MA 02543

Meetings of the Scientific Steering and Executive Committees

Executive Committee Meeting.

The JGOFS Executive Committee met in Bergen (September 1996). In response to a suggestion from the International Geosphere-Biosphere Programme (IGBP) directed to all of its core program elements, the April 1996 JGOFS SSC supported the suggestion to reorganize its membership. At their meeting, the JGOFS Executives developed a specific plan to reduce its membership by attrition over the next 3 years, which was later approved by both IGBP Scientific Committee and SCOR Executive Committee. During the restructuring process, the SSC

might retain current SSC members and/or chairs of the Planning Groups and Task Teams on the Committee. Accordingly, the SSC will be scaled down to six "at-large" members, who are approved by the IGBP and SCOR. The Chairs of JGOFS subsidiary activities serve as *ex-officio* members of the JGOFS SSC until activities are completed. Future JGOFS SSC Chairperson shall be nominated from among the "at large" or *ex officio* members for approval and appointment by SCOR and IGBP, and become one of the "at large" members. The Chairs of the subsidiary activities shall be nominated by the groups themselves and appointed by the SSC. All members would serve rotating 3-year terms of office. The next Executive Committee Meeting is planned in Williamsburg, Virginia, USA (October 1997). The anticipated incoming Chairperson shall attend this meeting.

Scientific Steering Committee Meeting.
The 1997 JGOFS SSC met in Oban (May 1997). Eighteen of twenty-one JGOFS members attended. Professor Toshiro Saino (Japan) was the only new SSC member, while Professor Egil Sakshaug (Norway) was approved for a second term. Six members will rotate off the SSC on 31 December 1997. They include Field, Liu, Morel, Takahashi, Lochte, and Shimmield. Field plans to recommend one rotating member to a second term for IGBP and SCOR approval. Field will step down as SSC Chairman on 31 December 1997). A candidate for chairperson has been nominated by the SSC, and Field has recommended this nominee to IGBP and SCOR for approval and appointment at their fall meetings. With the anticipated SSC changes in 1998, the proposed 1998 JGOFS Committee will be reduced to sixteen members (TABLE 2). Field is willing to remain on the SSC in the capacity of Past Chairperson to help the incoming Chairperson. The next meeting is tentatively planned for Cape Town (April 1998).

Planning Group Reports
North Atlantic Planning Group (NAPG) (Chair Michael Fasham).
Last April 1996, the SSC supported Fasham's plan to change the NAPG emphasis from planning to synthesis of the available North Atlantic JGOFS data. After discussions with 1997 SSC members and the NAPG, Fasham proposed to formally disband the NAPG and organize a North Atlantic Synthesis Working Group (NASWG). He proposed that this WG would liaise closely with the Synthesis and Modelling Task Team. An *ad hoc* group agreed to assemble and nominate a Chair, set membership criteria, and set terms of reference for the NASWG. Afterwards, the NASWG would convene meetings, decide on the best way of synthesizing these data sets, and write reviews of the NA process study. Moreover, it would produce a bibliography of published papers and a catalogue of metadata and JGOFS data sets. The later would be done jointly with the Data Management Task Team. Next meeting is planned in Southampton (September 1997).

Indian Ocean Planning Group (IOPG) (Chair Peter Burkill).
June 1997 will be the last field month for the Arabian Sea Studies. Like the NAPG, Burkill proposed to disband the IOPG, organize an *ad hoc* group to set new terms of reference and recommend membership for the "IOSWG". Burkill notified the SSC that plans are underway to assemble an Arabian Sea Synthesis Meeting in Plymouth (January 1998) that will be followed by the first meeting of the IOSWG in Paris (June 1998). There are plans to organize an Indian Ocean Science Meeting in India (1999).

Equatorial Pacific Planning Group (EPPG) (Chair James Murray).
Murray announced the third publication of Deep-Sea Research special issue on the Equatorial Pacific Process Study. Moreover, all U.S. EqPAC data sets have been completed and available to the U.S. JGOFS Synthesis and Modelling Project. Murray reports that plans are underway to set up an Equatorial Pacific Synthesis Working Group (EPSWG), develop new terms of reference and membership criteria for JGOFS Executive Committee approval (October 1997). No meetings mentioned in 1998.

Southern Ocean Planning Group (SOPG) (Chair Julian Priddle).
The SOPG met in Oban (May 1997), following the Oban Modelling Symposium. The last time they met was at the Southern Ocean Science Symposium in Brest (1995). Priddle reported that national field programs are completed or nearly so. Those completed are now appearing in the literature: two special issues of *Deep-Sea Research, Part*

II. Moreover, the Brest Symposium will appear soon in a special issue of the Journal of Marine Systems (*Carbon Fluxes and Dynamic Processes in the Southern Ocean: Present and Past*) and IGBP Book Series (*The Changing Ocean Carbon Cycle: A midterm synthesis of the Joint Global Ocean Flux Study*). Because of ongoing field activities, the SOPG plans to remain in its present form and develop a catalogue of SO-JGOFS data jointly with DMTT. For synthesis and modelling activity, there is a strong need to redefine the definition of Southern Ocean biogeochemical provinces. Therefore, the Group plans to arrange two workshops on biogeochemical provinces and develop system specific models (1998/9). The Group nominated Ulrich Bathmann as SOPG Co-Chair for JGOFS Executive Committee approval (October 1997).

Task Team Reports

Global Synthesis and Modelling Task Team (GSMTT) (Chair Trevor Platt)
With a shift in planning groups focus underway, several planning group chairs and GSMTT are formulating a procedure to reorganize regional planning groups towards regional synthesis working groups that will liaise closely with the GSMTT for global perspective (see above Planning Group Reports). In addition, plans are now underway to organize a workshop theme around data management and data users, i.e., Data Management and Synthesis Workshop (see DMTT report). Because of the International Ocean Color Co-ordinating Group (IOCCG) plans to hold a training course on *Remote Sensing of the Ocean: Application for Ocean Color, Temperature, Wind Stress and Altimetry* in Chile (November 1997), the GMSTT plans of a similar training course are now on hold. Platt and Sathyendranath (RSTT) are involved, as instructors, in the IOCCG Remote Sensing-training course. During the past year, GSMTT Modelling Symposium Committee, chair by Coleen Moloney, organized the first JGOFS Synthesis and Modelling Symposium, which was completed successfully in Oban (May 1997). The Symposium provided a productive forum of international expertise in modelling ocean biogeochemical processes. Biogeochemical modelling design, development, interpretation and validation concerns were major priorities of the symposium. Moreover, JGOFS GSMTT and participants engaged in high level discussions with IGBP GAIM participants on merging biogeochemical process models with large-scale General Circulation Models. Patrick Monfray (GAIM) mentioned plans for a joint JGOFS-GAIM Task Team (JGTT) that are developing from discussions at the 1996 IGBP Congress and recently from 1997 GAIM Task Force. Fasham, who is a Task Force member, prepared a written report on this activity for the 1997 SSC.

Data Management Task Team (DMTT) (Chair Roy Lowry)
The DMTT met at the British Oceanographie Data Centre (January 1997), with new appointed members since their last meeting in Tokyo in 1994. Terms of Reference were modified to include the role of the International Project Office as a resource to DMTT activities and to act as a link between the JGOFS DMTT and IGBP Data and Information System (DIS). Lowry announced plans to release of the Arabian CTD CD-ROM, with JGOFS data gathered during the Arabian process study (May 1998). Lowry will appoint a French representative to the DMTT, in view of French efforts in developing a national data centre that will archive JGOFS data. The DMTT reported the launching of the JGOFS Data Index (JDI) project. This will be a centralized index to the data collected during the JGOFS field programme, which may be queried by anyone engaged in JGOFS data synthesis. The DMTT proposed the organization of a workshop with the DMTT and the GSMTT, to establish a channel of communication between modellers and data managers. In developing stronger links with IGBP Data and Information System (DIS) and World Data Centers (WDC), Lowry and the IPO officers participated in the DIS/WDC Workshop in Boulder (April 1997). Lowry and Sidney Levitus (WDC-A, Oceanography) made plans for the long-term archival of synthesized JGOFS data sets at the WDC-A, Oceanography. Plans are also underway to assemble an international JGOFS Data Management Workshop in conjunction with a Synthesis Workshop (1998).

Continental Margin Task Team (CMTT) (Chairs J. Hall-JGOFS & S. Smith-LOICZ).
The CMTT will meet again before the planned CMTT Workshop in Texel (October 1997). This workshop is in conjunction with the LOICZ Open Science Meeting in The Netherlands. The workshop will follow on the Nigerian CMTT Workshop of last year. Afterwards, the CMTT plans to consider the implementation and designation of JGOFS-LOCIZ projects for process studies on continental margins. No additional meetings were

mentioned.

Photosynthesis Measurement Task Team (PMTT) (Chair Egil Sakshaug).
The Chair reports that the article "*Measurement of the Parameters of Photosynthesis: Light Absorption and Quantum Yield of Photosynthesis Derived from P vs E Determinations*" has been accepted by the Journal of Plankton Research. A "small" Symposium is planned to complete the report on *Protocols of Photosynthesis Measurements: Growth vs net production and dissolved organic carbon* in Svalbard (August 1997). As no future meetings are anticipated, a final PMTT report is expected at the next SSC Meeting.

Deep Ocean Flux Task Team (DOFTT) (Co-Chairs Graham Schimmield & Karin Lochte).
The Chairs reported on the deep-sea synthesis plans in the EU and the project *"Atlantic Data Base for Exchange Processes at the Deep-Sea Floor"* (ADEPD). They also mentioned interests in establishing a joint JGOFS/PAGES Task Team to bridge JGOFS and PAGES interests in the deep sea. Moreover, plans are underway to meet and develop a DOFTT implementation plan, term of reference and membership criteria (1998), as well as a scientific meeting or workshop with support coming from the ADEPD program (1998).

Remote Sensing Task Team (RSTT) (Chair James Yoder).
The Japanese successfully launched the Ocean Color and Temperature Sensor (OCTS) in 1996 and are now receiving satellite images. However, transmission ceased in June 1997, possibly owing to the collision with a meteorite. The U.S. SeaWiFS (Ocean Color Scanner) satellite was finally launched on 1 August 1997. Yoder and Platt also reported on the newly established International Ocean Color Co-ordinating Group (IOCCG) and possible links with RSTT and GSMTT. The IOCCG is sponsored by NASA (National Aeronautics Space Administration), NASDA (National Space Development Agency of Japan), ESA (European Space Agency), CNES (Centre National d'Etudes Spatiales), Canadian Space Agency (CSA) and the JRC (Joint Research Centre, EC). Yoder and Platt recommended that Saino represent JGOFS at future IOCCG meetings. SSC approved the recommendation. At this time, no meeting is planned for 1998.

North Pacific Task Team (NPTT) (Co-Chairs Alexander Bychkov and Toshiro Saino)
The NPTT held its first Meeting in Japan (November 1996). Following the meeting, Bychkov requested approval for three additional members and/or replacement. The SSC approved the appointments of Professors Stephen Riser (USA), Stephen Emerson (USA), and Nianzhi Jiao (China-Beijing) to the NPTT. The SSC approved travel support for members to a second NPTT Meeting in Korea (October 1997).

IOC-JGOFS CO_2 Panel (Chair Andy Watson)
The CO_2 Panel met in Warnemuende (June 1997). Among many items discussed, Watson emphasized the importance of the quality control programme behind the dissolved inorganic carbon (DIC) measurements with Certified Reference Material. Certified DIC measurements provide a quality control on the accuracy of oxygen and nutrient measurements compared to laboratory prepared standards. The CO_2 Panel notified WOCE and recommended a multivariate approach, rather than comparison methods, to identify astigmatic biases in nutrient and oxygen concentrations. Next meeting is planned in Japan (June 1998).

JGOFS International Project Office: Highlights and Achievements
The International Project Office (IPO) falls under the auspices of the International Geosphere-Biosphere Programme (IGBP) and the Scientific Committee on Oceanic Research (SCOR). Funds in support of the IPO, Scientific Steering Committee and JGOFS activities come from SCOR, Norwegian Research Council, University of Bergen and Meltzer Foundation, and IGBP.

Administrative Activities
IGFA Resouree Assessment. In addition to administering program funds for approved scientific meetings, the IPO has maintained strong administrative support for all JGOFS oceanographic and/or synthesis activities, as recommended by the Scientific Steering Committee. Accordingly, the IPO has provided a function as an

information resource for non-government and government organizations. Recently, IGBP Scientific Committee agreed that IGBP IPOs should co-operate fully with IGFA resource assessment and requirement for global change research. To facilitate IGFA Resource Assessment and Requirement, IGBP requested a meeting with IGFA national contacts, global change program directors and its program elements in Potsdam (August 1997). The JGOFS Executive Officer will attend and present JGOFS interests.

IGBP Book Series. In May 1995, The First Joint Global Ocean Flux Study (JGOFS) International Scientific Symposium was held in Villefranche-sur-Mer, France. The Symposium provided a special opportunity to review the mid-program synthesis of JGOFS activities under various national JGOFS programs and to demonstrate JGOFS scientific achievements in ocean biogeochemistry. Selected proceedings from the Symposium will be published by Cambridge University Press as part of the IGBP Book Series (*The Changing Ocean Carbon Cycle: A midterm synthesis of the Joint Global Ocean Flux Study*. Editors, R.B. Hanson, H.W. Ducklow, and J.G. Field).

European Commission Proposal. An European Commission Research Training and Mobility application (title: *A parameter-Level Oceanographic Data Index on the Internet*) was submitted for consideration. The name of the applicant is John Hughes, who has proposed a project to develop Internet technology for the JGOFS Data Index (see also Data Management Activities regarding JGOFS Data Index). If funded, the project will start January 1998 under the supervision of Drs. Roy Lowry (British Oceanographic Data Center) and Roger Hanson (University of Bergen). The Center for Studies of the Environment and Resources offered to host the project and the IPO will support its computer requirements.

Norwegian JGOFS Data Center. Norwegian JGOFS science community lacks an effective ocean data exchange and depository in Norway. Arrangements are presently being made to improve existing structure. Norwegian JGOFS Committee with assistance from JGOFS IPO are planning a pilot project with the Institute of Marine Research (IMR of Bergen) to create a database within IMR's system to archive of Norwegian JGOFS data and to service data exchange within JGOFS scientists. If the pilot project succeeds, IMR plans to become a national data centre for oceanographic data. Funds for the 1-year pilot project will be sought from the Norwegian Research Council.

Planned JGOFS Activities for 1998. At the 1997 SSC Meeting, Chairs of the subsidiary JGOFS activities identified their group plans. TABLE 1 is a compilation of remaining 1997 activities, as well as proposed plans and annual meetings for 1998.

Data Management Activities

JGOFS Cruise Inventory. Over the past year, the IPO has focused a considerable amount of efforts to enhance and strengthen JGOFS data and information links within IGBP framework activities, focused JGOFS activities, and its oceanographic community. It began with launching of the JGOFS international homepage on the WWW (August 1996). For example, Balino helped to implement the JGOFS cruise inventory, developed earlier by the DMTT. The inventory contains the records of all JGOFS cruises since the start of the field program (1986). Hypertext links are now being established between each cruise and its data.

Hypertext Links. The IPO has implemented the biogeochemical data collected at the 1-D Modelling Workshop (Toulouse, France) on the homepage, which enhances the publication *One-Dimensional Models of Water Column Biogeochemistry* (JGOFS Report No 23, 1997). *Protocols for JGOFS core measurements* (JGOFS Report No. 19, 1996) is now available on the homepage and together with a hyperlink to DOE *Oceanic Carbon Dioxide Quality Control* handbook.

Data Coordination. We also provide administrative support for the JGOFS Data Management Task Team (DMTT) by tracking the location of data sets, adding lines of communication between JGOFS planning groups and DMTT functions related to synthesis and modelling, and acting as a data coordinator to strengthen our links between JGOFS DMTT and IGBP Data and Information System (DIS).

JGOFS Data Index . In the coming year, we plan to assist in the development and implementation of the JGOFS Data Index at the IPO (see DMTT Report). Once completed, this catalogue will describe all data sets acquired during the JGOFS field program, accompanied by comprehensive documentation (metadata) and with pointers to the physical location of the data (archives). Users will be able to query the database via the IPO homepage. DMTT will supervise this project.

Additional Reports and Publications

JGOFS Reports. The IPO has printed *Remote Sensing in the JGOFS Program* (JGOFS Report No. 20, 1996), *First Report of the JGOFS/LOICZ Continental Margins Task Team* (Report No. 21,1996), *Report on the International Workshop on Continental Shelf Fluxes of Carbon, Nitrogen and Phosphorus* (No. 22, 1996). We are now compiling a list of JGOFS articles (over 1200 citations) published since 1988 (in preparation, Report No. 24, 1997).

Articles. We have also assisted with articles for the IGBP Global Change Newsletter, *JGOFS Process Studies in the Arabian Sea,* No. 28 (December 1996), and to the U.S. JGOFS News, *Multinational JGOFS Effort in the Arabian Sea Nears Completion,* Volume 28 (March 1997). More recently, we have supplied information and science highlights for the IGBP exhibition booth posters at the United Nations General Assembly Special Session in New York (June 1997).

Posters. There are plans to develop a general International JGOFS Poster under a uniform template for IGBP International Projects. The JGOFS poster will be distributed to the Scientific Steering Committee and national chairs for display at symposia, workshops, or meetings. A poster about JGOFS Data Management policy, model, and products is being developed together with the DMTT to present at the Ocean Data Symposium in Dublin (October 1997).

TABLE 1. FUTURE ACTIVITIES: JGOFS SPONSORED MEETINGS WITH SCOR-IGBP-NRC FUNDS

I. JULY THROUGH DECEMBER 1997

Photosynthesis Measurement Task Team-Symposium (Svalbard, August)
North Atlantic *ad hoc* Synthesis Working Group-Meeting (Southampton, September)
Continental Margin Task Team-Workshop (Texel, October)
North Pacific Task Team-Meeting (Pusan, October)
JGOFS Executive Committee-Meeting (Williamsburg, October)

II. January through December 1998

Indian Ocean Planning Group-Arabian Sea Synthesis Meeting (Plymouth, January)
Southern Ocean Planning Group-Biogeochemical Provinces Workshop I (Cambridge)
JGOFS Scientific Steering Committee-Meeting (spring)
Data Management Task Team-Data and Synthesis Workshop (Bergen or Halifax, May)
Global Synthesis and Modelling Task Team-Data and Synthesis Workshop (Halifax, May)
Deep Ocean Flux Task Team-Meeting (Warnemuende)
IOC-JGOFS CO_2 Panel-Meeting (Tokyo, June)
Indian Ocean Synthesis Working Group-Meeting (Paris, June)
JGOFS Executive Committee-Meeting (fall)
Southern Ocean Planning Group-Biogeochemical Provinces Workshop II (Cambridge, 1998)
JGOFS-GAIM Task Team-First Meeting (tentative, 1998)

1998

Joint Global Ocean Flux Study

Scientific Steering Committee and Function Leaders

Name	Country	Function	Term
Fasham, Michael	UK	SSC, Chair, NA	2000
Lochte, Karin	Germany	SSC, DOF	2000
Liu, K.-K.	China-Taipei	SSC	2000
Quinones, Renato	Chile	SSC	2000
Hong, Huasheng	China-Beijing	SSC	2000
Sakshaug, Egil	Norway	SSC, PM	1999
Saino, Toshiro	Japan	SSC, NP	1999
Field, John	South Africa	SSC, PC	1998
Bychkov, Alex	Russia	SSC, NP	1998
Willebrand, Jürgen	Germany	SSC	1998
Murray, James	USA	SSC, EP	1998
Ducklow, Hugh	USA	SSC	1998
Tilbrook, Bronte	Australia	SSC	1998
Shimmield, Graham	UK	DOF	
Hall, Julie	New Zealand	CM	
Bathmann, Ulrich	Germany	SO	
Lowry, Roy	UK	DM	
Watson, Andrew	UK	CO2	
Yoder, James	USA	RS	
Burkill, Peter	UK	IO	
Platt, Trevor	Canada	GSM	

SSC = Scientific Steering Committee Member
PC = Past Chair
DOF = Deep Ocean Flux Task Team
CM = Continental Margin Task Team
SO = Southern Ocean Planning Group
IO = Indian Ocean Planning Group
DM = Data Management Task Team
CO2 = Carbon Dioxide Panel
RS = Remote Sensing Task Team
GSM = Global Synthesis and Modelling Task Team
NP = North Pacific Task Team
NA = North Atlantic Planning Group
EP = Equatorial Pacific Planning Group
PM = Photosynthesis Measurement Task Team

ANNEX 7 - Global Ocean Ecosystem Dynamics

Report to the 33rd Executive Committee Meeting of SCOR
GLOBEC: Global Ecosystem Dynamics Program
(Report of the SCOR/IOC/IGBP Scientific Steering Committee)

Contributed by Roger P. Harris Chairman GLOBEC SSC

This has been a year of active development for GLOBEC, and the support of the co-sponsors, IGBP, SCOR and IOC has been valuable and is gratefully acknowledged.

Publication of the GLOBEC Science Plan

A significant landmark in the year under review was the publication of the GLOBEC Science Plan (GLOBEC Report No.9, IGBP Report No.40).

Scientific Steering Committee

The GLOBEC SSC met twice during the year, at the Johns Hopkins University, Baltimore, USA (11-13 November, 1996) and at the Plymouth Marine Laboratory, UK (21-24 June, 1997). Agenda items discussed included, the Science Plan, progress on developing the Implementation Plan for GLOBEC, planning for the Open Science Meeting, establishment of an International Project Office, reports on, and updates on plans of, major GLOBEC field components, data management for GLOBEC, reports from, and future plans for, GLOBEC Working Groups, reports from National and Regional GLOBEC programmes, relations with other international global change programs , communications, visibility and other meetings. The full Minutes of the SSC meetings are available from the GLOBEC Web-Site (http:/www1.npm.ac.uk/globec/), or on request from the Plymouth Office. Selected issues are reported on under the appropriate headings below.

The current membership of the GLOBEC SSC is shown in Table 1. Nominations are currently being sought to fill the one vacancy, and to replace the two members whose terms end at the end of 1997.

International Project Office

The major practical problem facing GLOBEC, and potentially hindering it's development, is the continuing delay in establishing an International Project Office (IPO). A bid to host the IPO in Plymouth was made to the UK Natural Environment Research Council in August 1996 and a negative response to the bid was received in March 1997. NERC linked the IPO bid to the UK GLOBEC research proposal bid, and although that proposal was highly graded, it was not funded in that year's funding round. In the face of this situation a local effort is being made within the Plymouth Marine Laboratory to provide a bridging support, to plan for the Open Science Meeting, and to keep the momentum going. This interim support *might* lead to funding for the IPO next year if NERC does fund a re-submitted UK GLOBEC next year. In the meantime the Plymouth Office is being run by the Chairman with limited part-time secretarial assistance, supported on a temporary basis by PML funds.

Because of the continuing uncertainly in the UK regarding the IPO, active steps should be taken to explore other alternative host countries for a fully funded, viable, GLOBEC IPO. The help of the co-sponsors may be sought in this respect.

Open Science Meeting

The First Open Science Meeting of GLOBEC will be held next year and will serve to present a draft of the GLOBEC Implementation Plan to the international science community and provide a forum for its discussion, and for feedback. It take place from 17-20 March 1998 at the Intergovernmental Oceanographic Commission of Unesco, Paris, France.

The Open Science Meeting will feature invited plenary key note presentations on GLOBEC, its major subprojects

and their implementation. The overall structure of the meeting will reflect the four GLOBEC research foci:

1. Retrospective analysis in the context of large-scale climatic changes.
2. Process studies
3. Predictive and modelling capabilities
4. Feedbacks for changes in ecosystem structure

In parallel sessions, additional contributions in smaller groups will address specific topics such as national and regional GLOBEC initiatives, relationships with other IGBP Core Projects (e.g. JGOFS, LOICZ, PAGES) and other programmes such as WCRP (WOCE, CLIVAR), GOOS, the Large Marine Ecosystems Project (LME) and the International Human Dimension Programme (IHDP). GLOBEC researchers are encouraged to display contributed posters on concepts, results and conclusions of their own research. One session will be devoted to training, education and capacity building within GLOBEC.

The following are the members of an organising sub-committee, drawn from the GLOBEC Scientific Steering Committee: Professor Dag Aksnes (Norway), Dr Jürgen Alheit (Germany), Dr Roger Harris (United Kingdom), Dr Tsumotu Ikeda (Japan), Dr Ian Perry (Canada), and Dr Qisheng Tang (China).

Development of the GLOBEC Implementation Plan

Linked to the Open Science Meeting is the timely development of the Implementation Plan for GLOBEC, which is the key task for the SSC during 1997. Much work has been done already, and progress has generally been good. The broad structure for the Implementation Plan was identified at the Baltimore SSC as an outgrowth of the four Foci of the GLOBEC Science Plan. Draft texts have been developed subsequently. These were reviewed at the Plymouth meeting and feed-back sought from the SSC. The overall structure of the Implementation Plan is:

Focus 1: Retrospective Analyses in the Context of Large-Scale Climatic Changes
- Activity 1.1. Analyses of Existing Historical Data
- Activity 1.2. Creation of new, Historical, Data sets
- Activity 1.3 Support for ongoing, and development of new, data sets for future comparisons

Focus 2: Conduct Process Studies organised around the Themes of
(1) Research and modelling of Ecosystems and Trophodynamics,
(2) Identification and Understanding of Mesoscale Physical-Biological Interactions and
(3) Research on Forced Responses in Ecosystems.
- Activity 2.1: Ecosystem and Trophodynamics
- Activity 2.2: Multiscale Physical-Biological Interactions
- Activity 2.3: Ecosystem Response to Forcing
- Activity 2.4: Global Integration and Cross-links to Other Foci, e.g. Process Modelling

Focus 3: Develop Modeling and Predictive Capabilities with Interdisciplinary, Coupled Modeling-Observational Systems
- Activity 3.1 Review Relevant Sampling and Observational System Capabilities
- Activity 3.2 Review Relevant Modeling Capabilities
- Activity 3.3 Review Relevant Coupled Modeling-Observational Capabilities and Applications

Focus 4. Cooperate with other Ocean, Atmosphere, Terrestrial and Social global change research efforts to estimate Feedbacks from Changes in Marine Ecosystem Structure to the Global Earth System.
- Activity 1: Climate Interaction on Multiple Scales and its Consequences for basic Biological Processes.
- Activity 2: The Interaction between Phytoplankton and the Zooplankton-Fish System.
- Activity 3: Ecosystem Effects on Higher Trophic Levels.
- Activity 4: Relations to International Programmes.

It is expected that final drafts of the four Foci will be completed by mid-September. A detailed outline of the Implementation Plan, down to focus subheading structure, has been sent to National Chairs for comment and input; a developed text will be available by late autumn and a polished draft before the Open Science Meeting.

GLOBEC Working Groups

At both SSC meetings there was extensive discussion of the status of, and plans for the existing GLOBEC WGs, and the need for new WGs to address new topics. It was decided that there was no need at present to constitute WGs on "Retrospective Data Analysis" and "Process Studies". It was, however, agreed that the formation of a new group on "Data Management" issues should be actively considered.

The future of the "Sampling and Observational Systems" and "Numerical Modelling" Working Groups was discussed in detail at both SSC meetings. It was recognised that both groups had been influential in the development of GLOBEC to date, and that it was important to consider their future role and direction carefully. This was recognised in Baltimore, but no clear action had ensued. In Plymouth plans for the future development of modelling and technology for GLOBEC were agreed and steps were taken to ensure that two efforts would be closely tied to the GLOBEC field programmes. It was agreed that a new combined group should be formed, revised terms of reference, new membership, a rotation plan, and a new name for the combined NMWG and SOS groups as a "Modeling and Sampling Working Group" should be recommended by a subgroup of the SSC. This proposal will be approved by the GLOBEC Executive. The new group plans a major workshop for the summer of 1998, with a substantial focus on data assimilation in the context of an update and review of advances in modeling

The Major Components of GLOBEC

Four major field programs are currently being planned as part of international GLOBEC. Significant developments are briefly reviewed below.

***GLOBEC Southern Ocean Programme (SO-GLOBEC)*:** A newly constituted SO-Ocean Planning group has been set up under the leadership of Eileen Hofmann. The first meeting of the new SOPG is planned for La Jolla, August 1-3. The meeting aims to review the existing Science and Implementation Plans; updates to these will then be circulated. The group intends to reaffirm selection of study areas, and it is hoped to agree cruise and sampling plans for SO-GLOBEC for the next 3-4 years. The SOPG group will serve a function of co-ordinating national cruise schedules, etc. It will also develop a timeline for SO-GLOBEC. The need for an international Southern Ocean office will be discussed at the La Jolla meeting.

Small Pelagic Fishes and Climate Change (SPACC): SPACC is developing actively. SPACC has 10 WGs and some of these have had meetings during the past year; the modelling WG which met in October 1996 in Ispra, was attended by about 20 participants. The meeting emphasized the southern hemisphere and developing countries, and particularly considered simple models of practical use to scientists in these countries.

In June 1997 there was a meeting of the WG on Comparative Population Dynamics in Dartmouth, Mass. This considered methodology for studying mortality and growth rates. In the autumn of 1997 the WG on Daily Juvenile Growth and Zooplankton will meet in Mar del Plata, Argentina. The WG on Decadal Changes of Ecosystems will hold a meeting in La Jolla in October with the final meeting of SCOR WG. Subsequently the WG 98 effort will be assimilated into SPACC, and there is the intention to try to involve climatologists in the future. There are also strong interests in several of the WG meetings planned for 1998, especially the three on process studies.

At Plymouth the draft SPACC Implementation Plan was presented to the SSC for comments and approval. It was agreed to publish the Publish SPACC Implementation Plan (with modifications as discussed) as a GLOBEC Report with the SPACC modeling report as an Annex.

ICES-GLOBEC Cod and Climate Change Programme (CCC): Three workshops are planned for 1997 and 1998:

Environmental Data in Stock Assessment - Fall 1997, Bergen
Decadal-scale oscillations an climate prediction - Fall, 1997 Copenhagen
Backward Facing Workshop III

The ICES Annual Science Conference in Baltimore in September 1997 has a special theme session on GLOBEC issues ("GLOBEC Results from Inter-disciplinary Programmes in the North Atlantic") and a large number of contributions have been submitted.

An ICES/GLOBEC Regional co-ordination Group has been established to support and direct activities in the ICES area. The office is located at the ICES Secretariat in Copenhagen and Keith Brander is responsible for it's operation. The ICES GLOBEC Regional co-ordination group met in Copenhagen in June 1997 and several issues were referred for advice from the SSC.

PICES-GLOBEC Climate Change and Carrying Capacity Programme (CCCC): Three Task Teams have been formed to move forward on major research activities and to involve a larger number of people in the North Pacific. These Teams are: - MODEL: conceptual/theoretical studies and model development; - REX: Regional EXperiments to develop the structure and to facilitate comparisons among the "regions" (i.e. to coordinate the National GLOBEC programs); and - BASS: BASin Studies to develop the structure and coordinate studies in the open Pacific basin (i.e. to develop the international GLOBEC program in the North Pacific). There will be a REX workshop to be held at the PICES Annual Meeting in Pusan, South Korea, October 17-18, 1997, and the GLOBEC SSC have been involved in it's planning.

National Programmes
There has been continuing concern during the year about improving links and communication with national committees. This is the responsibility of the SSC, and members have been encouraged to communicate actively with their national committees, national committees encouraged to use the Newsletter and also to attend the Open Science Meeting as a productive forum for dialogue.

China GLOBEC has the aim of identifying how the change in climate and anthropogenic influences will affect the dynamics of the coastal ecosystem. The field study is in the Bohai Sea and has 4 research teams concentrating on, Bohai prawn early life history, zooplankton population dynamics, trophodynamics of the food web, and Bohai Sea ecosystem dynamics modelling. The project did get funding from the Chinese NSF, but team 1 is experiencing some problems since the prawn population is very low in the Bohai Sea at the moment.

Japan GLOBEC is still waiting for funding for Monbu-sho GLOBEC (Universities). Suisan-sho (Fisheries Agency) GLOBEC is funded and is making a comprehensive study of the environmental variation influencing the fisheries resources in the North Pacific.

The Benguela Ecology Programme (BEP-IV) in South Africa is extremely active and links to other programs such as BENEFIT, LME, ENVIFISH, VIBES, and the NORAD modelling project were discussed by the SSC.

Within US GLOBEC the NW Atlantic/ George's Bank program is in it's 3rd year and is currently in midst of an active field season. The NE Pacific program has 15 funded projects for which notifications are just going out; this is the beginning of this phase for the US. There is a transition to operational monitoring, with a move of the Georges Bank effort towards monitoring. There is interest in co-ordination with new US LOICZ interests. There has been preliminary planning for a workshop to address comparative issues.

GLOBEC Canada is entering the second year of the funded program. Fieldwork and modelling are underway, and there will be a Science meeting in Vancouver in January 1998.

The Norwegian program is starting into the second half of a six year program. The emphasis is on zooplankton and the feeding of herring. In the second half there will be an increased focus on large-scale ecological modeling in the Norwegian Sea. There may be the possibility of a successor GLOBEC program to start in 1999/2000, and this will be based on international plans.

A proposal for a UK GLOBEC programme has been highly graded but not funded, and will be re-submitted for possible funding in 1998

There has been a meeting to discuss setting up a Baltic Sea GLOBEC program. This will be structured after the EU GLOBEC Science Plan (to be developed at a meeting in Warnemuende, in October) and will be further developed with the Baltic Sea countries later this year.

A number of other countries are considering establishment of national programmes.

Reports and Publications
GLOBEC Reports are now available directly from the Plymouth Office or via the GLOBEC Web-Site. Additional copies of a number of reports, still being requested, have been reprinted.

The GLOBEC Science Plan was published by IGBP, Stockholm, as GLOBEC Report No. 9, and IGBP Report No. 4.

Two previous GLOBEC documents have been printed and circulated from Plymouth, they are:

GLOBEC Special Contribution No. 2. An Advanced Modelling/Observation System (AMOS) for Physical-Biological-Chemical Ecosystem Research and Monitoring (Concepts and Methodology). By GLOBEC International Working Groups on Numerical Modelling and Sampling and Observational Systems.

Interdisciplinary Model Formulation and Parameterisation; Report of the Second Meeting of the International GLOBEC Numerical Modelling Working Group, Nantes, France, 17-20 July 1995.

The Plymouth office also plans to publish two further GLOBEC Reports by the end of the year, the SPACC Implementation Plan, and the Report of the First SPACC Modelling Workshop, 14-16 October, 1996, Ispra, Italy.

TABLE 1

The 1998 membership of the GLOBEC SSC is:

Name, Country		Term		
		12/98	12/99	12/00
Alheit, Jürgen	Germany			
Carlotti, François	France			
Dickey, Tommy	USA			
Harris, Roger	UK			
Hofmann, Eileen	USA			
Ikeda, Tsutomu	Japan			
Kim, Suam	S. Korea			
Perry, Ian	Canada			
Pinardi, Nadia	Italy			
Piontkovski, Sergey	Ukraine			
Poulet, Serge	France			
Rothschild, Brian J.	USA			
Shillington, Frank	S. Africa			
Snndby, Svein	Norway			

ANNEX 8 - Surface Ocean - Lower Atmosphere Study (SOLAS)

In order to begin outlining plans for a potential new IGBP Programme Element in the area of marine biogeochemistry and climate, the following group met in London at the Ciba Foundation in January 1997: Andrew Watson (UK, Chair), Wallace S. Broecker (USA), Robert A. Duce (USA) Patrick M. Holligan (UK) M. Dileep Kumar (India), Michael Witfield (UK), Phillip Williamson (UK). The chairman of the group submitted the following report.

Summary

The group proposed a new project with a new approach to cover the area of marine biogeochemistry and its interaction with the atmosphere. The following goal is pro-posed for the "Surface Ocean-Lower Atmosphere Study" (SOLAS):

To address key interactions among the marine biogeochemical system, the atmosphere and climate, and how this system affects and is affected by past and future climate and environmental changes.

This goal will be attained by:

- formulating and testing hypotheses about these key interactions,
- quantifying cause and effect in these interactions, and
- incorporating this new understanding into models

SOLAS should proceed by use of perturbation experiments to examine key interactions, and by detecting the responses to ongoing variations in the system. Perturbation experiments should include both *in vitro* and *in situ* enclosed and unenclosed studies. Detection of responses of global system should include both anthropogenic change and studies of the effects of natural variation (dust deposition, El Niños, monsoons, volcanic eruptions etc.). These studies should make full use of the anticipated great increase in the availability of remote sensing data, and both existing and new observational time series in the ocean and atmosphere.

Five important hypotheses in need of testing are:

- marine sulphur emissions have a substantial effect on climate by influencing cloud albedo
- atmospherically derived iron stimulates diatom and other phytoplankton growth in "high-nitrate-low-chlorophyll" regions of the ocean, and this may exert significant feedback effects on climate
- changing patterns of atmospheric nitrogen deposition consequent on increasing industrialization will significantly influence the marine biota in some parts of the ocean
- the influence of changes in marine biogeochemistry on ocean uptake of anthropogenic CO_2 in the next century will be small
- the principal effect on the marine production in a warmer world would be a decrease in global productivity, consequent on a slowing of the thermohaline circulation.

The development and prioritization of principal hypotheses will however be part of the planning of the programme – we do not intend these to be set in stone at this stage.

Though by reason of its membership, the focus of the working group's discussions was on biogeochemistry, physical interactions between atmosphere and ocean should not be neglected in SOLAS and future development of the programme will, it is hoped, include participation by scientists with an expertise in this area also.

Introduction

SOLAS would investigate the marine biogeochemical system as it affects, and is affected by, the atmosphere and climate. The diagram on page ** (Figure 1) illustrates some of the interactions of processes within the marine and atmospheric environment and the major projects being undertaken to investigate them. While a few studies within JGOFS, IGAC and LOICZ presently fulfil parts of the role envisaged for SOLAS, there has been relatively little emphasis on detailed study of such interactions. In addition, JGOFS and IGAC are due to finish by the early years of the next century.

The progress made by IGAC, JGOFS and their sister programmes was considered by the working group. Much has been learned, but many crucial questions regarding the interaction of the marine system with the atmosphere and climate have not been answered, and in some cases not even addressed. For example, while JGOFS has contributed in a major way to understanding of the role of the biota in the marine carbon cycle, its contribution to understanding the mechanics of global change has been much more modest.

The domain of SOLAS may be divided into effects of marine biogeochemistry on the atmosphere, and the effects of climate and atmospheric processes on the marine biogeochemistry. Regarding the effect of the marine biogeochemistry on atmospheric conditions and hence climate, the following describes present understanding and its limitations.

CO_2 : On a 50-100 year timescale, the degree to which the marine biota can increase or decrease the sink for CO_2 is small. An upper limit can be derived from a scenario in which the entire Southern Ocean is assumed to utilize all the available phosphate and nitrate nutrients (due to iron fertilization or changes in circulation for example). Then a shift in atmospheric CO_2 on the order of 60 ppm is possible, rather modest by comparison to projected increases of 300-700 ppm above the pre-industrial concentration by the end of the next century. The likely actual effect would be much lower than this extreme case. Major changes in for example, globally integrated carbon-to-nutrient "Redfield" ratios could also cause changes in the size of the ocean CO_2 sink, but since large shifts in these ratios are not currently seen between different marine ecosystems, it seems unlikely that these would occur. By contrast, in the glacial-interglacial context, 60ppm is a very significant shift in atmospheric CO_2. On longer time scales therefore, and in particular with regard to understanding the past history of CO_2 in the atmosphere, the study and understanding of marine biogeochemical controls on CO_2 remains a very important topic. SOLAS should include study of these controls, but should be careful not to overstate their relevance to short-term changes in climate.

Dimetiiylsulphide, (DMS): the hypothesis that cloud albedo may be substantially influenced by marine sulphur emissions through the formation of sulphate aerosol particles and cloud condensation nuclei has been in the literature since 1987. Potentially, this is a powerful climate-influence mechanism, even on the short 50-100 year timescale. It has been studied to only a very limited extent by IGAC and JGOFS, and to date its importance remains largely unresolved. We do not know the degree to which the underlying assumption, that more DMS makes more cloud condensation nuclei in remote areas is correct or not.

Other gases: the ocean is a relatively minor source of the radiatively active gases CH_4 and N_2O, so changes here are unlikely to greatly influence global change on time-scales of less than 100 years. Once again, on longer time scales, however, there may be important effects. N_2 production and fixation do not influence climate directly, but because the balance between them controls the nitrate concentration in the oceans on time scales of 1000 years, this will be important in maintaining the marine biota. The chemistry of the atmosphere is influenced by many trace gases of marine origin: non-methane hydrocarbons, CO_2 organohalogens, and ammonia for example. Factors influencing the sources and sinks of these gases have not so far been subject to detailed study.

With regard to the influence of the atmosphere and climate on marine biogeochemistry, the situation is less clear. One approach to this problem seeks first to characterize the marine biota in terms of biogeographic regimes, where the boundaries between the zones and the biology within them are strongly influenced by external factors set by the atmosphere and climate, such as ocean circulation patterns, light and supply of nutrients. The biota in these regimes may in turn have distinct biogeochemical attributes, for example, one can distinguish between the diatom dominated systems, common in upwelling and seasonal bloom regions (high organic carbon and silica deposition and low carbonate production rates) and low f-ratio systems found in the permanently stratified gyres, having broadly the opposite properties.

Attempts have begun to describe and model the response of these subsystems to changes in the external factors, but

confidence in the model results is generally low. Progress in this area has been hampered by (1) a lack of hard information on the impact of changing conditions and resource availability on marine ecosystems, and (2) the lack of good data on remote sensing of ocean colour in recent years. The following are important global change hypotheses in this area:

- Overall, a warming world might be expected to reduce the strength of the global thermohaline circulation, leading to lower marine production.
- In specific regions, the marine biota may be expected to respond to input of nutrients from the atmosphere, in particular iron from dust in iron-poor regions, and nitrogen inputs in nitrogen-limited regions. Changes are likely in these inputs in the next century due to anthropogenic effects. Of particular concern are inputs of nitrogen from the developing economies in Asia, affecting the western Pacific and North Indian Oceans, and industrial development in currently pristine regions of the Southern Hemisphere.
- Regional winds may increase in intensity. This would be expected to increase the prevalence of nutrient-rich ecosystems at the expense of steady-state ecosystems, for example by increasing the rates of coastal upwelling and open-ocean mixing.
- Many of the changes in source and sink strengths will occur especially in the coastal oceans. These are the site of a large proportion of marine productivity and will be subject to increasing nutrient input due to river eutrophication and waste disposal.

Philosophy of a new programme

A coordinated programme should have a guiding philosophy concerning the interaction of measurement with theory, if it is not to risk that these two elements become uncoupled from each other, resulting in observations made "for their own sake", and models which are not amenable to testing. An earlier suggestion for the Global Ocean Euphotic Zone Study (GOEZS, the precursor to SOLAS) was that it should be "model driven". This philosophy works best with models which are predictively robust. In most instances, such models do not exist in this subject area.

It was suggested that in SOLAS, theory and observation should be coupled by means of hypotheses. These should be formulated such that, if they are quantitatively established or refuted this will result in substantive increases in our knowledge. Five examples of such hypotheses are given at the beginning of this article.

SOLAS goals

We propose the following goal for SOLAS:

To address the key interactions among the marine biogeochemical system, the atmosphere and climate, and how this system affects and is affected by past and future climate and environmental changes.

This goal will be attained by:

- formulating and testing hypotheses about these key interactions,
- quantifying cause and effect in those interactions, and
- incorporating this new understanding into models.

It was felt that past climate change should not be sidelined, since a full understanding of the system will involve explaining observed past changes as well as predicting future ones. While a study of past changes is mostly the domain of IGBP-PAGES, investigations of specific biogeochemical mechanisms are appropriate to SOLAS.

Tools and technologies

Hypotheses such as those suggested above must be amenable to test. The following technologies and techniques would enable progress in this regard.

1. Perturbation experiments: the behaviour of marine ecosystems with regard to perturbations of nutrients and other parameters can be studied by enrichment experiments, be these *in vitro, in situ*, enclosed, partially enclosed or unenclosed. A recent example of the power of this technique has been the Ironex experiments in the equatorial Pacific; which proved beyond reasonable doubt that iron is an important factor limiting primary production there Though these experiments were convincing because they were unenclosed similar results had previously been obtained by the simpler technique of bottle incubations. The lesson is that when carefully performed, *in vitro* techniques do have the capability to mimic some aspects of the response of the real system.

A programme of perturbation experiments could advance our knowledge in many ways. For example, examination of the effect of adding increased phosphorus and nitrogen, separately or together, could be undertaken by careful *in vitro* experiments leading to unenclosed fertilization experiments. Attempts have been made to do in vitro experiments before, often with inconclusive results. However, the introduction of ultra-clean handling techniques means the approach can, and should, be revisited. Such a programme could quantify for example, whether the increased nitrogen input by atmospheric deposition into the subtropical gyres would materially affect the ecosystems there. The larger scale perturbation experiments also offer an unrivalled opportunity to study the internal dynamics of the marine ecosystem, and the effect of perturbation on regularly measured proxies such as isotope ratios.

In the atmosphere, the DMS-cloud albedo link is also amenable to study by perturbation. The potency of this mechanism remains uncertain, but there is good reason to suppose that in regions remote from land and human influence (such as most of the Southern Hemisphere) DMS emission may affect cloud albedo substantially. To test this hypothesis would require first, observations of existing sulphur emissions there (for example, effect of ships' emissions) and then probably, controlled releases of SO_2 and/or DMS, followed by studies of the consequent effects on the concentrations of sulphate aerosol and CCNs. Observations would also need to be designed to quantify the marine emission of DMS and the factors influencing it.

2. Coordinated atmosphere-ocean observation and experiment campaigns: there have been relatively few campaigns strong in both atmospheric and oceanic components in the past, but the potential for advancing knowledge by such experiments is large. The DMS study described above is one example, but atmospheric deposition of nutrients, fluxes of reactive gases from sea to air, and the influence of weather patterns on the marine biota are all areas where such an approach could pay dividends.

3. Detecting change and response to natural perturbation: Detection and early warning of global change are of course important to any programme concerned with the impacts of human activities on the planet. However, detection of response to natural perturbations can also serve as an important test of our understanding of the system. Thus, for example, the response to global natural perturbations such as El Niños, monsoons and large volcanic eruptions (which inject iron and sulphur in large quantities into the environment) will be useful to study in addition to changes due to increasing industrial and agricultural activities.

Several very promising new techniques are now becoming available for detecting such responses, and SOLAS should take full advantage of them. They include:

a) Monitoring of atmospheric oxygen/nitrogen and argon/nitrogen ratios at very high accuracy. The former ratio gives direct insight into changes in the net productivity of the global oceans, while the latter may enable direct monitoring of the temperature response of the global ocean. SOLAS should encourage the setting up of a network of stations at which such ratios could be monitored, and technology transfer to en able more groups around the world to make these very exacting measurements.

b) Remote sensing of ocean properties. Sensors for ocean colour, at much improved spectral and spatial resolution, are now becoming available after more than a decade in which no instruments were flying.

c) Establishment of ocean time series. This was one of the important activities of JGOFS. It should be continued and the number of such stations increased, for example by fostering their establishment by a wider variety of nations. Such stations give data which may be difficult to interpret in isolation, because of the

heterogeneity of the ocean. However, in conjunction with the new remote sensing and atmospheric data, separation of global from local trends in such time series is much more likely to be possible.

What should happen next

First, to stimulate discussion a publication of the conclusions of the working group should be made widely available to scientists in the international community. If enthusiasm for the approach is evident, we suggest a small group should organize an international workshop on the hypo-thesis testing approach. At the workshop steps would be taken to form a steering group to work up a science plan. The group should include one or two members of the task force which produced this document. The planning group would be responsible for ensuring adequate links with other projects (both within IGBP and relevant WCRP activities). A reasonable time-scale would be for the workshop to be held in late-1998, followed by production of a science plan in mid-1999.

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ANNEX 9 - Submarine Groundwater Discharges

MAGNITUDE OF SUBMARINE GROUNDWATER DISCHARGE AND ITS INFLUENCE ON COASTAL OCEANOGRAPHIC PROCESSES

A Proposal for a new SCOR Working Group

Submitted by W. Burnett, Evgeny Kontar and the LOICZ International Project Office

1. Background and Significance

Marine Geochemical Budgets: One of the persistent uncertainties in establishing marine geochemical mass balances is evaluating the influence of submarine groundwater discharge (SGD). The major rivers of the world are gauged and well analyzed, thus allowing relatively precise estimates of riverine input to the ocean. Elemental fluxes at hydrothermal systems along mid-oceanic ridges and elsewhere have been studied in considerable detail, and although there is still considerable debate concerning the absolute magnitude of hydrothermal discharge, it is well established that hot springs are significant in the marine budgets of many elements. However, in spite of the recognition that many land-sea interfaces of the world are characterized by "leaky" continental margins, it is unclear how important these fluxes are in terms of overall marine geochemical budgets.

According to the late Fran Kohout (U.S. Geological Survey), submarine springs are a "neglected phenomenon of coastal hydrology throughout the world — known to exist off the coasts of California, Florida, and New York; the islands of the Bahamas, Cuba, Jamaica, and Barbados; Mexico's Yucatan Peninsula, Chile, Hawaii, Guam, American Samoa, Australia, and Japan; at Bahrain in the Persian Gulf, and in the Mediterranean Sea off Spain, France, Italy, Greece, Syria, Lebanon, Israel, and Libya." In addition, slow yet persistent seepage of groundwater into coastal waters apparently occurs over large areas in many coastal regions. Increasingly, groundwater is being recognized as a potentially significant, but still poorly quantified, source of nutrients and other dissolved solutes to coastal ecosystems. A recent report concerning the future of geoscience research by the U.S. National Science Foundation stated that "...at the present time, knowledge of groundwater fluxes is spatially and temporally isolated. Designing field, laboratory, and modeling programs to constrain these fluxes will not be easy, but will likely produce exciting and important results."

Environmental Issues: The direct discharge of groundwater into standing bodies of water may also have significant environmental consequences. Since the concentration of dissolved solids is typically much higher in groundwaters than surface waters, the impact of SGD on coastal chemistry and ecology may be considerably greater than one would estimate based on discharge assessments alone. Estimates for SGD, of course, are almost totally lacking. Furthermore, many groundwaters have become contaminated with a variety of substances (e.g., metals, radionuclides, organics, etc.) and seepage will occur anywhere that an aquifer with a positive head is hydraulically connected to a surface water body. Thus, almost all lakes, rivers, and coastal areas are subject to this general process and those adjacent to contaminated areas are likely to experience environmental degradation. Prior studies indicate that groundwater seepage is usually patchy, diffuse, temporally variable, and very difficult to quantify. How can we assess reliably the extent and impact of direct groundwater flow into the ocean?

2. Proposed Terms of Reference (as approved by SCOR 33rd Executive Committee Meeting):

The overall goal of this working group will be ***to define more accurately and completely how submarine groundwater discharge (SGD) influences chemical and biological processes in the coastal ocean***. We will consider development of the tools necessary to define effects of SGD on seasonal to interannual time scales. In addition, a typological approach will be used to define variations in SGD along different shorelines.

Recognition of the importance of groundwater flow into surface waters as a pathway for dissolved constituents has increased dramatically in the last few years. As one specific example, the Russian Academy of Sciences together with the "Land-Ocean Interactions in the Coastal Zone" (LOICZ) Project of the International Geosphere Biosphere Program convened an international workshop in Moscow last July entitled "Groundwater Discharge in the Coastal Zone." The initial impetus for convening the symposium stemmed from the recognition that an

understanding of the biogeochemical dynamics of the coastal zone required knowledge of all inputs, and that in some locations the contribution of groundwater discharge, although not as easily recognized as oceanic exchange or surface flow, could be important. The strength of the workshop was that it brought together scientists with disparate backgrounds (e.g., hydrology, chemical oceanography) who have been working on similar problems from different points of view — literally from the opposite end of the same process. Our intention is to pick up where the LOICZ symposium left off and focus on the key problems. Specifically, the following tasks will define the activities of the proposed working group:

- To review and assess deficiencies in our knowledge concerning the magnitude of fluxes of SGD.
  Although we will benefit from the recent LOICZ workshop on this subject, there are still areas which need further definition. For example, it remains unclear how effects of SGD may be distinguished from those caused by other processes.
- To define the existing methods and tools useful for measurement of groundwater fluxes to the coastal zone.
  There are several scientific questions that arise in this context. How can SGD estimates be validated? Are geochemical tracers reliable? Which tracers work best? Can direct measurement techniques (e.g., seepage meters) be improved? Can new instruments be designed to assist in the measurement problem?
- To examine the possibility of using a typological approach to assess SGD over broad areas.
  The identification of "type" areas (e.g., karst, volcanic terrain) where the process can be studied in detail and results applied elsewhere would appear to be a reasonable approach.
- To review and assess the chemical (nutrients, pollutants) consequences of SGD and to suggest follow-up studies of the physical and ecological consequences.
- To prepare a series of manuscripts for a special issue of an international journal that will describe the "Influence of Submarine Groundwater Discharge on Coastal Marine Processes."
- To prepare a final report to SCOR within four years and an interim report on the first term of reference within two years.

Membership of the Working Group:

Co-Chairs:

Bill Burnett	(USA)
Evgeny Kontar	(Russia)

Members:		**Associate Members:**	
Robert W. Buddemeier	(USA)	Henry Bokuniewicz	(USA)
Georgia Destouni	(Sweden)	Jaye Cable	(USA)
Toshitaka Gamo	(Japan)	Jeffrey Chanton	(USA)
Willard S. Moore	(USA)	Gerry Jacobson	(Australia)
Aldo da Cunha Reboucas	(Brazil)	June Oberdorfer	(USA)
Dr. Klaus-Peter Seiler	(Germany)	Leslie Smith	(Canada)
Makoto Taniguchi	(Japan)	B.L.K. Somayajulu	(India)
Igor S. Zektser	(Russia)	Luigi Tulipano	(Italy)

ANNEX 10 - Asian Monsoon Evolution

EVOLUTION OF ASIAN MONSOON IN MARINE RECORDS: COMPARISON BETWEEN INDIAN AND EAST ASIAN SUBSYSTEMS

Scientific Rationale

The Asian monsoon system exerts climatic control over much of the most populated region on Earth and is of primary importance in our understanding of global climate evolution. Monsoon circulation results from exchanges of heat and energy between the atmosphere, oceans, and continents and is responsible for a large portion of the global inter-hemispheric transport of water vapor. Long or short-term changes in any of the land, ocean or atmospheric subsystems can substantially alter monsoon circulation. Paleo-monsoon studies in the Indian Ocean, for example, have indicated that the long-term evolution of northern-hemisphere ice-volume has substantially altered the timing and strength of monsoon circulation and has thus contributed greatly to Cenozoic paleoclimatology.

The Asian monsoon is comprised of two subsystems, the Indian (or South Asian) monsoon and the East Asian monsoon. The two subsystems are linked in that they both respond to the strength of high and low pressure cells which grow and decay seasonally over the Asian landmass. However, they also have significant differences dictated by the different sea-land distribution. The South Asian system is dominated by a strong, tropical, summer monsoon which draws the southeast trades of the Indian Ocean across the equator and onto the Asian continent. Its winter component is relatively weak. The East Asian monsoon has both subtropical and tropical aspects, drawing winds and moisture from the tropical Pacific and Indian Oceans during summer but also exporting very cold, strong winds from the Asian interior during the winter monsoon.

The long-term evolution of the South Asian and East Asian monsoon subsystems are likely interrelated, since they are two subordinates of a single system, sharing in common the large Asian landmass. The paleo-monsoon studies to date are very much dominated by those on the Indian monsoon. In addition to the numerous publications on the late Quaternary variations of Indian monsoon, its late Neogene history has been studied on the basis of several DSDP / ODP cruises. By contrast, East Asian paleo-monsoon studies were mainly restricted to land-based works, such as monsoon information from the Chinese loess, until 1994 when a special cruise "Monitor Monsoon" with R/V SONNE was organized to explore the late Quaternary monsoon history in the South China Sea. A new IMAGES cruise and probably an ODP leg will also be devoted to East Asian monsoon records in the South China Sea. In addition, the extensive hydrocarbon explorations in marginal sea off East Asia have accumulated tremendous amounts of geological data rich in paleo-monsoon information although these data are only partly available to the global scientific community.

Given these developments, the time is now ripe to initiate comparative studies of the Asian monsoon subsystems. Comparative studies are expected to provide insight into the driving forces of monsoon variations over time scales ranging from tectonic to millennial, greatly improving our understanding of the role of ocean/continent/atmospheric interactions in climate evolution.

Terms of Reference

- To review the present status of our knowledge of Indian and East Asian monsoon evolution, to define similarities and differences in their histories based on records developed to date;
- To define the key climate proxies necessary for effective comparison of the two subsystems in their evolution over different time scales in response to tectonics, orbital forcing and ocean circulation;
- To provide recommendations for the East Asian monsoon studies on the basis of experience from the Indian Ocean;
- To propose a cooperative research effort in the region through various agencies and programs such as IMAGES and ODP, in order to promote and coordinate paleo-monsoon studies, including organization of an

international symposium, preparation of a paleo-monsoon volume and new ODP/IMAGES cruise proposals;
- To prepare a final report within four years.

Proposed Membership - for consideration by the Chair and Executive Committee Reporter and for final approval by the SCOR Officers:

Wang Pinxian	China	(CHAIR)
Steven C. Clemens	USA	
Michael Sarnthein	Germany	
L. Beaufort	France	
G. Ganssen	The Netherlands	
Yoshi Saito	Japan	
R. Ramesh	India	
J. Grimalt	Spain	
Peter Kershaw	Australia	
John Kutzbach	USA	
Yugo Ono	Japan	PAGES representative

ANNEX 11 - Acoustic Thermometry of Ocean Climate

Report on Activities of SCOR Affiliated Program: Acoustical Monitoring of the World Ocean

Our goal is to develop an international collaborative program to use long range sound transmissions to monitor ocean climate. This undertaking has involved significant technical developments of sound sources, autonomous listening arrays and analytical procedures. It has also had to overcome difficulties associated with the acquisition of permits required for satisfying concerns about environmental effects, especially relating to marine mammals. Despite these obstacles the program has made a successful start in the North Pacific. We are presently in a state of preliminary planning for a second thrust, this time in the Indian Ocean.

Scientific Highlights:

The ATOC program began transmitting acoustic signals on 2 December 1995 from a low-frequency acoustic source installed on Pioneer Seamount off central California. The transmitter started at a level of 26 Watts, increasing to a maximum of 260 Watts. The signals were recorded on horizontal receiving arrays at 11 U.S. Navy SOSUS stations in the Northeast Pacific, and on two vertical receiving arrays, one near the Big Island of Hawaii at a range of ~3515km and the other near Kiritimati (Christmas) Island at a range of ~5171km, just north of the equator in the central Pacific. They were also recorded by a single receiver off New Zealand. Over a year of data have now been collected on some of these receivers. Preliminary analyses indicate that acoustic thermometry is a powerful tool for making routine measurements of large-scale ocean temperature variability and heat content. A cable fault occurred on 15-16 March 1997, preventing further transmissions. Plans are underway to repair the cable, most likely in September/October 1997. Nevertheless, the data acquired to date have yielded a number of interesting scientific results:

(i) Precision of the Acoustic Measurement

Acoustic travel times can be measured with a precision of about 20-30 milliseconds at 3000-5000 km ranges. For comparison the total travel time at 5000 km range is nearly an hour. This measurement is more precise than originally thought possible. The initial concern that acoustic scattering from small-scale ocean structure, such as internal waves, might make accurate measurements of acoustic travel times impossible at 3000-5000 km ranges proved unfounded. Transmissions over these long ranges are needed to measure ocean gyre-scale variability, which is the scale on which ocean climate fluctuations are expected to occur. The corresponding precision with which range and depth-averaged ocean temperature changes can be measured is estimated to be about 0.001 degrees Centigrade per day.

(ii) Tidal and Seasonal Travel Time Changes

The observed travel time changes can be clearly related to known ocean processes. The ocean tides are well-known from other measurements and from models. Their effect on the acoustic travel times can be predicted, thus providing a very convenient large-scale test signal. The measured and predicted travel time fluctuations at tidal frequencies are in excellent agreement out to 5000 km range. One of the significant sources of lower frequency variability in ocean temperature is the seasonal change, with the upper ocean warming during summer and cooling during winter. The ATOC data show corresponding seasonal changes in travel times, as expected, particularly for acoustic paths that travel north of the Subarctic Front, where the seasonal temperature changes extend to significant depths, rather than being confined to a shallow seasonal thermocline.

(iii) Comparison between Acoustic and Satellite Altimetry Data

The range and depth-averaged temperatures derived from ATOC are consistent with and complementary to related estimates derived from measurements of sea surface height made by the TOPEX/POSEIDON satellite altimeter. Sea surface height is related to ocean temperature because of thermal expansion. The two estimates (ATOC and TOPEX/POSEIDON) are complementary, in that the altimeter has excellent horizontal but poor vertical resolution, and the acoustic data provides information from the ocean interior with moderate vertical resolution but poor horizontal resolution. Both have good temporal resolution. One of the primary goals of the ATOC program is to use the acoustic data to test and constrain models of the ocean circulation. Consistent results for the seasonal heat storage are found when the acoustic and altimetric data are combined with a computer model of the ocean general circulation. The two data types are both found to be important in constraining the model, with the combination providing more information than either data type alone.

(iv) Trans Arctic Propagation experiment

The Trans Arctic Propagation experiment in which sounds were transmitted north of Svalbard and detected north of Ellesmere Island in the Lincoln Sea and north of Alaska in the Beaufort Sea continues to yield insights on the potential for acoustic monitoring of the Arctic Ocean. Great phase stability of the signals was observed and analysis revealed the presence of water at intermediate depth that was significantly warmer than historical measurements would imply. This warming trend was subsequently verified with direct temperature measurements from an ice-breaker and also from a submarine. The direct measurements were fully consistent with the acoustically inferred results providing a remarkable illustration of the effectiveness of acoustic propagation studies for climate research in these waters.

Marine Mammal Research Program

The permit requirements for operation of the acoustic source at Pioneer Seamount specified that an extensive marine mammal study be conducted. Indeed, this program is by far the most elaborate and well funded of its kind ever carried out, involving extensive aerial surveys and playback experiments. At the present time there are no results from this research indicating that any species shows any biologically significant adverse response to ATOC or ATOC-like sounds, but for proper scientific evaluation this statement must be qualified by the conditions of the various contributing research components. The four animal groups of concern include sea turtles, deep diving pinnipeds, odontocetes, and mysticetes. Results on each are briefly summarised here:

Sea Turtles: A team from the New England Aquarium and the University of Maryland plan to produce an audiogram for a green sea turtle enabling better assessment of the potential ATOC transmission effects.

Pinnipeds: Elephant seals are believed to have moderately good hearing at the 75Hz ATOC source frequency. There are no results to date indicating that elephant seals avoid the California ATOC source at the Pioneer Seamount.

Odontocetes: Work on a captive false killer whale and a Risso's dolphin demonstrate that these animals are insensitive to the ATOC signal. An operational ATOC source would only become audible to a small odontocete swimming directly above the source if it dove to a depth of approximately 400m.

Sperm Whales and Mysteceti: Preliminary playback experiments show little effect, but further research is needed to directly assess sperm whale response. Despite some trends in the data, differences in average sighting distances based on aerial surveys of mysteceti do not have a strong causal linkage to the ATOC source.

Humpback Whales: Playback experiments show subtle responses to ATOC-like signals at received sound levels of up to ~130 dB re 1 uPa requiring comparison with observations of humpbacks exposed to full-scale ATOC

transmissions before any further conclusions can be reached.

Planned Extension of North Pacific Program

An important step in the North Pacific program will be taken when the Kauai source is successfully installed, most likely in July 1997. An earlier deployment was unsuccessful due to marginal weather conditions. The implementation of this second source will greatly extend the sampled area of the North Pacific, and also allow reciprocal transmission observations which permit measurement of the mean flow along the acoustic path in addition to temperature.

Acoustic Thermometry in the Indian Ocean

Now that the capability of acoustic monitoring is beginning to be demonstrated in the North Pacific, it is appropriate for the international community to consider other possible measurement sites. We identify the Indian Ocean as such and plan to discuss this in some detail at our forthcoming meeting at NIO in Goa, India, next October. Scientists in the surrounding nations, especially India, Australia and South Africa have already been investigating this possibility. The SCOR meeting will provide a very convenient opportunity for sharpening these plans and discussing ways in which they may be funded and implemented.

Current Membership in the Program

We have traditionally had a fully open policy toward participation in the SCOR program. While there was a Chair (David Farmer) who co-ordinated activities, the meetings were open to all who wished to come. Invitations were sent to as many as we could think of who might be interested. All aspects of the meeting were discussed openly, including not only the scientific topics, but also organisation issues such as the requirements for transition of WG 96 to its present Affiliated status. Perhaps as a result of this policy the meetings have had a very international flavour, with participation from many parts of the world, as identified in previous reports to the SCOR Executive. Reports sent to SCOR are also circulated to all participants at the previous meeting as well as others who we think might be interested. Having made this point, it should be mentioned that there has been a committee structure inherited from the origin of WG 96, active members of which include D Farmer, W Munk, V Akulichev, A Baggeroer, L Bjorno, G Brundrit, Y Desaubies, G Dinghua, N Dubrovskii, A Forbes, H Hurlburt, W Kuperman, P Mikhalevsky, I Nakano, R Spindel, M Slavinsky, and R Zhang.

It is recognised that there must be a change in the Chair which will be confirmed at the next meeting in Goa in October. (The present Chair will thankfully resign his duties!) However, we would appreciate input from the SCOR Executive on the best way to do this and on the matter of whether or not to have a formal steering committee. In the absence of recommendations from the SCOR Executive, the Chair will nominate a committee consisting of Chair, and minimum of three members, which will be proposed to the participants at the Goa meeting for ratification. The plan would be that the Chair would serve for a period of two years, to be replaced by a nominee identified by the Committee. The Committee members would serve for three years. Any active member of the program (defined as someone who has attended two or more previous meetings) would be eligible to serve as a committee member. The primary goal here is (a) to ensure an open and nonexclusive membership and (b) to encourage a strong international participation.

ANNEX 12 - InterRidge

InterRidge Report for SCOR, August 1997

Mid-ocean ridges, including those in marginal basins, are the primary sites of volcanic activity on the earth and the primary sites of creation of new crust. In addition to exerting a major influence on the evolution of the solid earth, they affect the chemistry of the ocean and support unique forms of life. Nonetheless, because they lie beneath the sea, ridges remain poorly understood. We know less about volcanic activity on the seafloor than we do for many other planetary bodies in the solar system. InterRidge is an international and interdisciplinary initiative concerned with all aspects of ridges. It is designed to encourage scientific and logistical coordination, with particular focus on problems that cannot be addressed as efficiently by nations acting alone or in limited partnerships.

Important Scientific Themes for the Future

The InterRidge initiative has identified three principal themes aimed at discovering the inter-relationships among the diverse manifestations of the ridge system and at integrating a growing understanding of ridge dynamics with knowledge about the functioning of the earth as a whole. Pursuit of these scientific themes involves integration of many disciplines, from seismology to bacteriology, and a variety of approaches at many different scales. The objectives of the three principal InterRidge themes, Global Studies, Meso-scale Studies and Active Processes, are to:

- Acquire a balanced set of global-scale data on the entire mid-ocean ridge system, which implies notably a concerted effort of exploration in high latitudes where data are extremely sparse.
- Observe, measure and monitor active processes at individual ridge sites in order to begin to quantify the fluxes of mass and energy involved and their biological consequences.
- Investigate the interplay of mantle processes at temporal and spatial scales that bridge the gap between the global perspective and fine-scale studies of active processes. These "meso-scale" studies focus on magmatic and tectonic patterns as well as on fluxes, and include a specific effort on ridges in marginal (back-arc) basins.
- Understand the evolution, reproduction strategies and dispersion paths of hydrothermal vent biota and determine their relevance to and interaction with physical, chemical, and geological processes at the ridge-crest.

Important Scientific Questions

To attain these objectives, InterRidge has initiated nine working groups within these three principal themes. Each of the projects has been formed around a specific scientific question or need identified as a priority by the international ridge crest research community. Each working group is followed by a brief summary of scientific objectives it is designed to achieve, and the name of its chairperson.

Global Studies:

- ***Global Digital Atlas***: the establishment of a global multibeam bathymetric database by linking distributed databases via the World Wide Web; Chair: Philippe Blondel (UK).
- ***SWIR*** (Southwest Indian Ridge): coordinated reconnaissance mapping and sampling of a complete super-segment, the Southwest Indian Ridge from the Bouvet Triple Junction to the Rodrigues Triple Junction including integrated Ocean Drilling experiments; Chair: Catherine Mével (France).
- ***Arctic Oceans:*** coordination of planning efforts for mapping and sampling of the Arctic Ridges; Chair: Roland Rihm (Germany).

Meso-Scale Studies:

- ***4-D Architecture of the Oceanic Lithosphere:*** an integrated study of a fast spreading segment (Hess Deep) in parallel with an integrated study of a slow spreading segment on the Mid-Atlantic Ridge both including important components of ODP; Chair: Lindsay Parson (UK)

- ***Quantification of Fluxes***: quantification of mass, energy, and chemical fluxes occurring at Mid-Ocean Ridges; Acting Chair: Chris German (UK)
- ***Back-Arc Basin Data Base***: petrological and geophysical database for Back-arc Basins on the World Wide Web; Chair: TBA.

Active Processes:

- ***Event Detection and Response***: detection of transient ridge-crest seismic, volcanic and hydrothermal events, and the launching of logistical and scientific response to them through a strategy of international collaboration; Chair: TBA.
- ***Biological Studies at the Ridge Crest***: development of a formal international agreement to provide for exchanges of samples and data, and to maximize the effectiveness of biological sampling and observations during non-biology cruises; Chair: Lauren S. Mullineaux (USA)
- ***Undersea Cables:*** explore the possibilities of utilizing abandoned undersea cables for scientific research; Chair: Alan Chave (USA)

Scientific Infrastructure Required

Given the current state of knowledge in ridge crest studies, the single cruise survey approach has become, to a certain degree, less effective in solving problems related to MOR. In order for the science to continue to develop and evolve, concerted effort, attention and funding must be focussed on addressing scientific questions identified by consensus. The infrastructure required to facilitate this would include:

- Development of a means of coordinating and funding multi-leg inter-disciplinary surveys.
- Maintenance of close communication links between the ridge crest research community and Ocean Drilling Program and promotion of drilling as an integrated part of the above projects, particularly those concerned with Global and Meso-scale Studies. This effort will require the coordination of multi-leg surveying and drilling cruises through exchange of data and information and through planning and scheduling facilitation.
- Initiation and maintenance of programs and projects to fully exploit communication networks, such as the World Wide Web, in the dissemination of information and data.
-

Major InterRidge Highlights since September 1996

- With the close of the 1993-1996 term, the InterRidge Office moved from Durham, UK to its new location for the next three years in the Laboratoire de Pétrologie at the Université Pierre et Marie Curie in Paris, France. Mathilde Cannat and Cara Wilson are the current Chair and Coordinator of InterRidge.
- Three Steering Committee members reached the end of the four year term and rotated off. Charles Langmuir (USA), David Needham (France), and Martin Sinha (UK) left and were replaced by Karen Von Damm (USA), Catherine Mével (France) and Chris German (UK).
- Application was put into SCOR to create a new working group on International Exchange of Biological Samples from Hydrothermal vents.
- Restructuring of the InterRidge WWW pages (http:/www.lgs.jussieu.fr/~intridge) has facilitated locating information from the InterRidge home page and as well as added information to the web pages about the current activities of InterRidge working groups and about the research in InterRidge member nations.
- Brazil and South Africa have joined InterRidge as corresponding members

InterRidge publications since September 1996

- InterRidge SWIR Project Plan, pp. 21, April 1997.
- InterRidge Active Processes Working Group Workshop Report: Event Detection and Response & A Ridge Crest Observatory, pp. 61, December 1996.
- InterRidge Meso-Scale Workshop Report: Quantification of Fluxes at Mid-Ocean Ridges: Design/Planning for the Segment Scale Box Experiment, pp. 20, March 1996.

- Quantification of Fluxes at Mid-Ocean Ridges: Design/Planning for the Segment Scale Box Experiment, pp. 20, March 1996.
- InterRidge Program Plan Addendum 1996, pp. 10, April 1997.
- InterRidge Steering Committee Report, Estoril, Portugal, 1996, pp. 17, December, 1996.
- InterRidge News 6(1), 72 pp.
- InterRidge News 5(2), 68 pp.

InterRidge plans for the upcoming year

- InterRidge Steering Committee Meeting will be held September 25-26, 1997 in Paris, France.
- InterRidge is organizing the First International Symposium on Hydrothermal Vent Biology, to be held in Madeira, Portugal October 19-24, 1997. The schedule includes 74 talks and posters, with 92 people registered. The InterRidge Office will be producing the abstract volume for the Symposium, in addition to a citable volume of full length papers. In addition there will be a scheduled meeting during the meeting to discuss the InterRidge International Sample Exchange Agreement, the topic of the recently proposed SCOR working group.
- There will be two InterRidge sponsored sessions at this year's Fall AGU meeting in San Francisco, CA, USA. The "Magma focusing and the segmentation of Mid-Ocean Ridges at all spreading rates" session developed out of the 4-D Architecture of Oceanic Lithosphere working group. This session, convened by Mathilde Cannat and Lindsay Parson, will be followed by an open discussion/4-D working group meeting to focus on the key areas of uncertainty in ridge architecture and how to address them. The other session, "Hydrothermal Activity at Different Spreading Rates" developed out of the Quantification of Fluxes working group. This session, convened by Cara Wilson and Chris German, will be followed by a panel to discuss unresolved questions about hydrothermal fluxes such as 1) the partitioning along axis as a function of spreading rate but also with tectonic vs magmatic controls and 2) the partitioning between on-axis vs off-axis, and between high-T axial flow, diffuse axial flow and off-axis flow.
- Two workshops are tentatively scheduled for the early part of 1998: to discuss the directions of the Event Detection and Response working group and of the Quantification of Fluxes working group.
- There are plans to try to improve working group communications by setting up electronic bulletin boards.
- Italy will be upgrading to an associate member, most likely by the beginning of 1998.

InterRidge Steering Committee - 1997

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Composition of InterRidge Steering Committee (total=21) by country:

France:	4
Germany:	2
Japan:	3
Norway:	1
Portugal:	1
Spain:	2
United Kingdom:	4
United States:	4

ANNEX 13 - Final Financial Statement for 1996

Scientific Committee on Oceanic Research
Budget and Financial Statement for 1996 - US Dollars

STARTING CASH BALANCE AND INCOME

	Budget Revised & Approved by 23rd General Meeting	Actual Income to December 31, 1996
BALANCE (CAPITAL) 1/1/96	122,541.00	122,541.45
INCOME:		
Membership	210,000.00	215,115.00
ICSU Grant / JGOFS	23,250.00	23,250.00
ICSU Grant / GLOBEC	23,250.00	23,250.00
IGBP Grant / GLOBEC	20,000.00	9,765.00
IOC Contracts	25,000.00	*18,000.00
START Fellowship	9,000.00	**4,529.10
Royal Society Grant / General Meeting	7,591.00	7,611.50
ICSU Support / GOOS LMR	13,038.00	13,037.62
NSF Grant / Travel Awards	75,000.00	76,212.14
NSF Grant / Geosciences	170,000.00	150,031.20
Miscellaneous	100.00	27.03
Total Income	**576,229.00**	**540,828.59**
TOTAL CAPITAL + INCOME	**698,770.00**	**663,370.04**

* Included $3,000 for WG 96 and $15,000 for SCOR/IOC WG 97

** The $9,000 START Fellowship for Dr. Kanthi Yapa (Sri Lanka) to train at the Bedford Institute of Oceanography has been divided between the 1996 and 1997 fiscal years. Of the $9,000 received in 1996, $4,470.90 will be taken into income in 1997.

Scientific Committee on Oceanic Research
Budget and Financial Statement for 1996 - US dollars

EXPENSES AND YEAR END CASH BALANCE

	Budget Revised & Approved by 23rd General Meeting	Actual Expenditures to December 31 1996
SCIENTIFIC EXPENSES		
WG 86	10,000.00	10,590.20
WG 95	5,000.00	4,319.13
WG 96 / ATOC	6,000.00	4,967.47
WG 97	30,000.00	30,000.00
WG 98	8,000.00	37.40
WG 99 / InterRidge	8,000.00	4,111.37
WG 101	9,000.00	6,428.45
WG 104	8,000.00	5,977.44
WG 105	15,000.00	16,822.11
WG 106	15,000.00	1,000.00
New WGs (WG 107)	12,000.00	5,569.54
JGOFS	120,000.00	94,219.31
GLOBEC	70,000.00	73,254.77
Total Subsidiary Bodies	**316,000.00**	**257,297.19**
START Fellowship	9,000.00	4,529.10
AOSB Symposium	0.00	11,993.93
GOOS LMR Workshop	13,038.00	13,037.62
Publications	10,000.00	9,013.76
Travel Awards	75,000.00	76,212.14
General Meeting	22,000.00	28,354.58
Representation	6,500.00	8,822.76
Total Other Scientific Expenses	**135,538.00**	**151,963.89**
TOTAL SCIENTIFIC EXPENSES	**451,538.00**	**409,261.08**

Scientific Committee on Oceanic Research
Budget and Financial Statement for 1996 - US Dollars

EXPENSES AND YEAR END CASH BALANCE (Continued)

ADMINISTRATIVE EXPENSES:		
Salaries + Benefits	120,000.00	115,064.51
(Allocated to JGOFS, GLOBEC & Travel Award Program)		(25,000.00)
		90,064.51
Communications	8,000.00	7,130.64
(Allocated to JGOFS, GLOBEC & Travel Award Program)		(2,500.00)
		4,630.64
Audit and Accounting Services	6,000.00	5,750.00
Office Equipment	1,500.00	1,406.05
JHU Overhead	19,000.00	18,149.87
Bank charges + (gain)/loss on exchange	325.00	365.67
Miscellaneous	3,000.00	4,488.12
TOTAL SCOR Administrative Expenses	157,825.00	124,854.86
TOTAL EXPENSES	**609,363.00**	**534,115.94**
BALANCE 12/31/96	89,407.00	129,254.10
EXPENSES + YEAR END BALANCE	**698,770.00**	**663,370.04**

ANNEX 14 - Strategic Review of SCOR
SCOR Strategic Review Meeting
Baltimore, April 15, 16 1997
REPORT

As a result of discussions at recent SCOR General and Executive Committee meetings, the Past-President of SCOR, Professor I.N. McCave, convened a small meeting at the SCOR Secretariat on April 15 and 16 to discuss issues relating to the present and future directions of SCOR.

Participants were:
I.N. McCave - Past-President, SCOR
John Field - President, SCOR
Bjorn Sundby - Secretary, SCOR
Warren Wooster - Former President of SCOR; Former Secretary, IOC; Former President, ICES; Past-Chairman, PICES
Su Jilan - Former Member, SCOR Executive Committee
Julia Marton-Lefèvre - Executive Director, ICSU
Elizabeth Gross - Executive Director, SCOR

As background documents, the participants referred to the SCOR Constitution, the report of the last ICSU review of SCOR, the report of the recent Assessment of ICSU and so on. The format of the discussion was based on a series of questions posed by its chair, Nick McCave.

1. The role, mission and mandate of SCOR. Is there a need for SCOR at all?

There is a continuing need for an international, non-governmental coordinating body in the field of marine science. The participants easily agreed that if SCOR were disbanded, for whatever reason, by ICSU, a similar organization would very quickly be created by the oceanographic community. The logical "home" for such a body is within ICSU.

The mission of SCOR, as stated in the Constitution, was reviewed and found to be somewhat inadequate to meet the demands being placed on non-governmental scientific organizations today. The report of this meeting will be provided to the group which was tasked by the last SCOR General Meeting to review the SCOR Constitution with a view to the needs for revision, expansion and up-dating. In general, ICSU bodies need to do a "little bit more than research" if they are to be relevant to the needs of modern society.

One of the most significant changes in modern scientific endeavors has been the growth of interdisciplinary efforts and the need for strong scientific advisory input to the policy and decision-making processes of governments. To date SCOR has not been active in this advisory role, apart from its relationship with IOC (See later), although ICSU is gradually assuming a much stronger position in relation to intergovernmental bodies and is receiving numerous requests for advice and reviews of the scientific understanding needed to underpin policy decisions. SCOR should inform ICSU that it is prepared to become more active, especially as a partner with ICSU, in issues relating to policy and the provision of unbiased advice of the highest scientific quality when this is required on topics which fall within SCOR's range of expertise. ICSU should ensure that it involves SCOR as appropriate when requests for such advice are received. It was agreed, however, that SCOR should take care not to become ensnared in policy debates once the scientific advice has been provided. In addition, in considering topics for new working groups and other scientific activities, SCOR should actively tackle problems that could lead to improved government policies. Examples of such topics are already to be found in, for example, SCOR's working groups on the impact of fishing methods on marine ecosystems and on sea level rise and its impact on muddy coasts of the world. With a small amount of extra effort, the finding of such working groups could be interpreted in a way that would be more easily understood by policy makers.

2. The position of SCOR among marine science and related organizations: IOC, ICES, PICES, IGBP, SCOPE, etc. Should one organization provide a larger focus; should there be an International Union of Ocean Sciences IUOS?

SCOR has had a formal advisory relationship with IOC since 1961, but there have been few specific requests for advice in recent years. There is, however, a variety of jointly-sponsored activities with the Commission. Links to PICES and ICES have been less formal and, at the moment are limited to a single fisheries-related working group and to regional components of the GLOBEC program.

SCOR should reiterate to the IOC its readiness to contribute the best scientific advice in support of IOC activities as needed. In making this commitment, SCOR must be sure that it can react in a timely way to requests for advice by moving quickly to establish a group to address the issue at hand, and ensuring that it reports back as soon as possible. IOC should be encouraged to take more advantage of SCOR's capabilities to be responsive to its needs in relation to the many scientific issues which are of interest to both organizations.

As one means of improving the dialogue between the SCOR and IOC communities, SCOR will urge its national committees to develop closer ties with their corresponding national IOC delegations, providing them with information on SCOR's scientific activities and its willingness to be of assistance to the Commission.

Participants agreed that all proposals for new SCOR working groups should be automatically sent to these intergovernmental organizations for their information and possible feedback as to their interests in the topic.

There was an extensive discussion of the position of SCOR, and of the interdisciplinary Scientific Committees in general, within the ICSU framework. The Scientific Committees (like SCOR, SCAR, SCOPE, SC-IGBP, etc) are established by ICSU and are not Members of ICSU. The Members of ICSU are the National Members and the international scientific Unions. The Scientific Committees have no role to play in the governance of ICSU, although they are the organizations responsible for all of the large-scale research programs such as IGBP and WCRP (and their components such as JGOFS and GLOBEC in the case of SCOR). Given the importance of interdisciplinary science in modern science, the significance of the impacts of environmental issues on humans and on the modern political scene, the participants agreed that ICSU should be urged to find a means of elevating the status of SCOR and other important ICSU interdisciplinary bodies within the ICSU framework to a level more equivalent to that of the unions. This point will be forcefully made in the response of SCOR to the Report of the Assessment of ICSU.

There has even been discussion in the past of the need for an International Union of Marine Sciences. Unions are independent of, and pay membership dues to, ICSU. In recent years there has been a proliferation of unions and some countries are beginning to find that their cumulative membership dues on all of these organizations are an intolerable burden. The issue of a union for the marine sciences was discussed at the First Joint Oceanographie Assembly, in 1970, when it was concluded that improved arrangements for marine science within ICSU were required and that a first step should be to broaden and strengthen SCOR appropriately. As a consequence, the SCOR Constitution was changed to establish a new relationship with the other ICSU organizations with interests related to SCOR's. For the foreseeable future, the participants in this meeting agreed that SCOR should continue to strive for a stronger position within ICSU. SCOR will respond in this vein to the call from ICSU for comments on the recent report of the Assessment of ICSU.

3. Is the *modus operandi* of SCOR appropriate to needs of the next 20 years (SCOR is now 40)? Subsidiary to this, are the mechanisms whereby SCOR receives and considers proposals for new W.G.'s likely to yield the hottest, most pressing topics? How are priorities established? What topics has SCOR missed?

After a lengthy discussion, the participants agreed that the area of greatest concern in SCOR operations is the need for more effective interactions with the marine science community at large through the national committees.

Somehow these interactions must be improved so that information from SCOR reaches scientists and the views and priorities of the various national oceanographic communities are made known to SCOR. Both of these functions are the role of an effective national committee.

Ideally, a national committee should have contacts with the entire national marine science community and with intergovernmental organizations as appropriate. A national committee should include representatives of all of the types of scientific institutions found in the country and of all the oceanographic disciplines which are important nationally. In the words of one participant, national committees should be "representative, communicative and responsive". The Executive Directors of ICSU and SCOR agreed to draft a definition of the ideal national committee for future use by both organizations as this issue of the effectiveness of national committees is of concern throughout ICSU.

SCOR national committees should be reminded again of the importance of their comments and suggestions when proposals for new working groups are being considered. National committees occasionally complain that their scientists are not well represented in SCOR activities and yet they have never sent in membership nominations when proposals are being considered. Although WG members from developed countries may be asked to contribute to the costs of their travel to meetings, SCOR does ensure that funds are available for all full members of WGs to participate in all their activities. National committees should not feel constrained by financial considerations from making nominations of excellent scientists for SCOR working groups.

As a means of improving the process of considering proposals for new working groups, the participants recommend that each incoming proposal be assigned to a member of the Executive Committee who should work with the proponent to ensure that the proposal meets the criteria established by SCOR in at its meeting in 1993. The strict application of these criteria (See *SCOR Proceedings* 29, pg 16 and *SCOR Handbook*, pg 67-71), would improve the quality of proposals received and would ensure that topics of the highest priority are being addressed by SCOR.

4. Should SCOR return to the organization of large all-embracing conferences, or any conferences at all? If not will SCOR become increasingly invisible?

Following the Joint Oceanographic Assembly (JOA) in 1988, SCOR decided to cease the organization of large conferences. JOAs had been held at six-yearly intervals since 1970, and appeared to have come into competition with large meetings, such as the IUGG Assembly, AGU meetings, etc, which were being organized successfully by organizations with significantly more financial and staff resources than SCOR.

However, the participants felt that there is a need, currently unmet, for the oceanographic community to meet as a distinct entity occasionally. Such a meeting would also improve SCOR's profile and visibility, but would be very demanding of SCOR's resources. A discussion along these lines has already been initiated between IABO and IAPSO with a view to organizing a joint meeting in the year 2001 and SCOR has been asked if it wishes to become involved in this effort. It is already on the agenda for the Executive Committee meeting in September 1997.

Such a large, interdisciplinary marine sciences conference should occur only at six to ten year intervals, should reintroduce the JOA name, and should build on other international meetings rather than competing with them by careful scheduling and a scrutiny of their themes and programs.

5. Is the way in which SCOR is comprised of members nominated by National Committees militating against young (sub 40) oceanographers in its deliberations? They are rarely among officers or nominated members but some are on W.G.'s. Is this a matter of concern? What about female scientists? Oceanographers from developing countries? Is affirmative action required or desirable?

The discussion expanded on some of the points already covered in item 3, especially in relation to the functioning of national committees. The most appropriate place for scientists to become involved in SCOR at an early stage in

their careers is in its working groups, rather than in the more bureaucratic business of the Executive Committee.

The participants recommend that a renewed effort be made to ensure that the developing countries are better represented in the membership of working groups.

6. Involvement of the global community of marine scientists in SCOR has been held to be a problem (too low). Is it?

The number of countries with national committees that are members of SCOR has remained constant at 39 for a number of years. While all of the major oceanographic countries have established national SCOR committees, there are large areas of the world where SCOR is poorly known. In particular, on all of the African continent, only Egypt and South Africa are members of SCOR although several countries (Kenya, Nigeria, etc) have sizeable oceanographic efforts. In South America, Chile, Brazil and Argentina are members, but Venezuela, Peru, Colombia and Uruguay are not. Although contacts have been made in many of these unrepresented countries, it frequently takes quite some time for a national committee to be established and for a membership application to come to SCOR. In the meantime, there is no information flowing from SCOR to these countries and vice versa. A SCOR Newsletter could be very effective in this regard (see item 8).

The participants recommended that the unused SCOR category of Invited Members be extended to specific individuals who are involved in trying to bring their countries into SCOR. Such invitations should be of limited duration, say four years (the period covered by 2 SCOR General Meetings) and the expectation that the Invited Member is being invited in order to move his or her country towards membership in SCOR should be very clearly stated. In the meantime, all SCOR information will be sent to the Invited Members who can serve as points of contact in countries where no national SCOR committee yet exists. There should be no more than 5 such Invited Members at any one time.

SCOR should also form links with the Third World Academy of Sciences (TWAS); one opportunity to do this has already presented itself since TWAS will be meeting in Rio de Janeiro at the same time as the SCOR Executive Committee and an effort has already been initiated to have the two meetings at the same location.

7. Is the balance of disciplines represented, and topics treated by SCOR, appropriate to modern needs of the science (Phys/Chem/Biol/Geol), deep ocean vs coastal, pure vs applied etc?

In reviewing the list of current SCOR activities, participants agreed that there is a good disciplinary balance among them and that the lack of SCOR involvement in coastal science noted by the 1992 ICSU review of SCOR has been redressed by the addition of several working groups dealing with coastal oceanography.

One area of growing international importance, especially with respect to global change issues, is the interface between the natural and the social sciences. Many oceanographic topics such as fisheries, climate change, coastal science, etc, have socio-economic impacts, but these impacts are rarely considered within SCOR. ICSU is also addressing this question and is a cosponsor of the International Human Dimensions (of global change) Program.

SCOR does not have natural links to the international social sciences community, but it would welcome the assistance of SCOR national committees, or of ICSU in identifying the best social scientists interested in problems relating to such topics as fisheries and coastal zones. With their help, perhaps the findings of scientific working groups could be interpreted in a socio-economic context and made even more useful to policy makers. This could be significant at a time when the Commission for Sustainable Development has identified the oceans as one of its top three priorities.

8. Is the secretariat (1 Executive Director, 1 Executive Assistant) adequate to service the demands placed upon it now and for the next 5-10 years? If not; more funds?, offload work?, contract staff/tasks.

The tasks assigned to the Secretariat were reviewed and it was clear that there was already a significant overload without the addition of tasks such as the production of a newsletter and the search for additional sources of funding (and administering those funds if they are found).

It was agreed that the members of the Executive Committee could be used to better advantage for specific responsibilities, especially relating to increasing the visibility of SCOR, the involvement of developing countries in SCOR activities, and so on. The SCOR President and Secretary will draft a series of "job descriptions" for the officers.

The participants also agreed that some of the work load of the Executive Director could be relieved if the Executive Committee Reporters for Working Groups fulfilled their obligations as described on page 69 of the *Handbook*, especially in communicating the decisions of SCOR meetings to WG chairs.

It was agreed that additional help should be found for the Secretariat, in the form of a half-time person with skills in scientific writing to take over the production of a SCOR Newsletter, the maintenance and improvement of the SCOR Home Page and other tasks related to outreach. Given the space limitations in the present one room Secretariat, it may be desirable for such a person to be hired as an outside contractor. Sufficient funds are available in the current year to do this on a trial basis. Should more space become available to the Secretariat (a request from the Executive Director is under consideration at the host institution, but is unlikely to be successful), then it would be preferable for this additional part-time person to be located in the office.

In the meantime, the Secretary and Executive Director will work together on the production of one issue of the SCOR Newsletter (which was only produced once before, in 1994) for distribution before the Rio de Janeiro meeting if possible.

ANNEX 15 - Intergovernmental Oceanographic Commission
REPORTS OF JOINT IOC-SCOR ACTIVITIES

IOC-JGOFS Ocean CO_2 Advisory Panel

The CO_2 Panel met 2-4 June 1997 in Warnemuende at the Baltic Research Institute. Like WOCE and JGOFS this Panel is nearing completion of its observational phase, i.e., the global CO_2 survey, and the meeting was a time to reflect on its achievements and look to the future. Important contributions were made by the Panel in providing oversight to the global CO_2 survey done in cooperation with WOCE. The development and widespread use of certified reference materials, the interlaboratory intercalibration tests and other measures taken served well to assure that an international internally consistent data set would be obtained with known error bars, irrespective of who took the data, and what equipment or ship platform was used. This was essential because, despite the best efforts of section-by-section quality control efforts, without standard reference materials the potential for systematic biases of varying signs and amplitudes to exist between individual cruise data sets was always present. This is, of course, true of all biogeochemical parameters including those obtained by WOCE, such as dissolved nutrients and oxygen, for which, unlike CO_2 , no certified reference materials exist.

The Panel perceived that the unprecedented accuracy of CO_2 measurement achieved has implications for these other WOCE data sets. The relevance to WOCE is, that despite the significant stoichiometric variability in the concentrations of individual parameters in the deep ocean (which complicate simple direct comparisons of data collected on different cruises), the relations between inorganic carbon and the concentrations of nutrients and oxygen are relatively robust and invariant over extensive temporal and spatial scales. Thus the globally consistent CO_2 data set, because it's accuracy is anchored in certified reference materials, could be used for an assessment of the internal consistency of WOCE nutrient and oxygen data. This multivariate approach to the analysis of cruise data allows astigmatic biases among different cruises to be identified more reliably than via direct comparisons. The Panel has brought this to the attention of the WOCE Hydrographic programme for consideration during the WOCE synthesis process.

Members of the CO_2 Panel have continued to play important roles in other IOC Panels and workshops,. particularly where biogeochemical expertise is needed. For example, the previous chair Liliane Merlivat, was also a member of the OOSDP, a participant in the GOOS- GCOS- WCRP- JGOFS sponsored Time Series of Ocean Data Workshop, and has been appointed as a new member of the GOOS Steering Committee (GSC nee J-GOOS). The present chair, Andrew Watson played a key a role in the IPCC assessment.

The Panel has been focused up until now on issues of measurement protocol, validation of techniques, and the co-ordination of the measurement effort by different nations to assemble a consistent global ocean pCO_2 data set. It plans to continue it's efforts to seek out p CO_2 data sets obtained through other programmes and have them submitted to the Carbon Dioxide Data and Information Centre (CDIAC). At present, however, the emphasis of the ocean CO_2 effort is exhibiting change in several ways. For example:

(i) As American and European measurement programmes such as JGOFS are now beginning to wind down, and emphasis is shifting towards synthesis and modelling, in Japan, by contrast, increasing funding is now being directed towards measurement programmes.

(ii) An awareness is growing that significant change in air-sea CO_2 fluxes is only one of several processes by which the marine biogeochemical systems may affect global change and atmospheric chemistry, and that these processes are linked through complex feedback mechanisms that coupled models have not yet got right. Clearly, it will be necessary to better understand these systems in order to predict future global change.

With this in mind, the Panel debated the question of whether the scope of its mandate should be broadened to include other climatically active gases that are affected by ocean processes (e.g., nitrous oxide,

methane, methyl halides, hydrohalocarbons, dimethyl sulphide). There is justification for contemplating such change in that this is an area that is poorly understood, the roles of these gases in coupled climate models are recognized weak points, and there is no international group that is specifically concerned with this science. Nevertheless, the consensus of the Panel was that there were still significant CO_2 issues to be resolved and that the successes thus far were due in large part to its intentional narrow scope. The members concluded that taking on such a new Pandora's box as an additional responsibility would overly dilute the Panel's effectiveness. Instead, the discussion led to a recommendation for a milder course correction, still based on CO_2.

At present, there are two dominant issues that should be considered in forming a follow-on Ocean CO_2 Panel: 1) how realistic are the simulated future ocean circulation changes for a prescribed radiative forcing scenario; and 2) how will the marine biosphere and the carbon export production be affected by global warming and ocean circulation changes. Discussion of these issues led to a conclusion that the complexion of the Panel should be changed to include at least more biogeochemistry and modelling expertise, and perhaps greater representation from the atmospheric side. The need for more biogeochemical expertise was also based on the Panel's belief that processes in the coastal areas that influence the carbon cycle are not sufficiently well understood. Their potential impact on the carbon cycle can be much greater than their proportional 16% area of the oceans since distribution and biological productivity are twice per unit area of that of the open ocean. The Panel has opened a dialogue with LOICZ to consider appropriate interaction on this subject.

Regarding the issues related to the role of the non-CO_2 climatically active gases, the Panel believes they could begin to be addressed by a measured approach by scheduling a particular aspect for expanded discussion at each meeting and inviting experts to address it. This would preserve the fundamental CO_2 emphasis while scoping out a future, perhaps separate Panel activity on other climatically active gases.

As for geographic representation, it was agreed that more scientists from the Asian countries should be sought to reflect the shift of focus of observational efforts towards the western Pacific countries. The Panel sponsors, IOC and JGOFS, were informed of these conclusions and recommendations by letters from the Chair.

At Warnemuende, Professor Shizuo Tsunogai offered to host the next Panel meeting sometime during the last quarter of calendar year 1998 or the first quarter of 1999. He also invited the Panel's cooperation to assist in organizing the Second International Ocean CO_2 Symposium in conjunction with the meeting. In his offer, Professor Tsunogai recognized the additional travel expense involved and indicated that he had options he could exercise with regard to accommodations that would reduce that cost significantly. On this basis the Panel accepted his invitation. It is hoped that in the interim, the sponsors will consider the recommendations herein and that initial steps will be taken to begin the metamorphosis of the Panel by the next meeting.

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The Continuons Plankton Recorder (CPR) Programme (Sir Alister Hardy Foundation for Ocean Sciences).

At the Eighteenth Session of the IOC Assembly, in Paris 13-26 June 1995, it was decided to continue support of the CPR Survey of the Sir Alister Hardy Foundation for Ocean Science (SAHFOS) in Plymouth, United Kingdom. The IOC supported the CPR activities with a contract of US$15000 a year in the biennium 95/96. The Survey, which in the North Atlantic has been carried out since 1946, provides information on the influenee of climate on long-term changes in the abundance and composition of phytoplankton and zooplankton.

The CPR activities are now, through the work of SAHFOS, being applied to more and more areas by the use of commercial ships of opportunity. The development of Large Marine Ecosystems (LME) in the Gulf of Guinea has been closely associated with the activities of the SAHFOS, and the CPR has been used in the region in

the development of new routes.

The report of the GLOBEC-IOC-SAHFOS-MBA workshop on the analysis of time series with particular reference to the CPR Survey has been published (IOC Workshop Report No. 124). The papers submitted at the workshop are enclosed in the report.

The Survey, since it has been operational for very long, provides considerable experience in operational aspects, data handling, analyses and presentation of results.

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Global Ocean Ecosystem Dynamics (GLOBEC)

The Global Ocean Ecosystem Dynamics (GLOBEC) Programme was accepted in 1995 as one of the Core Projects of the International-Geosphere-Biosphere Programmes (IGBP), and is co-sponsored by SCOR and IOC. The aim of the programme is to increase the general understanding of ecological processes and mechanisms and how these change in time and space under the influence of physical forcing. The programme focuses on zooplankton population dynamics in relation to the physical forcing of the oceans. It bridges the gap between phytoplankton studies and predator-related research and links the research to climate change perspectives.

GLOBEC includes a range of different, national, regional and international activities such as GLOBEC Southern Ocean Programme, Cod and Climate Change (CCC) Programme, the Climate Change and Carrying Capacity (CCCC) Programme, and the Small Pelagic Fish and Climate Change (SPACC) programme. Furthermore, several countries have, or are in the process of establishing national or regional GLOBEC programmes; United States, Canada, UK, Japan, China and Mara Cognitum (Norway, Island and Faroe Islands).

Besides the main sponsors of GLOBEC, several other organizations are involved in and contributing to the development of the programme. Organizations like ICES and PICES are active in the process of developing GLOBEC regionally, participating in consultations and scientific working groups and can be considered as regional co-sponsors of GLOBEC.

The new Scientific Steering Committee (SSC) of GLOBEC had its second meeting in Plymouth, UK, June 1997. The GLOBEC Science Plan is published and the SSC is expected to develop an Implementation Plan during 1997, in collaboration with GLOBEC researchers. This Implementation Plan will be presented for further discussion by the international scientific community at the first GLOBEC Open Science Meeting at IOC/UNESCO in Paris 16-20 March 1998.

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Large Marine Ecosystems

The Large Marine Ecosystem (LME) concept provides a useful approach to monitoring ocean processes at a regional scale, empowering nations to address the problems of long-term sustainability of marine resources. So far, forty-nine LMEs have been identified and the LME concept has now been included as one of the activities designated for support under the World Bank-Global Environmental Facility for the International Waters projects.

The LME concept recognizes the importance of the Continuous Plankton Recorder (CPR) in sampling strategies addressing large-scale variability. The CPR is an integral part of the Gulf of Guinea LME project and future LME core monitoring programmes are considering the CPR as an appropriate tool as well. LME monitoring and assessment projects are being planned for the following areas: the Benguela Current System, the Baltic Sea, the South China Sea, the Yellow Sea, the Bay of Bengal, the Canary Current and the Caribbean LME.

An international consultative meeting on Large Marine Ecosystems was held at IOC in Paris 23-24 January 1997 to discus the developments of LME and how to proceed with the future activities. Together with marine scientists, representatives from several international organizations discussed the use of the LME concept to link science to marine environmental and natural resource management and the further application of the concept to other activities in the marine sciences. The meeting was a follow-up to the first consultative meeting on LMEs "Large Marine Ecosystems Concept and its application to Regional Marine resources Management" held in Monaco 1990.

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Harmful Algal Bloom Programme

The overall goal of the Harmful Algal Bloom Programme is to foster the effective management of, and scientific research on, harmful algal blooms in order to understand their causes, predict their occurrences, and mitigate their effects. The programme has existed since 1992; it is divided into three major parts: educational, scientific and operational.

The programme office in Paris is staffed with one Associate expert seconded by Denmark. IOC Science and Communication Centres on Harmful Algae have been established in Copenhagen and Vigo with the support of Denmark and Spain. Japan supports a large number of training and capacity building activities in the WESTPAC Region.

A comprehensive training and capacity building programme has been established, with about 20 courses held in cooperation with other organizations. More than 300 people received training on biology, taxonomy, toxin chemistry and monitoring and management of harmful algae.

A significant number of publications have been delivered, including a 500-page manual on harmful algal blooms,

the quarterly newsletter Harmful Algal News and other relevant bibliographic material. Furthermore, working groups, and study groups have been formed in cooperation with other organization, such as ICES, IMO and SCOR, focussing on different issues related to harmful algae.

During the Fourth Session of the IOC Intergovernmental Panel on Harmful Algal Blooms (IPHAB) held in Vigo, Spain, July 1997, priorities were set for 1997-98 in order to make significant progress in our capability to mitigate the effects of Harmful algal blooms.

To address the issue, and inspired by similar initiatives taken by the United States, the Panel recommended the preparation of a HAB science agenda on ecology and oceanography, to help Member States in setting national priorities and in particular to promote the establishment of national and international research programmes.

The IOC Secretariat has been instructed to investigate and establish an appropriate mechanism within the IOC, or together with other appropriate organizations, to have such a HAB science agenda prepared by a group of leading scientists, and to publish it.

Some other major achievements of the Programme are:

(i) association with and support of the SCOR-IOC NATO Advanced Study Institute on the Physiological Ecology of Harmful Algal Blooms, Bermuda Biological Station, 27 May - 6 June 1996. The workshop assessed our understanding of the fundamental physiological and ecological processes underlying harmful algal events, identified inadequacies, impediments, and advanced and disseminated new approaches and technologies. The workshop had 80 participants. The Proceedings will be published by NATO. The workshop resulted from activities of SCOR-IOC Working Group 97;

(ii) development of cooperative research projects/proposals with institutions in Member States (Institute of Oceanography, NhaTrang, Vietnam; University of the Philippines; College of Fisheries, University of Agricultural Sciences, Mangalore, India; Institut Agronomique et Veterinaire Hassan II, Morocco). The projects include supervision of Ph.D and M.Sc. students;

(iii) provision of 'HAB Literature Grants' to libraries of marine science institutions in developing countries through which more than 1200 books were donated. Grants consist of copies of one or more key reference books.

(iv) preparation of a database on scientists and managers engaged in matters of toxic and harmful algae. The database is accessible at the IOC WWW and will also be made available in print version.

(v) publication of an IOC-ICES technical report presenting examples of design and implementation of harmful algal monitoring systems (IOC Technical Report No. 44);

(vi) progress in the establishment of a HAB bibliographic database within ASFA;

(vii) establishment of an ICES-IOC-WMO Working Group on Transfer of Organisms by Ballast Water

(viii) preparation of a series of slides for identification and demonstration of harmful algae. The slides are prepared by WESTPAC/HAB/ University of Tokyo, essentially for teaching purposes;

(ix) obtaining support from Swedish SIDA for a joint activity between the Kenya Marine Fisheries Research Institute, the Marine Science Institute, Dar-es-Salaam, Tanzania, and the IOC Science and Communication Centre in Copenhagen;

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GOOS

SCOR has been an intimate partner in GOOS activities this past year. SCOR President, John Field, hosted the 2nd session of the GCOS-GOOS-WCRP Ocean Observations Panel for Climate (OOPC), 11-13 February 1997 in Cape Town. The GOOS Project Office has two GOOS module reports (LMR and Coastal) in the printer's shop. The drafts for these reports were prepared with assistance of the SCOR Executive Director Elizabeth Gross. SCOR also hosted and helped organize a Joint JGOFS, GOOS, GCOS, WCRP Workshop on Ocean Time-Series Observations 18-20 March 1997 in Baltimore. The initial draft report of this workshop is being circulated for comment by the participants and will be published in the next quarter.

The Report of SCOR Working Group 107 on Improved Global Bathymetry will provide a source of useful advice for IOC in its bathymetric pursuits.

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ANNEX 16 - Ecology and Oceanography of Harmful Algal Blooms

Background

Over the last several decades, coastal countries throughout the world have been increasingly impacted by the phenomena we now term "harmful algal blooms" (HABs.) These blooms of microscopic algae cause a diverse array of impacts ranging from mortalities of fish and other marine animals to the disruption of ecosystem structure and function and the transfer of dangerous toxins to human consumers of seafood. Where only a few countries and a few areas had problems in the past, now virtually every country with a marine coastline faces significant threats from HABs Recognizing this significant and expanding problem, national and international programs have been created to address these complex phenomena and their impacts. At the international level, working groups have been established by ICES, SCOR, APEC (Asia-Pacific Economic Cooperation Program), and the IOC, to name just a few. Foremost among these programs has been the IOC's HAB program, which has taken a leadership role in coordinating many international activities related to HABs. The program has been administered by IOC staff in Paris, as well as through two Science and Communication centers, staffed and funded by Denmark and Spain.

Coordination of the IOC HAB program has been through an intergovernmental panel that meets every two years. Panel members should be agency officials with authority and funds that can be directed towards HAB problems. In reality, many countries send only scientists as their representatives, reducing somewhat the ability of the panel to attack problems with significant financial cost, since those present often lack the fiscal authority to commit funds. The IOC program has been exceptionally productive in areas such as education and training , but has had a difficult time attacking the scientific elements of the program, in large part because of the significant cost of research programs.

The IOC international HAB program was intended to be a coalescence of numerous national HAB programs. Countries differ dramatically, however, in the extent to which they allocate resources to HAB research. Some (e.g., Japan, Canada, France, China, and the United States), have made efforts to coordinate national research activities to some extent, but in most countries , HAB scientists struggle to obtain funding for basic research in competition with many other disciplines and without sustained federal agency participation or involvement. It is surprising but true that HAB research has not elicited the programmatic focus and multinational collaboration that other disciplines have been able to attract.

What is clearly needed is an international science program on HABs that incorporates the full participation of numerous countries. To accomplish this, we believe that SCOR has a significant role to play in helping to formulate and implement a program on the ecology and oceanography of harmful algal blooms. The motivations for SCOR involvement are several:

1) Harmful algal blooms have significant and growing impacts on human health and fisheries resources throughout the world;

2) Strong political and scientific leadership is needed to coordinate international activities in this area. This has been difficult for the intergovernmental panel or the IOC HAB office to accomplish since the former meets only once every two years and the latter is perenially understaffed and under funded;

3) The ecological and oceanographic issues underlying HAB's and their impacts are significant and involve all of the oceanographic disciplines as well as numerous coastal habitats and ecosystems; and

4) Considerable progress has already been achieved and a framework exists on which an international ecology and oceanography program can be based.

ECOHAB

Several years ago, scientists and agency officials in the U.S. recognized that HAB research activities were not coordinated to any extent at the national level. A *National Plan for Marine Biotoxins and Harmful Algae* was formulated, and an interagency task force established to help implement elements of that national plan. To address the ecological and oceanographic aspects of HAB's, a workshop was held which culminated in the publication of a science agenda entitled *ECOHAB: The Ecology and Oceanography of Harmful Algal Blooms*. In its simplest form, the goal of the ECOHAB program is:

To develop an understanding of the population dynamics and trophic impacts of harmful algal species which can be used as a basis for minimizing their adverse effects on the economy, public health, and marine ecosystems.

The objective of this program is:
To investigate fundamental physical, biological, and chemical oceanographic questions critical to scientifically based management of fisheries resources, public health, and ecosystem health in regions threatened by toxic and harmful algae.

International ECOHAB

The ECOHAB report has been widely distributed among scientists, agency officials and politicians and has been remarkably successful in attracting support for the research activities and priorities it contains. It served as the basis of a partnership among four U.S. funding agencies which have agreed to support ECOHAB activities for the next 5 years at a cost of at least $ 3,000,000 per year. In one sense, the status of the ECOHAB program at this point in time resembles that of the Global Ocean Flux Studies some years ago when initial development of national programs on carbon flux in the United States and Germany served as the basis of the international initiative now called JGOFS. We are hoping that with SCOR assistance, a multinational ECOHAB program can be implemented.

The first step towards this internationalization should be a workshop to assess the state of international science activities relating to HAB's and to formulate a strategy for implementing a cooperative international program. This will likely involve the development of a science agenda similar to the U.S. ECOHAB, but there are significant challenges to address as well. One of these relates to the fact that the HAB problems in many different countries are diverse and in most cases involve unique organisms, hydrography, and toxicology. It is thus difficult to identify individual sites where multiple countries will send scientists and research vessels to work concurrently, as in the JGOFS studies.. It is more likely that a series of concurrent regional studies will be proposed, each of which might involve the cooperation of several countries. This is the approach which has been taken in the United States ECOHAB Program, which will be supporting several separate regional field programs, as well as a number of smaller projects by individual investigators. In the international context, one might envision ECOHAB field exercises in the Baltic, off the Iberian Peninsula or in the open waters of Southeast Asia, for example.

Results from regional studies can provide critical information necessary for understanding physical and biological processes responsible for HAB expression in a given area with unique basin characteristics, physical oceanography and taxon physiology. In turn, development of predictive capabilities for each region can be compared with all other systems and taxa, progressing toward a 'global' predictive capability and providing a suite of models for possible adaptation to new regions impacted by other HAB species. Through a long-term commitment to this approach, development of predictive abilities for all basin morphometries, circulations and taxa is envisioned, providing mitigation capabilities through model forecasts in specific areas.

After this initial workshop and the development of a science plan, it is essential that guidance in the politics and strategies of international cooperative programs be provided. Hopefully this is where SCOR will also take an active role in fostering this project. This may involve the creation of a Scientific Steering Committee, which we believe should be separate from the IOC Intergovernmental Panel on HAB's, which has a much

broader purview than ecology and oceanography and which meets relatively infrequently.

We are thus proposing that SCOR take the steps that are needed to internationalize the ECOHAB program - that it work with the IOC and other agencies to build a strong international partnership which can build on the momentum that has already been established by the IOC HAB and the U.S. ECOHAB programs.

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ANNEX 17 - International Council for the Exploration of the Sea

ICES Reorganisation

After several years of debate, ICES will implement a new Science Committee structure at its upcoming Annual Science Conference (ASC) in Baltimore, USA in September 1997. A goal of this re-organisation is to create a structure which will promote and facilitate interdisciplinary activities required to allow ICES to evolve effectively to the production of interdisciplinary advice required by ICES (regulatory Commissions and Member Country governments).

As a result of this re-organisation, the number of scientific Committees will be reduced from twelve to seven. The following Committees are to be disbanded:

a) Hydrography (in existence since 1928), b) Statistics, c) Marine Environmental Quality, d) Demersal Fish, e) Pelagic Fish, f) Baltic Fish, g) Shellfish, h) Biological Oceanography, i) Anadromous and Catadromous Fish and j) Marine Mammals.

The seven new Science Committees, with preliminary remits which have yet to be fully developed are:

Oceanography Committee - The Committee's responsibility will be physical, chemical, and pelagic biological oceanography, especially with regard to the processes relevant to living marine resources and environmental quality. This will include such issues as impacts of climate variability, physical, chemical and biological fluxes in coastal areas, shelf seas and the open ocean.

Marine Habitat Committee - The Committee's responsibility will be the quantity, quality and functional value to living resources of marine habitat of coastal areas, continental shelves and slopes, and the open ocean. The Committee's responsibility includes studies of marine biodiversity, the effects of human activities (including fishing and coastal development) and subsequent anthropogenic effects on habitat and dependent living resources (including the effects of contaminants, but also habitat change).

Living Resources Committee - The Committee's responsibility will be the biology and ecology of living resources, including those that are subject to harvest or have the potential to be harvested in the foreseeable future. Topics should include taxonomy, genetics, behaviour and migration, trophic relationships, distribution, abundance, and population dynamics. The Committee would be expected to include most of the topics dealt with by the previous Demersal, Pelagic, Shellfish, Anadromous and Catadromous, and Marine Mammals Committees.

Resource Management Committee - The Committee's responsibility will be to provide a bridge between fisheries and environmental issues, and between science and management. It will therefore be responsible for developing methods to:

- assess the status of exploited living resources;
- evaluate the effects of alternative exploitation and management strategies on the resources, and economic and social aspects of exploitation and management;
- and, in consultation with the Marine Habitat and Oceanography Committees, take into account natural environmental effects and anthropogenic effects other than fishing, in resource management decisions.

Fisheries Technology Committee (presently Fish Capture Committee) - The Committee's responsibility will be to co-ordinate and evaluate developments and investigations concerning methods of resource detection, quantification and harvesting, including fishing effort, selectivity, behavioural responses of fish, effects on habitat of fishing operations, developments in measurement methods and survey techniques, the design and operation of fishing vessels and fishing gears. It will liaise with the other Science Committees to ensure that they are aware of technological developments related to their activities.

Mariculture Committee (unchanged name)- The Committee's responsibility will be the biological, ecological and engineering aspects of systems for the culture of marine organisms, including effects of anthropogenic factors on these systems, and the effects of culture systems on habitat. The Committee will also be responsible for scientific aspects of stock enhancement, and the transport and introduction of non-indigenous species and stocks.

Baltic Committee - The Committee's responsibilities will include the effects of human activities on the ecosystem, links between environmental quality and living resources, integration of environmental and fisheries issues, and coastal zone management and development. The Committee's responsibility is to ensure co-ordination of its scientific work with other Committees, to avoid area-based isolation.

Most of the nineteen ICES Member Countries have nominated members to these Committees (up to two per Committee per country). One of the first actions of the 1997 ASC is to elect Chairmen to the four completely new Committees (Oceanography, Marine Habitats, Living Resources and Resource Management Committees). Thereafter all the Committees will commence a consideration of their terms of reference and the role and viability of the Working Groups that they have inherited from the old Committees.

In addition to the re-structuring of the Science Committees, consideration is also being given to the required changes in the Advisory Function of ICES arising from the growing need for integrated fisheries and environmental advice. ICES currently has two Advisory Committees, the Advisory Committee on Fishery Management (ACFM), and the Advisory Committee on Environmental Management (ACME).

Matters related to Fishery Advice

The main ICES body for the provision of advice on fishery matters is the Advisory Committee on Fishery Management. It comprises thirty-eight nationally nominated members and alternates and has five Commission Clients. The Committee meets twice a year. Its agenda covers the consideration of advice on over one hundred commercial fish stocks. The Committee draws on the work of some twenty assessment Working Groups and six science Working Groups. The area of competence for ACFM is the northeast Atlantic and Baltic and, for salmon, the whole of the north Atlantic.

ACFM advice is aimed at defining the optimal use of commercial fish resources. However, this often ignores the effects of by-catches of non-target species, including marine mammals, seabirds and non-commercial fish species, the effect of incidental damage to benthic organisms caused by fishing gear and the effects on the food chain of removing large quantities of fish. In addition, the effects of fishing on biodiversity and on the genetic composition of fish populations are also considered to be potentially important issues.

Studies on the effects of fishing activities on the ecosystem are being encouraged by ICES. These include studies on the effect of trawling on benthic organisms, the effects of discarding of fish and offal, changes in biodiversity linked to changes in fishing effort over long periods of time and the effect of removing large quantities of prey organisms on top predator populations. The results of these studies are being reviewed and synthesized by the Working Group on "Ecosystem Effects of Fishing Activities", and to a lesser extent, by the Working Group on "Benthos Ecology".

As a result of a number of recent international initiatives there is a growing recognition for the need to adopt a precautionary approach to the management of marine resources and the marine environment. While the basic principles involved are clear, much has to be done to define the operational requirements for applying the precautionary approach in a fisheries context. This is currently under discussion within ICES, primarily via a new Study Group on "Precautionary Approaches to Fishery Management". It is expected that ACFM advice will, in due course, incorporate the precautionary approach.

Matters related to Environmental Advice

The Advisory Committee on the Marine Environment (ACME) provides scientific advice and information on the marine environment, including marine pollution, as may be requested by ICES Member Countries, other bodies within ICES, and various Regulatory Commissions. In handling these requests, ACME draws on the expertise of its thirty-eight nationally nominated members and alternates, and on the work of twelve Advisory Working Groups and fourteen Science Working and Study Groups. The ACME considers the reports of these groups and requests them to carry out specific activities or to provide information on specific topics.

During 1997 ACME considered the status of, and provided a review of, a wide range of marine environment-related issues. These included consideration of monitoring guidelines and techniques; quality assurance procedures and intercomparison exercises; fish disease issues; the distribution, availability and effects of marine contaminants; marine biological processes and responses; seabird ecology issues; marine mammal issues; introduction and transfers of marine organisms; mariculture; assessment tools; and the handling of environmental data.

GLOBEC

The North Atlantic Regional Office of GLOBEC, which is located in the ICES Secretariat, is directed by Dr Keith Brander. The functions and activities of this Office are overseen by the ICES/GLOBEC North Atlantic Coordination Group which meets twice a year. One of the main responsibilities of the Coordination Group is to develop and oversee the execution of an integrated implementation plan for GLOBEC within the limits of various constraints. SCOR has observer status on the Group.

The ICES Working Group on Cod and Climate Change, the activities of which form the core of much of the ICES GLOBEC activities, will not meet during 1997, but it is overseeing the development of a number of relevant workshops within the next few months. These include:

- Workshop on Prediction and Decadal-Scale Ocean Climate Fluctuations of the North Atlantic. This Workshop is due to be held at ICES Headquarters from 8-10 September 1997 and will study the decadal-scale ocean climate fluctuations of the North Atlantic. The reason for such a study arises from the fact that decadal-scale climate fluctuations of the North Atlantic have been shown to be correlated with fluctuations on growth, recruitment and distribution of some of the North Atlantic cod stocks. The workshop will attempt to review the efforts now being made on predicting decadal-scale ocean climate fluctuation.
- Workshop on Application of Environmental Data to Fisheries Assessments. This Workshop will be held in Bergen, Norway in the spring of 1998. The rationale behind this Workshop is that evidence of the role of food abundance and the physical environment on growth and mortality of fish, particularly cod, has increased over recent years. However, most of the new information is still not in a form which can be considered by the ICES Assessment Working Groups. This workshop will evaluate, in particular, the suitability of using environmental data in stock assessment.

In addition to these workshops, a third "Backward-Facing" Workshop is being planned for 1998. The first two "Backward-Facing" workshops have shown that causal relationships between the climate events and the influence on fish stocks are different. This third Workshop is intended to provide more information about the variety of causal links between climate events and fish stock fluctuations. The primary objective will be the analysis of North Atlantic basin scale physical and biological processes with a perspective to provide potential linkages between events which took place on both sides of the North Atlantic in the early 1960s.

Comments Arising from Working Group Activities

Working Group on Ecosystem Effects of Fishing Activities - The objectives of this Working Group are similar to those of SCOR WG 105 on "The Impact of World Fisheries Harvests on the Stability and Diversity of Marine Ecosystems". Overlapping memberships should ensure an effective transfer of information between these two groups.

The Working Group has not met since early 1996, but is seen to be making good progress in attempting to address questions quantitatively, including the use of information from the ICES Multispecies Assessment Working Group. Attention is now being made to ensuring a balance within the group between fisheries specialists and the more environmentally oriented scientists and their scientific interests. The Group is scheduled to meet at ICES Headquarters in November 1997 when it will address a number of issues including the underlying theory on the behaviour of community metrics in relation to fishing activities, the estimation of changes in levels of predation on benthos by fish in relation to changes in exploited fish species, and the identification of potential reference points which might be used for including ecosystem considerations in relation to the precautionary approach.

In co-operation with the European Commission, ICES has established a Study Group to prepare a work programme to evaluate the environmental impacts of fisheries.

Working Group on Phytoplankton Ecology - A parallel activity of this working group was the running of the ICES Symposium on "Temporal Variability of Plankton and Their Physico-Chemical Environment" which was held in Kiel, Germany from 19-21 March 1997. Amongst their conclusions was that the symposium established that variability is an inherent property of planktonic systems, both phytoplankton and zooplankton and in the physical-chemical properties of their habitats. That is to say, variability is just as much an intrinsic property of the phytoplankton, as is their requirement for nutrients and irradiance for photosynthesis. As such, variability should be measured on a routine basis. This major scientific result of the symposium superseded the long held notion that variability is primarily a feature of fish stocks, while that at the planktonic level is relatively trivial and not particularly relevant to fisheries. It also indicates that the justification for plankton time series' analyses is not simply a practical one, e.g. to help understand fisheries stock variability, but should be incorporated into the basic methodological and conceptual approaches of biological oceanography. The symposium also revealed that there is now a critical mass of long term time series data sets and researchers interested in variability, trends, cycles and changes in planktonic systems. The presentation of their results at the symposium provided much needed collation, synthesis and identification of time series results. The published proceedings will be a benchmark, stimulating the integration of such results into contemporary biological oceanography issues. It should also stimulate similar research and the continuance of ongoing time series.

A term of reference addressed by this working group at its 1997 meeting was to propose new pigment procedures for measurement of chlorophyll *a* , taking into account recommendations contained the conclusion of SCOR WG 78. In doing so, the Working Group examined the new publication "Phytoplankton Pigments in Oceanography" (Eds: S. W. Jeffrey, R. F. C. Mantoura and S. W. Wright, Monographs on Oceanographic Methodology No. 10, UNESCO Publishing 1997). The Working Group endorsed almost all of the conclusions and recommendations of SCOR WG 78, but intends to continue discussion on some aspects. In particular the Working Group will prepare a concrete proposal for a standard method for the measurement of chlorophyll *a*. To achieve this it proposes to establish a closer contact with SCOR WG 78 in order to be rapidly updated regarding newest development, especially of trichromatic equations for methanol.

ICES-IOC Working Group on Harmful Algal Bloom Dynamics - This Group considered in detail the results of the NATO Advanced Study Institute on the Physiological Ecology of Harmful Algal Blooms which was Co-sponsored by IOC and SCOR. This discussion was developed further at IOC's IPHAB which was held in Vigo, Spain in late June 1997. A result of this discussion was that two of the proposals made by the Advanced Study

Institute for new SCOR working Groups concerning the links between physics and biology of HABs and the link between eutrophication and HABs should be first considered by this ICES Working Group and the Working Group on Phytoplankton Ecology who will hold a joint meeting in 1998.

An important remit for this Working Group in recent years has been in the consideration of the design of an experiment to elucidate the role of physical-biological interactions in harmful blooms. Progress on this issue was slow partly because of the difficulties of fostering a useful discussion amongst a multi-disciplinary group of scientists. The WG has now decided to compile available scenarios for various harmful events in the ICES area in order to facilitate the communication between the disciplines and identification of information gaps, sampling problems, etc. This compilation will be made on the basis of a questionnaire identifying the critical steps in the development of a toxic event. The joint description of the basic systems will form a common base for discussion and modelling. The Working Group considers that understanding how thin layers of particles develop, what is their relation to the physical fields of temperature, salinity, and density, and what physical processes are involved in forming these biological and chemical layers is necessary for quantitative explanation of physical-biological interactions. The theme session at the 1997 ASC in Baltimore on this subject (see section below on the 1997 ASC) should provide some basis for the establishment of a joint investigation.

ICES Working Group on Zooplankton Ecology - Among the main aims of the 1997 meeting of this Group were to link observations of zooplankton to the needs of fishery management and in particular to provide information and advice for the ICES/GLOBEC Workshop on the Application of Environmental Data in Stock Assessment. It also discussed (i) zooplankton monitoring in the ICES area, (ii) the CPR survey and national monitoring activities, (iii) taxonomic coding systems and (iv) the Zooplankton Methodology Manual.

A series of Tables and a map were produced to show existing time series of zooplankton data for seven countries. The Tables give locations, duration, frequency of sampling, additional items sampled and contact addresses.

A current major responsibility of this Working Group is to develop an updated manual on Zooplankton Sampling Methodology which is intended to replace the UNESCO/SCOR/IAPSO/ICES monograph on this topic which is now considered to be outdated.

The scope of the Manual is to provide an updated review of basic methodology used in studies of zooplankton including recommendations on improvements, harmonisation and standardisation of methods. The reviews will keep a balance between being introductory and comprehensive. They will provide an overview of methods that are useful for e.g. graduate students who are orienting themselves into a new field. They will emphasise the sources of error and the strengths and weaknesses of methods for various purposes and tasks. It may not be possible, however, to go into great detail for all methods, and reference to recent reviews and detailed descriptions of methods will be used where possible and/or appropriate.

The review of methods will be accompanied by recommendations regarding choice and conduct of methods. Where possible detailed descriptions of standard protocols should be included. In many cases it may prove difficult to propose an agreed standard protocol. It should be possible, however, to provide guidelines that will reduce the variability in methods and contribute towards harmonisation and standardisation. The standard protocol or guidelines need to have a clear reference to investigative purpose and biological conditions, e.g. a standard protocol may be suggested for a given purpose but need not be generally applicable for all purposes. The Working Group on Zooplankton Ecology takes the main responsibility for the issue of standardisation based on contributions from chapter authors and other selected experts.

Development of this Manual has been in progress for several years and several of the chapters have been completed for some time. In order not to delay the transmission of the information contained in these chapters, these are now accessible from WWW via the URL http://www.ices.dk/committe/boc/zemanual.htm. No clear decisions have yet been made on the final publication of the Manual but discussions are underway with the European Commission concerning the possibility of funding the publication. SCOR is invited to consider their

interest in being a co-publisher of this Manual.

1997 Annual Science Conference

The 1997 ASC is scheduled for Baltimore, USA, 25-30 September 1997. Main points of the programme include:

- Open Lecture by Dr K. Richardson on "Algal Blooms—the Good, the Bad, and the Ugly";
- Theme Sessions:
  - The Role of Small-Scale Physical and Biological Processes in the Dynamics of Harmful Algal Blooms;
  - Diadromous Fish Extinction: Threats On Local And Global Scales;
  - By-catch Of Marine Mammals: Gear Technology, Behaviour, And Kill Rates;
  - Arctic Oceanographic Processes;
  - Spatial Gradients in Estuarine Systems;
  - GLOBEC: Results From Interdisciplinary Programmes in the North Atlantic;
  - Reproductive Disturbances of Marine Species, and Contaminant Related Issues;
  - Applying the Precautionary Approach in Fisheries and Environmental Management;
  - The Catching Performance Of Fishing Gears Used in Surveys;
  - Synthesis and Critical Evaluation of Research Surveys;
  - Aquaculture and Genetics;
  - Biology and Behaviour;
  - Assessment Methods;
  - Environmental Factors;
  - Fisheries Technology;
  - Trophic Relationships;

1998 Annual Science Conference

The 1998 ASC will be held in Estoril, Portugal from 16-19 September 1997. Preliminary programme details include:

- Open Lecture on "Acoustic Methods in Studies of Fish Ecology" by Mr O. Nakken (Norway).

- Theme sessions:
  - Variation in the Pattern of Fish Aggregation: Measurement and Analysis at Different Spatial and Temporal Scales and Implications;
  - The Use of Genetics in Aquaculture;
  - Advances in On-growing Systems for Marine Fish;
  - Impact of Cephalopods in the Food Chain and their Interaction with the Environment;
  - Ecology of Diadromous Fishes during the Early Marine Phase;
  - Developing Deep Water Fisheries;
  - Marine Biological Diversity: Should we feel Guilty about our Guilds;

Forthcoming Symposia

Eight Symposia are currently planned under the auspices of ICES some of which are co-sponsored by SCOR, or co-sponsorship is sought. Complete details of these symposia are posted on the ICES web page (www.ices.dk/symposia) whenever it become available. Summary information is as follows:

1 "Recruitment Dynamics of Exploited Marine Populations: Physical–Biological Interactions", Baltimore, Maryland, USA 22–24 September 1997
This Symposium is co-sponsored by SCOR, PICES, IOC, GLOBEC International, US-NSF, US-ONR, US-

NMFS, US GLOBEC, GLOBEC Canada, The Johns Hopkins University, and the University of Maryland System, Center for Environmental and Estuarine Studies. Plans are now well underway for this symposium which takes place in Baltimore immediately prior to the 1997 ASC. A very satisfactory level of submissions has been received, most of which address the main themes of the symposium which are:

Trophodynamics and Recruitment Success;
Physical Transport, Retention, and Loss;
Climate Variability and Recruitment Processes;
Population Regulation and Environmental Variability;
Life History Strategies in Variable Environments;

2 "Marine Benthos Dynamics: Environmental and Fisheries Impacts" in Heraklion, Crete, Greece, October 1998.
Co-Conveners: Prof. A. ('Tasso') Eleftheriou (Greece) and Dr P. Kingston (UK).
A possible programme for this symposium includes:

Evaluation of direct and indirect effects of fisheries-related perturbations on the benthos by the use of appropriate ecosystem descriptors such as biodiversity, biomass, carrying capacity, assemblage structure, size spectrum and trophic structure. Disturbance due to natural and anthropogenic causes and recovery of benthos communities;
Food chains and energy flow in fisheries-perturbed benthic ecosystems;
Long- and short-term consequences of fishery activities upon the benthos and the environment;
Temporal variation in benthos communities: mechanisms and causes;
Ecosystem modelling of fisheries-related impact upon the benthos.

The European Commission has agreed to co-sponsor the Symposium

3 "The Evaluation and Implementation of Management Strategies for Fisheries in an Uncertain World", in Cape Town, South Africa, 16-19 November 1998.
Co-Conveners: Dr K. Stokes (UK), Professor D. Butterworth (South Africa), Dr R. L. Stephenson (Canada), Dr J. McKoy (New Zealand), Dr S. Garcia (FAO) and Dr V. Christensen (ICLARM).
The objectives of this Symposium are to:

examine procedures for decision making in fisheries management, including the evaluation and comparison of fisheries management procedures and system performance;
examine case studies of the evaluation of fisheries management systems, in diverse settings and addressing diverse challenges;
provide a forum for discussion of successes and failures in implementing fisheries management systems;
provide a forum for discussion of global fisheries management options.

4 "Oceanography of Brackish Water Ecosystems", Helsinki, Finland, 25-28 August 1998
Convener: Prof P. Malkki (Finland)
The purpose of the Symposium is to bring together scientists studying large brackish water seas such as Baltic Sea, Black Sea, White Sea, Chesapeake Bay, Mississippi Delta, Hudson Bay as well as small scale brackish water systems such as coastal areas and estuaries, to review specific features and recent results on relevant research.

5 "Ecosystem Effects of Fishing", Montpellier, France, 16-19 March 1999
Co-conveners: Prof H. Gislason (Denmark) and Dr M.M. Sinclair (Canada). SCOR has been invited to co-sponsor this Symposium.
The objective of this Symposium is to provide a global synthesis of what is known about the impacts of fishing on the marine ecosystem, to report on new methods for quantifying these impacts and to provide a forum for discussions on how objectives related to nature conservation can be integrated in future fisheries management.

The symposium will consist of invited contributions covering four different themes:

Ecosystem synthesis;
Quantification of fisheries impacts on ecosystems;

Management objectives and indices of ecosystem change;
Options for sustainable development.

6. "Environmental Effects of Mariculture" : St Andrews, N.B., Canada, 13-16 September 1999.
Co-Conveners: Dr D. Wildish (Canada) and Dr M. Héral (France). More details to be announced.

7. "Population Dynamics of *Calanus* in the North Atlantic: Results from the Trans-Atlantic Study of *Calanus finmarchichus*", Tromso, Norway, from 24-27 August 1999
Co-conveners: Prof. K.S. Tande (Norway) and Prof. C. Miller (USA).

With support from EU-MAST, U.S. GLOBEC and Canada GLOBEC, the Trans-Atlantic Studies of *Calanus finmarchicus* (TASC) programme has been seeking a quantum increase in ecological understanding of *Calanus*, with emphasis *on C. finmarchicus*. Some components of TASC have emphasised the interaction between the population dynamics of *Calanus* and physical processes in the North Atlantic pelagic habitat. Work has been vigorous since early 1994. The goals of the symposium will be to sum up results to date, to couple those results to studies of related species in other oceans, and to find directions for future research.

Contributions will be considered for the following areas of research and for any others that authors might propose as germane to the biological oceanography of *Calanus*.

Fecundity and production
Mortality and predation
Life History
Climatic change and Calanus biology
Genetic variability
Other Calanus species: (*C. chilensis, C. pacificus, C. sinicus, C. Agulhensis*)
Physical environment
Modelling

8. "100 Years of Science under ICES", Helsinki, Finland , 2000.
Convener: Dr E.D. Anderson (USA).
This Symposium is one of a number of activities in connection with the ICES Centenary to be celebrated in 2002. It will focus on the development of major scientific issues of relevance to the ICES over the course of the past Century.

ANNEX 18 - North Pacific Marine Science Organization

Report of PICES activities for the period of June 1, 96 - June 1, 97

The North Pacific Marine Science Organization (PICES) is an intergovernmental scientific organization which was established and held its first meetings in 1992. Its present members are Canada, the People's Republic of China, Japan, the Republic of Korea, the Russian Federation, and the United States of America. The purposes of PICES are (1) to promote and coordinate marine research in the northern North Pacific and adjacent seas especially northward of 30 degrees North; (2) to advance scientific knowledge about the ocean environment, global weather and climate change, living resources and their ecosystems, and the impacts of human activities; and (3) to promote the collection and rapid exchange of scientific information on these issues.

The activities of PICES for achieving its purposes include (1) Annual Meetings, symposia and workshops to present scientific papers, exchange latest results and ideas, and plan joint research; (2) the small short-term (1-3 years) Working Groups to concentrate on scientific topics selected by Scientific Committees and Science Board; and (3) planning of long-term interdisciplinary international research programs in marine science to use the collective scientific expertise and take advantage of the cooperative efforts of scientists of various specialties and nationalities. These scientific activities are reflected in the Scientific Reports of the Organization and other publications.

PICES activities for the period of June 1, 1996, to June 1, 1997, are briefly summarized below:

Meetings

Annual Meeting: The PICES Fifth Annual Meeting took place on October 11-20, 1996, in Nanaimo, B.C., Canada. The meeting was well attended with more than 230 participants from all six member countries, plus two invited speakers from Australia and United Kingdom, and representatives from international scientific organizations. The program of the meeting included four scientific sessions: *Exchange of water, organisms and sediments between continental shelf waters and the nearby ocean* (Physical Oceanography & Climate Committee), *Regional and interannual variants in life histories of key species* (Biological Oceanography Committee), *Ecological effects of truncated age and size distribution and fishing on fish population* (Fishery Science Committee) and *Processes of contaminant cycling* (Marine Environmental Quality Committee); and a Science Board Symposium on *Methods and findings of retrospective analyses* organized by the CCCC (Climate Change and Carrying Capacity) Program.

Special Workshop: The PICES-GLOBEC Workshop on Conceptual/Theoretical Studies and Model Development was held in Nemuro, Japan, on June 23-28, 1996. The Workshop was an element of the CCCC Program whose Implementation Panel and Task Teams (BASS (BAsin Scale Studies), REX (REgional Experiment) and MODEL) also met during the week. The objectives of the Workshop were (A) to review the state-of-the-art models and gaps in knowledge of coupled physical-biological and ecosystem models in member countries and in ongoing international programs; and (B) to develop the model related requirements of the CCCC Implementation Plan. A report of the Workshop has been completed, revised, presented at the PICES Fifth Annual Meeting in Nanaimo, and published as PICES Scientific Report No.7.

Working Groups

PICES currently has six Working Groups tasked to meet specific objectives:

WG 5. Bering Sea (Science Board): Working Group 5 met in Hakodate (Hokkaido University), Japan on July 24-26, 1996, to discuss the final report of the Group and the status of the Bering Sea review book that is being prepared for publication. The Working Group proposed the development of a broad outline for research in the near future in the Bering Sea, and more specifically, development of two areas of focus on dominant physical phenomena in the Bering Sea and the biological consequences of these phenomena. The final WG 5 Report was published in the 1996 Annual Report.

WG 8. Practical Assessment Methodology (MEQ): Working Group 8 met in October 1996, immediately prior

to the PICES Fifth Annual Meeting in Nanaimo, Canada. The objective of the meeting was to review and refine the draft work plan for convening a Practical Workshop in Jiaozhou Bay, Qingdao, China, in summer-fall 1997, aimed at harmonizing approaches among PICES countries when assessing ecological impacts of pollution.

WG 9. Subarctic Pacific Monitoring (Science Board): Working Group 9 met in October 1996, immediately before the PICES Fifth Annual Meeting in Nanaimo, Canada. Based on the seven possible monitoring initiatives outlined in their first report of the Working Group, three categories of programs were discussed: new initiatives, continuing programs, and programs that are not yet ready for commencement of monitoring. The WG 9 Reports 1 and 2 were published in the 1996 Annual Report.

WG 10. Circulation and Ventilation in the Japan Sea/East Sea and Adjacent Areas (POC): Working Group 10 met immediately prior the PICES Fifth Annual Meeting in Nanaimo, Canada, to set out the task in accordance with the terms of reference. The Working Group developed a number of tasks to be undertaken and set out a tentative schedule for their accomplishment. The second meeting of the Working Group was held in Fukuoka, Japan, on January 31 to February 3, 1997, following the Second International CREAMS (Circulation of Regional East Asian Marginal Seas) Symposium. The aim of the meeting was to advance the development of the WG 10 Report. The preliminary paired "Findings and Recommendations" were published in the PICES Press (Vol.5, No.2).

WG 11. Consumption of Marine Resources by Marine Birds and Mammals in the PICES Region (BIO): Working Group 11 met immediately before the PICES Fifth Annual Meeting in Nanaimo, Canada, to develop strategies to meet the goals set out in the terms of reference. A set of regions of interest were defined within the PICES area and the Working Group agreed to construct a tabulation of the population of marine mammals and birds found in the area, dates of residency, energy demand, food habits and food consumption.

WG 12. Crabs and Shrimps (FIS): Working Group 12 met immediately prior to the PICES Fifth Annual Meeting in Nanaimo, Canada. The terms of reference were reviewed and some changes were suggested to focus on just a few key species. A provisional list of exploited and important species was developed. The Working Group recommended that the next 5-day WG meeting be held late summer-early fall to compile a multispecies compendium as to what appears to be driving population abundance fluctuations and what research is underway or planned in member countries. The Working Group will also prepare a list of organizations and key scientific experts along with their field of interest from each member country.

Current Program:

PICES initiated the planning for an interdisciplinary program called the PICES-GLOBEC International Program on Climate Change and Carrying Capacity (the CCCC Program), appointed an Implementation Panel for the program, finalized and published (in March 1996) CCCC Implementation Plan along with a Science Plan (PICES Scientific Report No. 4). The next stage in the development of the CCCC Program was the PICES-GLOBEC Workshop on Conceptual/Theoretical Studies and Model Development which took place in Nemuro, Japan, in June 1996 (see PICES Scientific Report No. 7). Further discussions held by the Implementation Panel/Executive Committee and Task Teams during the PICES Fifth Annual Meeting led to the following recommendations concerning future workshops and symposia:

1. The BASS Task Team to convene a symposium on *Ecosystem dynamics in the eastern and western gyres of the subarctic Pacific* during the PICES Sixth Annual Meeting to review contemporary knowledge of physical forcing and ecosystem response at all trophic level, with a view to exploring the differences in response on the two sides of the Pacific;
2. The REX Task Team to convene a workshop on *The Development of Cooperative Research in Coastal Regions of the North Pacific* immediately prior to the PICES Sixth Annual Meeting (PICES-GLOBEC REX Workshop) to (a) identify and prioritize desired retrospective and process oriented research programs needed for regional comparisons, (b) discuss standardization of plankton sampling methods, (c) identify key species within the 10 REX regions, and (d) identify methods for monitoring their distribution and abundance in selected regions;
3. The MODEL Task Team to convene a workshop in California in early 1998 to (a) develop vertical profiles for nitrate in the open North Pacific, and (b) compare lower trophic level physiological process models.

Publications:

1. PICES Scientific Report No. 6: Proceedings of the Workshop on the Okhotsk Sea and Adjacent Areas, 426 pp. (September 1996).
2. Abstracts from the PICES Fifth Annual Meeting, 74 pp. (September 1996).
3. PICES Scientific Report No. 7: Summary of the Workshop on Conceptual / Theoretical Studies and Model Development and the 1996 MODEL, BASS and REX Task Team Reports. PICES-GLOBEC International Program on Climate Change and Carrying Capacity, 93 pp. (April 1997).
4. North Pacific Marine Science Organization Annual Report 1996, 175 pp. (January 1997).
5. PICES Press, Vol. 5 No. 1 (January 1997).
6. PICES Press, Vol. 5 No. 2 (June 1997).

Relations with other organizations:

Scientific Committee on Oceanic Research (SCOR)

Considering that fishing itself is one of the important causes of stock changes, PICES decided to work with SCOR on this aspect of the problem through participation in the SCOR Working Group 105 on *The impact of World Fisheries Harvests on the Stability and Diversity of Marine Ecosystems* and designated Dr. Chang-Ik Zhang, the Chairman of the Fishery Science Committee, to represent PICES.

International Council for the Exploration of the Sea (ICES)

Co-sponsorship of the ICES Symposium on *The Role of Physical and Biological Processes in the Recruitment Dynamics of Marine Population*. Dr. Dan Ware represented PICES on the Scientific Advisory Committee for this Symposium.

Global Ocean Ecosystem Dynamics (GLOBEC)

The Climate Change and Carrying Capacity (CCCC) Program is a joint effort between PICES and GLOBEC. This year (immediately prior to the PICES Sixth Annual Meeting in Pusan, Korea) PICES and GLOBEC will co-sponsor a multi-national workshop on *The Development of Cooperative Research in Coastal regions of the North Pacific*. The purpose of this workshop will be to review the present status of national research projects and to identify areas for cooperative research experiments in support of the CCCC Program.

Joint Global Ocean Flux Study (JGOFS)

PICES and JGOFS will co-sponsor the second JGOFS North Pacific Task Team (NPTT) meeting to be held in conjunction with the PICES Sixth Annual Meeting in Pusan, Korea. The purpose of this meeting will be to review current and future national and international projects with JGOFS components in the North Pacific region and to identify areas for cooperative research in support of JGOFS activities

For further information about PICES or any of the activities described in this report, please contact: Dr. W. Doug McKone, Executive Secretary, PICES, c/o Institute of Ocean Sciences, P.O. Box 6000, Sidney, B.C., Canada V8L 4B2, Tel: (1-250)-363-6826, Fax: (1-250)-363-6827, E-mail: mckone@ios.bc.ca or Dr. Alexander Bychkov, Assistance Executive Secretary, PICES, Tel: (1-250)-363-6364; Fax: (1-250)-363-6827; E-mail: bychkov@ios.bc.ca

ANNEX 19 - World Climate Research Program

Report on activities of the World Climate Research Programme (WCRP)
(submitted by the Joint Planning Staff, WCRP)

Contents:

1. WCRP Highlights 1996/1997

The past year has been very active and fruitful for the WCRP. WOCE results continue to pour in as they prepare for the critical Analysis, Interpretation, Modelling and Synthesis (AIMS) phase, the International Research Institute (IRI) for Seasonal to Interannual Prediction has been officially established to exploit and build on the successes of TOGA, and the major new WCRP activity to study the ocean's role in climate, CLIVAR, is getting underway. A new IPCC assessment has been issued which, for the first time, states that the balance of evidence suggests that there a discernible human influence on global climate and calls for increased activities in climate research.

This year will see the formal end of 8 years of WOCE observations. The data collected, along with the models which have been developed, will give an view of the world's oceans of unprecedented scope and accuracy. WOCE time series stations and repeat sampling of earlier hydrographic sections have revealed a much more variable and dynamic ocean than previously envisaged. The concerted global survey of WOCE, along with the time series stations, repeat sections and new technology for autonomous sampling have given us a tantalising glimpse of strong, low frequency ocean change and provide a firm knowledge base on which CLIVAR can build. Section 3 of this report discusses in more detail the status of WOCE and plans for the Analysis, Interpretation, Modelling and Synthesis phase.

Several major hydrographic and shelf survey expeditions in the Arctic have taken place in the past year under the aegis of ACSYS. Numerous modelling and data activities have been undertaken, including the production of a CD-ROM atlas containing 1.3 million Russian and USA hydrographic observations taken over the period 1948-1993. Looking to the future, WCRP called a meeting of experts to discuss optimum observational and modelling strategies to study the cryosphere and climate and what new programmatic links might be necessary to achieve a comprehensive approach.

TOGA, which formally ended in 1994, showed that observing and modelling the sea and its interaction with the atmosphere formed the basis for skillful predictions of El Niño sea surface temperature anomalies and associated changes in atmospheric circulation a year or more in advance. Recognition of the significant social and economic benefits which could result from such predictions has led to operational and quasi-operational prediction and applications activities around the world. A major step this past year has been the official establishment of an International Research Institute for Seasonal to Interannnal Prediction (IRI) which had been called for by the IOC and WMO-sponsored Intergovernmental TOGA Board. This activity which has its headquarters at Lamont Doherty Earth Observatory of Columbia University in Palisades, New York, USA, involves scientists from many nations and institutions working together to exploit and expand upon the TOGA results.

1996 has seen the publication of the Intergovernmental Panel for Climate Change's (IPCC) second full assessment of knowledge related to climate change. A far-reaching new conclusion was that "the balance of evidence suggests a discernible human influence on global climate". This conclusion was made possible by

major research advances in modelling of natural climate variability and of climate forcing by greenhouse gases and aerosols, as well as by new techniques in pattern recognition. Further actions to address anthropogenic climate change will be considered by governments at the third meeting of the Conference of Parties to the Framework Convention of Climate Change in Kyoto, Japan in November 1997. The FCCC also specifically commits countries to collaborate in climate research (Article 5) and to undertake related systematic observations.

The Climate Variability and Predictability Study (CLIVAR) is now the main thrust in the WCRP for exploring climate variations on time scales of season to decades, occurring naturally or as a result of anthropogenic effects. CLIVAR will exploit the "memory" in the slowly changing oceans and further understanding of the interactions between the atmosphere, land surface, oceans and cryosphere as they respond to natural processes and human influence. It has three major components, one to build upon the results of TOGA, another to explore longer time scale climate variability and most notably the role of the ocean therein, and a third to detect, predict and attribute anthropogenic climate change. CLIVAR also includes a particular focus to develop understanding and predictive capabilities for monsoons and their interactions with the ocean, ENSO and land surface processes. The CLIVAR Science Plan was published in 1995; the scientific community is now in the final stages of preparing an initial CLIVAR Implementation Plan which will be widely distributed in autumn of this year (see also Section 2). Plans call for a major international CLIVAR conference in April of next year at Unesco to consider national plans for implementing this new activity and to assess what additional resources will be necessary to make the programme a success.

The development of global climate models is the main unifying component in the WCRP, building on the scientific and technical advances in the discipline-oriented activities. Output from models provide the basis for understanding and prediction of climate variations and for projections of climate change that could result from either natural or anthropogenic causes. Models also offer the essential means of synthesising all the relevant atmospheric, cryospheric and land observations collected in the WCRP and other programmes. A recognition of the importance of the modelling effort was the recent decision by the JSC to reconstitute the CLIVAR NEG-2, which was concerned with numerical experimentation related to the DecCen and ACC portions of CLIVAR, as the JSC/CLIVAR Working Group on Coupled Modelling. This Group would now report directly to the JSC as well as continuing to support CLIVAR activities, and would serve as a clear WCRP interface with the IPCC in considering the production of required projections of climate change for the next assessment activity. Good coordination with the WOCE Synthesis and Modelling Working Group (SMWG) is assured by cross membership; a joint ocean modelling data intercomparison project is being developed.

Maintaining and expanding the global climate observing systems is of major concern to the WCRP. The JSC, at its most recent session, expressed concern at the deterioration and threats faced by existing in situ atmospheric and ocean observing systems and the serious limitations for supporting these systems. The Committee stressed the need to maintain these systems and the free and unrestricted access to and exchange of the data which is generated. In this respect, the activities of the jointly GCOS/GOOS/WCRP-sponsored Ocean Observations Panel for Climate (OOPC), such as the recent Time Series Workshop, form an important foundation for WCRP projects. The proposed GODAE project would demonstrate the feasibility and practicality of global ocean data assimilation systems similar to those existing for the atmosphere. This ambitious project, if implemented, would contribute to advancing the goals of the climate research community, and, most notably, those of WOCE and CLIVAR.

The JSC has also recognized the need for greater involvement of developing countries and regions in the WCRP to foster scientific capacity in climate-related disciplines. Two activities have been initiated through the Global Change System for Analysis, Research and Training (START) (jointly sponsored by WCRP, IGBP and IHDP) to develop end-to-end projects on climate variability, agricultural productivity and food security in the Asian monsoon region and in sub-Saharan Africa. As well as increasing interest and interaction with START, the WCRP will also have closer relationships and provide more input to the regional intergovernmental networks such as IAI, APN and ENRICH.

2. CLIMATE VARIABILITY AND PREDICTABILITY (CLIVAR) STUDY

2.1 Introduction

Building on the success of TOGA and the global perspective on the ocean and its role in climate supplied by WOCE, CLIVAR is now the main thrust in the WCRP for exploring climate variations on time scales of seasons to decades, occurring naturally or as a result of anthropogenic effects. The CLIVAR Science Plan which was published in August 1995 (WCRP-89; WMO/TD No. 690) lays out the following overall objectives for CLIVAR:

- To describe and understand the physical processes responsible for climate variability and predictability on seasonal, interannual, decadal, and centennial time-scales, through the collection and analysis of observations and the development and application of models of the coupled climate system, in co-operation with other relevant climate-research and observing programmes.
- To extend the record of climate variability over the time-scales of interest through the assembly of quality-controlled paleoclimatic and instrumental data sets.
- To extend the range and accuracy of seasonal to interannual climate prediction through the development of global coupled predictive models.
- To understand and predict the response of the climate system to increases of radiatively active gases and aerosols and to compare these predictions to the observed climate record in order to detect the anthropogenic modification of the natural climate signal.

CLIVAR has been organized initially into three component programmes:

- **CLIVAR-GOALS**: a study of seasonal-to-interannual climate variability and predictability of the global ocean-atmosphere-land system;
- **CLIVAR-DecCen**: a study of decadal-to-centennial climate variability and predictability;
- **CLIVAR-ACC**: modelling and detection of anthropogenic climate change.

The scientific community, in cooperation with the CLIVAR SSG and the International CLIVAR Project Office, is now in the final stages of preparing an initial CLIVAR Implementation Plan which will be widely distributed in autumn of this year. An outline of the contents of this plan are given in section 3 below. A major international CLIVAR conference is being planned for April of next year, at Unesco in Paris, to consider national plans for implementing this new activity and to assess what additional resources will be necessary to make the programme a success.

Further information about CLIVAR and CLIVAR activities can be found by accessing the CLIVAR Home Page at http://www.dkrz.de/clivar/hp.html or contacting the International CLIVAR Project Office, c/o Max-Planck Institut fur Meteorologie, Bundesstrasse 55, D-20146 Hamburg, Germany (email: clivar@clivar.dkrz.de). The latest issue (April 1997) of "Exchanges", the CLIVAR Newsletter, highlights the recent programme developments.

2.2. Preparation of an Initial CLIVAR Implementation Plan

The past year has seen prodigious planning activity within the CLIVAR community and significant progress in constructing an overall implementation plan for the programme. A range of planning meetings has taken place, complemented by various editorial and writing group sessions. A first draft of the plan has been produced and is undergoing further internal review and revisions. The current status can be found at the Web site: http://www.dkrz.de/clivar/climp.html or http://www.clivar.ucar.edu/climp.html.

In developing CLIVAR planning, the CLIVAR Scientific Steering Group has recognized that the implementation of the various activities called for would be an evolutionary process. Amendments to the initial

implementation plan would be issued when appropriate to accommodate changes in the direction of existing activities and to add new. A basic element in the implementation strategy would be the continuation of observational and data management systems built up in TOGA, and the maintenance of WOCE observing components that would serve the scientific objectives of CLIVAR. Existing bodies will also be used as far as possible for the management of observing systems and data collection and, in particular, relationships with the WWW, GCOS and GOOS would be strengthened in, for example, the maintenance of an effective network of land-based climatological observing sites and in the development and implementation of new ocean observing systems and strategies.

2.3. Principal CLIVAR Research Areas

In the draft implementation plan, eleven principal CLIVAR research areas have been identified. The first four of these are considered to be broadly elements of the GOALS (Global-Ocean-Atmosphere-Land System) component of CLIVAR, the following five of DecCen (Decadal-to-Centennial variability) and the final two of ACC (Anthropogenic Climate Change).

(i) *Improving and expanding ENSO predictions:* The objective is to build on the successes of TOGA which made major strides towards understanding ENSO, and demonstrating the predictability of sea surface temperatures in the tropical Pacific, that skillful predictions of tropical sea surface temperatures could be made, and that there was associated predictability of temperature and precipitation anomalies in several other parts of the world. TOGA modelling programmes will be carried forward and developed, complemented by numerous analytic and diagnostic studies of the tropical Pacific Ocean seasonal-to-interannual variability associated with ENSO. The links between high and low latitudes and the effects of intrinsic low frequency components at higher latitudes such as extra-tropical sea surface temperatures, soil moisture, sea ice, snow cover will also be explored. Emphasis will be given to encouraging effective scientific support for, and working relationships with burgeoning experimental and operational climate prediction activities throughout the world, and with groups developing methodologies for the provision of climatic services.

(ii) *Inter-annual variability of the Asian-Australian monsoon:* The effect of slowly changing boundary conditions such as sea surface temperature, snow cover and other slow variables on the tropical climate system will be explored. Past studies have shown that the intensity of the Asian-Australian monsoon is linked to the inter-annual variability of the tropical ocean-atmosphere system, in particular ENSO. There is also a body of scientific evidence indicating that the Asian monsoon may strongly influence ENSO and have other impacts outside the monsoon region. The three objectives of this research element of CLIVAR have therefore been set down as:

- to explore and determine the limits of predictability of the Asia-Australian monsoon climate system;
- to quantify the relative contribution to monsoon predictability from slowly varying boundary conditions and internal dynamics within the Asian-Australian monsoon system;
- to investigate the Asian-Australian monsoon as a factor in the predictability of the global climate system, in particular as related to ENSO.

(iii) *Inter-annual variability of the American monsoon:* A number of studies in the past few years have provided descriptions of both North and South American warm season monsoonal circulations. These circulations are distinct from monsoon systems in other regions in that they are strongly influenced by tropical sea surface temperatures, and that the local complex orography and coastal geometry affect their overall planetary-scale structure and behaviour. This element of CLIVAR will thus attempt to understand and model the dominant modes of climate variability in the Americas during the respective northern and southern hemisphere warm seasons, with emphasis on seasonal to inter-annual time scales and to assess whether skillful predictions may be possible.

(iv) *Inter-annual variability of the African climate system:* The need to predict inter-annual climate variations over Africa is evident from the devastating socio-economic consequences of droughts and failure of water storage systems over the past few decades. An improved understanding of the physical mechanisms that govern the climate of Africa together with more reliable predictive models is essential. A start will be made by studying climate variability over the continent at different time scales and assessing prospects for improved predictability, and developing the already known relationships between seasonal rainfall anomalies and the phase of ENSO. Anomalies of sea surface temperature as well as the heat storage in the upper layers of the tropical Atlantic and Indian Oceans, their influence on overlying monsoonal circulations and possible role in climatic fluctuations over Africa will also be investigated.

(v) *North Atlantic Oscillation:* The North Atlantic Oscillation (NAO) is characterized by a large scale alternation of atmospheric pressure anomaly between the Icelandic low pressure region and the Azores high, and is the dominant mode of variability in the North Atlantic sector. Analysis of the frequency spectrum of the NAO index reveals variability on time scales from a few months to several decades, and also that, whilst a quasi-biennial variation was dominant late in the last century, decadal and inter-decadal variability has become prominent during this century. The NAO signal is associated with the most significant proportion of the northern hemisphere temperature variability of any mid-latitude or tropical fluctuation, involving both sea surface and surface air temperature see-saws between northern Eurasia and eastern Canada and Greenland, as well as between Mediterranean Eurasia/Africa and the eastern USA. CLIVAR will particularly take up the extent to which multi-annual to decadal changes in the NAO index and accompanying climate variations are predictable. New data on deep-seated oceanic temperature anomalies which appear to propagate in the Atlantic basin on decadal and longer time scales and which could affect air-sea interaction, hold a tantalizing suggestion of predictability of the NAO on these time scales. Improved monitoring, process studies and modelling activities will be required to understand the workings of the NAO.

(vi) *Tropical Atlantic decadal variability:* Although sea surface temperature anomalies in the tropical Atlantic are weaker than those associated with the El Niño in the Pacific, they may be linked to changes in climatic patterns of the Americas and Africa having major socio-economic impacts (e.g., the relationship between drought in northeastern Brazil and the sea surface temperature in the tropical Atlantic). The Atlantic sea surface temperature "dipole" (characterized by spatially coherent sea surface temperature patterns in the sub-tropics of either hemisphere, accounting for about 20% of the total yearly-averaged variance of sea surface temperature in the tropical Atlantic) is also a phenomenon of considerable interest. The consequent variation of the inter-hemispheric sea surface temperature gradient has a significant impact on the position and intensity of the Intertropical Convergence Zone which in turn influences the rainfall over northeast Brazil and the Sahel region in Africa. Modelling studies have also hinted at a mode of variability similar to ENSO in the tropical Atlantic Ocean which can affect the rainfall in the Gulf of Guinea. Activities in CLIVAR will thus be directed to extending our knowledge of the underlying dynamics of low frequency variability and coupled climate variability in the tropical Atlantic and developing predictive capability. Investigation of whether the two components of the "dipole" are dynamically related or independent and of the physical processes involved is also needed, as well as determining how much of the variability in the tropical Atlantic is attributable to "remote" influences and how much to "local" air-sea interactions (in particular, the influence of Pacific sea surface temperature anomalies on the Atlantic).

(vii) *Atlantic thermohaline circulation:* The thermohaline circulation in the North Atlantic accounts for most of the equator-to-pole ocean heat transport in the northern hemisphere, and is thus obviously is a fundamental element of the global climate system. Variations of the thermohaline circulation on decadal-to-centennial time scales leading to changes in sea surface temperature and ocean heat transport are of direct interest to CLIVAR. Although the thermohaline circulation is a basin-to-global scale phenomenon, its dynamics and in particular its variability are controlled by small-scale processes

involved in the formation and spreading of deep water, including deep convection, flow through narrow passages, deep recirculating gyres, western boundary currents and vertical mixing. CLIVAR activities in investigating the role of the thermohaline circulation in decadal-to-centennial climate variability will thus aim at determining the sensitivity of the thermohaline circulations to changes in surface fluxes, improving the understanding and the representation of the physical processes critical in simulating the dynamics of the thermohaline circulation in ocean models, describing the space-time characteristics of variability that could be related to modifications of the thermohaline circulation, and establishing the predictability of variations in the thermohaline circulation and associated changes in atmospheric climate.

(viii) *Indian and Pacific Ocean decadal variability:* At decadal time scales (peaking in the 20-30 year range), a mode of sea surface temperature variation in the Pacific, symmetric about the equator with the tropics out of phase with mid-latitudes, is apparent. The pattern is roughly similar to that of ENSO variability at seasonal to interannual time scales except that the magnitude of mid-latitude and tropical antinodes are about the same (in contrast to the ENSO mode where the magnitude of the equatorial antinode is much higher than that of the mid-latitudes). This 20-30 year mode modulates the more rapid ENSO signal with sometimes significant effects and correlates strongly with changes in the amplitude of the Pacific-North American pattern on decadal time scales, with the consequences being seen in changes in the strength of the Aleutian low. There is evidence that this mode is part of a larger-scale pattern of variation including the Indian Ocean and possibly the western North Atlantic. The key thrusts for CLIVAR will be to understand the changes in ocean and atmosphere conditions linked to this large-scale Pacific decadal mode, and the extent to which these are predictable. A better description of decadal variability in the Indian Ocean and South Pacific also needs to be established and whether this variability is related to the Pacific mode.

(ix) *Southern Ocean thermohaline circulation:* The Southern Ocean is the main connection between the three major ocean basins, permitting a global-scale circulation to exist and providing a means for the propagation of heat and freshwater anomalies from one basin to another. The Southern Ocean is also a principal source of very cold bottom water in the deep ocean. It is likely that variability in the formation and spreading of Southern Ocean water masses and inter-ocean fluxes is associated with climate variability, for example through changes in the heat supplied by the deep ocean influencing the atmosphere directly, or through changes in sea ice in turn affecting albedo, and air-sea fluxes. However, the state of observations and modelling of the Southern Ocean is not as developed as for other regions of the ocean. The component of CLIVAR concerned with the Southern Ocean will thus have to give particular attention to exploratory investigations, including assessing variability in the Antarctic Circumpolar Current, of the formation and circulation of sub-Antarctic mode water and Antarctic intermediate water, and of deep water upwelling and bottom water formation, as well as and feedbacks with sea ice, glacial ice and the atmosphere.

(x) *Climate change prediction:* Advancing the understanding of anthropogenic climate change in CLIVAR will be predominantly based on modelling activities and does not involve organized field experiments or process studies. Through the agency of the JSC/CLIVAR Working Group on Coupled Modelling, efforts will be directed to reducing uncertainty in projections of climate change, particularly by fostering studies (in collaboration with other WCRP activities as appropriate) to elucidate the factors controlling the distribution of clouds and their radiative characteristics, the treatment of the hydrological cycle in models, and to improve the coupling between the atmosphere and ocean. A sustained long term development and evaluation of climate models will be encouraged, based on a deeper analysis of climate experiments and systematic intercomparison of model results to understand the mechanisms underlying the simulated response and to identify reasons for different responses. Models will also be measured by their simulation of past climates (in conjunction with the IGBP core project PAGES). The development of standard forcing scenarios, including improved estimates of future emissions, will also be undertaken in liaison (as appropriate) with IPCC.

(xi) *Climate change detection and attribution:* CLIVAR efforts in this area will also largely rest on modelling, but will require major inputs from observation and modelling activities outside CLIVAR (e.g., from GEWEX, IGAC, GCOS). The IPCC Second Assessment Report suggested that "the balance of evidence suggests a discernable human influence on climate", and further studies have continued to show evidence of a change in global climate and that this change is due, at least in part, to human activities. The detection of climate change is based on demonstrating that an observed variation in climate is highly unusual in a statistical sense and is larger than would occur as a result of natural internal fluctuations. To attribute the change to human activity requires showing that the observed change cannot be explained by natural causes. The fundamental elements needed are systematic observations of key variables, especially the three-dimensional temperature structure of the atmosphere, historical records and plausible proxy data, long model integrations to provide the measure of natural climate variability, and the development and refinement of statistical detection techniques. CLIVAR will encourage all these activities (in conjunction with the World Climate Data and Monitoring Programme and IGBP PAGES, as appropriate). Particular attention will be given to climate model integrations with various specified anthropogenic forcing terms for comparison with the observed behaviour of the atmosphere. These latter activities closely complement those under the "Climate change prediction" research thrust of CLIVAR.

2.4. Other CLIVAR Activities

Although the focus of attention in CLIVAR during the past year has been the preparation of the implementation plan, several activities that will underpin the future development of the programme are already under way.

2.4.1. Numerical Experimentation

Numerical experimentation activities in support of CLIVAR continue to develop. Those under the auspices of the CLIVAR Numerical Experimentation Group formed in support of CLIVAR-GOALS (hitherto known as CLIVAR NEG-1) include:

- an intercomparison of ENSO simulations in coupled models (ENSIP) coordinated with the Coupled Model Intercomparison Project (see below);
- a study of the behaviour of the tropical oceans on seasonal and inter-annual time scales in coupled ocean-atmosphere models (STOIC), focusing on the Atlantic and India Oceans and exploration of the relationship with the equatorial Pacific Ocean (e.g., complementing ENSIP);
- a study of dynamical seasonal prediction (SHIP), aiming to assess the prospects of dynamical predictions of seasonal anomalies of atmospheric circulations and rainfall given the observed initial state of the climate system, and the most accurate observed surface boundary conditions;
- an intercomparison of simulations of monsoon variability and predictability, based on firstly, an analysis of the prediction and treatment of monsoons in the summer ensemble cases in SHIP, secondly, the AMI diagnostic sub-project on the representation of monsoonal circulations and their variability in the AMI integrations, and thirdly, a study of the treatment of monsoons in integrations in the Coupled Model Intercomparison Project (CMIP);
- an intercomparison of ocean models forced by NCEP, ECMWF, and NASA/GSFC reanalysis wind stress products;
- preparation of improved initializations and analyses for forecasts on multi-seasonal time scales, including establishment of the "best" (monthly-mean) ocean analyses for sea level and upper ocean thermal structure (based on all available data including error estimates), and assessment of impacts of analyses on forecasts (i.e., what characteristics in the initial conditions are important for skillful forecasts (in conjunction with the CLIVAR Upper Ocean Panel).

The CLIVAR Numerical Experimentation Group formed in support of CLIVAR DecCen and CLIVAR-ACC (CLIVAR NEG-2) was reconstituted at this session of the JSC as the joint JSC/CLIVAR Working Group on Coupled Modelling. Activities initiated by CLIVAR NEG-2 and that will now continue under the auspices of the Working Group on Coupled Modelling include a major intercomparison of coupled models (CMIP). In the first stage, selected features from multi-decadal control integrations of current global coupled GCMs are being intercompared, with a view to assessing systematic errors in the various components of coupled models, attempting to quantify the effects of flux adjustments on coupled simulations of the mean climate and climate variability, and documenting the characteristics of the simulated variability. The interest and response to CMIP has been very positive and all major global coupled modelling groups have submitted model runs. It is planned to undertake a number of CMIP diagnostic sub-projects (on the lines of AMI). The second stage will involve an intercomparison of 80-year coupled model integrations with a 1% per year compound increase of CO_2. This will be a major effort to demonstrate the state of the art in global coupled modelling by examining the mean response of the coupled climate system to a transient increase of CO_2.

An ocean model/data intercomparison project is being considered in conjunction with the WOCE Synthesis and Modelling Working Group. As an initial step, a joint workshop on "Ocean Modelling for Climate Studies" will be held in mid-1998 which will take further the planning of this project.

Other studies being organized are idealized sensitivity experiments exploring (atmospheric) model responses in terms of mean zonal changes in water vapour, temperature lapse rate and cloud (i.e., the differences between doubled CO_2 and control integrations) and the definition of standard (realistic) forcing scenarios (i.e. the increase of atmospheric carbon dioxide, tropospheric and stratospheric ozone, atmospheric aerosol loading, solar variations, vulcanisms) to be used by coupled modelling groups in transient experiments.

2.4.2. CLIVAR Observational Activities

The CLIVAR Scientific Steering Group is acutely aware of the importance of maintaining basic observing systems to meet CLIVAR objectives and, in this connection, is in close contact with existing GCOS, GOOS and IGOSS groups. The CLIVAR Scientific Steering Group is looking to its Upper Ocean Panel to consider the strategy for obtaining the sustained global upper ocean observations needed for CLIVAR including assessing the effectiveness of existing observing systems and recommending the systematic measurements that should be made in support of ENSO prediction. The Upper Ocean Panel has reviewed in detail the report of the Ocean Observing System Development Panel and has concluded that it does contain the basis on which to build the required observing system. The Upper Ocean Panel has also considered how the observing systems, primarily implemented in the Pacific Ocean for ENSO prediction, can be developed and extended to measure the evolution of the mass and circulation fields in the sub-tropics in all three tropical ocean basins. In conjunction with CLIVAR NEG-1, the impact of specific observing systems on prediction skill is being examined. The Upper Ocean Panel has also set down a series of recommendations for observing systems in support of CLIVAR research which have been incorporated in the draft implementation plan.

Management of existing observing systems needed by CLIVAR has been entrusted to the joint GCOS/CLIVAR Tropical Atmosphere Ocean (TAO) Panel, the Data Buoy Co-operation Panel and the Ship-of-Opportunity Programme Implementation Panel (these last two being primarily under the aegis of IGOSS). The status of the drifter and XBT network has remained essentially unchanged over the past year. Plans call for the expansion of the TAO moored array in the tropical Pacific over the next one to two years in particular in cooperation with the Japan Marine Science and Technology Center (JAMSTEC) and for the establishment of a pilot array in the tropical Atlantic (as part of the Pilot moored Research Array in the Tropical Atlantic, PIRATA, project).

3. WORLD OCEAN CIRCULATION EXPERIMENT (WOCE)

3.1 Introduction

At the end of 1997 WOCE will have reached the formal end of the intensive observational period. A few observational elements will however continue (completion of the North Atlantic hydrography resurvey by mid 1998, continuation of data recovery from drifting surface buoys and subsurface floats and from moored current meter arrays and tide gauges). The earth observing satellites (Topex-Poseidon and ERS-2) continue to provide outstanding data and a follow-on altimeter mission (Jason) and a future gravity mission hold exciting prospects beyond WOCE but building on WOCE experience. Evaluation of what percentage of the in-situ observations described in the 1986 Implementation Plan were actually achieved will take some time but we can already say the over 85% of the stations planned for the one-time survey will have been occupied. The project will now concentrate on its Analysis, Interpretation, Modelling and Synthesis (AIMS) phase for which a draft Implementation Plan has been produced by the WOCE Synthesis and Modelling WG and will be published in Autumn 1997. There are now clear priorities which are outlined below together with a description of the present situation.

3.2 Delivery of data from PIs into the WOCE network of Data Assembly and Special Analysis Centres (DACs and SACs)

Following early delays in data delivery there has now been a substantial improvement. This has been in part due to a change in the rules that now forbid release of submitted data by a DAC without the PI's approval. Certain segments of the WOCE community are slow at delivering data and a particular problem lies with tracer data. Steps are being taken to try to improve the situation.

3.3 Dissemination of WOCE data sets

Many of the WOCE data sets are already available on-line via the WWW. The WOCE DACs and SACs have also undertaken to produce the first set of WOCE data CD-ROMs by the time of the WOCE Conference in May 1998. (See WOCE Data Guide 1997 http://www.soc.soton.ac.uk/OTHERS/woceipo/dguide97/index.html for full details of WOCE DACs and SACs)

3.4 WOCE data analysis and interpretation

WOCE observations and model results have provided a wealth of information of relevance to WOCE objectives and of specifically oceanographic interest. In the past year a number of significant findings have been made. Among these are the use of in-situ and satellite altimetry data to construct a 2-year time series of Kuroshio transports (a key component of North Pacific heat flux measurements) and the discovery of a radically different distribution of energetic diapycnal mixing in the S Atlantic showing high vertical diffusivities over extensive areas of the mid-ocean ridge and penetrating over most of the water column.

A searchable bibliography has been assembled of papers relating to WOCE research and this presently contains some 2800 entries. Many of the recent papers stem from the analysis of data sets collected during WOCE. The WOCE International Newsletter published quarterly by the WOCE IPO is an initial route via which many early results are publicised.

3.5 Initiating regional foci for WOCE research

The WOCE measurements have by and large been carried out basin by basin and basin-wide workshops have been convened to act as catalysts for the interpretation of data, for the initiation of groups of scientists to work on generic problems and for the comparisons of models with data. The first, on the Pacific, was held in California in August 1996 and will result in the publication of the first dedicated collection of 16 papers in JGR

(O) in autumn 1997. Workshops on the S Atlantic (Brest, France, June 1997) and the S Ocean (Hobart, Australia, July 1997) have been completed and will be followed by Indian Ocean (USA, 1998) and N Atlantic (Kiel, Germany, 1999). It is planned that other workshops based on global phenomena may follow.

3.6 Model improvement through model/model and model/data intercomparisons

Ocean model improvement is the central objective of WOCE and the existence of long (multi-year to multi-decade) runs of global eddy-permitting models has allowed comparisons to be made of the mean state of the ocean (fluxes, water mass distributions, current transports) without the ambiguities caused by geographical boundary conditions. Similarly comparisons are being made between different model formulations (Bryan-Cox, isopycnic code) that highlight the strengths and weaknesses of each model type in terms of their ability to reproduce flows through passages and upper ocean seasonal stratification cycles. A workshop will be held in August 1998 co-sponsored by WOCE and CLIVAR to determine the critical deficiencies of and tests to be made on ocean models.

3.7 Data assimilation

The assimilation of both in-situ and remote sensed data into models remains a major challenge. Such ocean data assimilation activities are in their infancy and make even greater demands on computer resources than do diagnostic model runs. However the end result would be a dynamically consistent realisation of the "state of the global ocean in the 1990s" that would provide a baseline against which future (and past) changes could be assessed.

3.8 WOCE Conference

Planning is well advanced for the conference "Ocean Circulation and Climate" being organised by WOCE in Halifax, N.S., Canada, May 24-29 1998 to mark the end of the WOCE observational phase. Plenary speakers have already committed themselves to talks focussed on the progress made by WOCE towards the achievement of its goals. The programme is available on the WWW at http://www.soc.soton.ac.uk/OTHERS/woceipo/wconf/index.html.

A request for initial expressions of interest in the conference has resulted in 250 replies (many from scientists not recognised as the "old guard" of WOCE. We are therefore optimistic about the likely attendance. Non-invited science will be presented as posters and will include the global CO_2 survey thereby entraining elements of the JGOFS community. A formal registration invitation will be issued in September 1997.

3.9 Infrastructure status and future requirements

The science infrastructure for WOCE has been streamlined with now effectively only four committees, Scientific Steering Group, Synthesis and Modelling WG, Data Products Committee and Hydrographic Programme Planning Committee. The latter is expected to have completed its oversight tasks by 2000. The project is supported by the International Project Office (IPO) in Southampton, UK, a Data Information Unit (DIU) in Delaware USA and a distributed system of DACs and SACs. These elements are expected to be required for some considerable time - the IPO exclusively to support WOCE but the other elements may well be able to support not only WOCE but other programmes now starting their observational phase (ACSYS, CLIVAR). Funding and staffing these offices is an immediate concern. Commitments to the WOCE IPO and to the WHP SAC have been obtained but the funding of other elements is less sure. WOCE has already received enormous financial support (approaching $500m), however it has become increasingly difficult to secure adequate funding for the post-observational AIMS phase. This extended funding is essential if we are to capitalise on the investment already made. Additionally it must be made clear to the agencies that have provided the early funding that it has been well spent on making progress towards improving our understanding of the role of the ocean circulation in climate. Thus publicising the achievements of WOCE will be a high priority.

4. ARCTIC CLIMATE SYSTEM STUDY (ACSYS)

4.1. Introduction

The Arctic Climate System Study (ACSYS) has been established as a 10 year programme running from 1 January 1994. It is aimed towards determining the role and sensitivity of the Arctic in the global climate system and, in particular, towards answering whether Arctic climate is as sensitive to global changes as climate models seem to suggest. The main ACSYS components are:

- Arctic Ocean Circulation programme
- Arctic Sea-Ice Programme
- Arctic Atmosphere Programme
- Arctic Hydrology Programme, and
- ACSYS Modelling Programme

The overall scientific concept of ACSYS is given in WCRP-72 (1992) and the initial plan for its implementation - in WCRP-85 (1994),

So far, ACSYS has concentrated on the central Arctic Basin, though its programme on sea ice extends into the Nordic Seas, while determination of the fresh water fluxes from the Arctic Basin into the Nordic Seas and thence from the Nordic Seas to the world ocean forms a particular focus for ACSYS.

4.2. Progress in ACSYS development of Arctic studies

4.2.1. Arctic Ocean Circulation Programme

A number of Arctic Ocean hydrographie and shelf survey expeditions have contributed to meeting the aims of ACSYS in 1996. Some of these were:

- German-Russian Laptev Sea cruises
- a joint Swedish-Germany survey of the Eastern Eurasian Basin, and
- joint Norwegian-Russian surveys of the Barents and Kara Seas.

Plans for 1997 and 1998 include a joint Russian-USA expedition (1997) and a joint Canadian-USA hydrographie survey of the Canadian Basin. Several German cruises to the Arctic, aboard the Polarstern, are planned until 2001. Repeat Canadian sections in the Canadian, Beaufort and eastern Arctic, plus expanded shelf and coastal ocean surveys in the Canadian Archipelago, are also under consideration.

A substantial contribution to ACSYS has been the development, under the auspices of the Gore-Chernomyrdin Commission, of a CD-ROM Atlas containing 1.3 million Russian and USA hydrographic observations taken over the period 1948-1993.

4.2.2. Arctic Sea-Ice Programme

A number of countries have contributed to the WCRP Arctic Ice Thickness Project network (Canada, Germany, Iceland, Norway, UK and USA). The present Upward-Looking Sonars (ULS) network consists of some 15 moorings, mainly located around the peripheries of the Arctic Basin with a concentration of the instruments in the Fram Strait. Results from this project were drawn together in an ACSYS-sponsored workshop on Sea-Ice Thickness Measurements and Data Analysis (Monterey, CA, USA, April 1997), which was combined with the fourth session of the ACSYS Sea-Ice/Ocean Modelling Panel (SIOMP). The SIOMP met jointly with the Sea-Ice Thickness Workshop in order to ensure that the ACSYS modelling com unity has the opportunity to express its requests for sea-ice thickness data and offer its insight. The meeting reviewed the role

of ULS and submarine ice draft data and developed an ice thickness monitoring strategy for the period 1998 to 2003.

4.2.3. ACSYS Arctic Atmosphere Programme

ACSYS aims to develop Arctic historical atmospheric data sets by utilizing the products from the atmospheric re-analyses. ACSYS also seeks to provide improved data sets of the surface forcing of the Arctic Ocean and sea ice. To assist in these efforts, ACSYS has established a panel on Polar Products from Re-analysis with the aims, in particular, of promoting the evaluation and assessment of re-analysis products for polar regions and the development and implementation of techniques for blending modelled and *in situ* data sources to provide optimal gridded polar data sets. As a contribution to the establishment of an improved data base of historical meteorological observations, ACSYS sponsored the USA National Snow and Ice Data Centre CD-ROM of Russian North Pole Drifting Station Snow and Meteorological Observation Data for 1937 and 1950-1991, which has already been released.

A workshop was held in November 1996 (Bracknell, UK) on Arctic Regional Climate Models. It was sponsored jointly by ACSYS, the International Arctic Science Committee and the European Marine and Polar Board. The workshop made good progress with the development of the interaction between modellers and those seeking data for impact studies. The modelling data needs for impact studies were identified both as a list of parameters and in terms of the time and space scales required.

4.2.4. ACSYS Hydrology Programme

ACSYS is working to develop research quality Arctic hydrological data sets of run-off and of Arctic precipitation. The ACSYS Run-off Data Base (ARDB) is being established by the Global Run-off Data Centre (GRDC) in Koblenz, Germany. Monthly mean discharge data from 235 rivers flowing to the Arctic Ocean are already stored. The ARDB is accessible to every user registered with the GRDC.

In July 1996, ACSYS sponsored a workshop on the implementation of the Arctic Precipitation Climatology Centre (GPCC) (Offenbach, Germany). It is intended that a pilot APDA on CD-ROM be published by 1998 and a final version by 2000. APDA will include station data (both corrected and uncorrected) as well as gridded products.

4.2.5. ACSYS Modelling Programme

The ACSYS modelling strategy includes optimisation of the components of global and regional models of the Arctic, in particular of the physical parameterizations required by atmosphere, ocean, sea ice and hydrological models and coupled configurations of these components. The SIOMP, so far, has concentrated its efforts on intercomparing available sea ice models for climate studies. Present strategy is to develop the SIOMP into a full ACSYS numerical experimentation group to stimulate and coordinate work on physical parameterization of other components of the climate system. It will also seek to collaborate with the WCRP CLIVAR programme in stimulating climate response experiments on the role of Arctic processes on global climate.

4.3 The Second ACSYS Science Conference

As noted in section 4.1, a primary aim of ACSYS is to determine the role of the Arctic in global climate. This topic forms the overall theme for the second ACSYS Science Conference to be held at the Rosario Resort, Orcas Island, WA, USA, from 3 to 6 November 1997. Under the heading "Polar Processes and Climate", this conference will focus on new observational insights, sources, sinks, budgets and processes and their modelling in the polar climate system, as well as on variability and feedbacks between the polar regions and global climate.

5. ORGANIZATION OF WCRP RESEARCH INTO CRYOSPHERE AND CLIMATE

5.1. Introduction

The ACSYS Scientific Steering Group (SSG), at its fifth session (Copenhagen, Denmark, October 1996) discussed the need for an international co-ordination of cryospheric research relevant to climate (Antarctic sea ice dynamics, ice-shelf/ocean interaction, Greenland and Antarctica ice sheet dynamics and their stability, the climate effects of snow cover, permafrost and other cryospheric variables which are important for understanding climate variations and change on time scales from seasons to centuries) and agreed to support an exploratory meeting of experts on cryosphere and climate. It was underlined that WCRP was particularly well suited to forging links between research into cryospheric, oceanic and atmospheric components of the physical climate system and to do so on a bi-polar basis. The Group was of the opinion that WCRP should recognize the numerous existing scientific activities in the Arctic and the Antarctic, many long standing and pertinent to climate, as well as the growing number of internationally based bodies/programmes with interest in global change in the polar regions.

5.2. Meeting of experts in cryosphere and climate

A meeting of experts on cryosphere and climate was held in Cambridge, UK, from 3 to 5 February 1997. Representatives of virtually all bodies and programmes having interest in climate-related polar research attended the meeting. The principal scientific questions to be resolved and the critical gaps in observational and modelling programmes were identified. Requirements and possibilities for an overall internationally coordinated research programme on cryosphere and climate were discussed in depth. Based on this, the meeting suggested the following strategy towards establishing and internationally coordinated research on cryosphere and climate:

(i) The WCRP Conference on Achievements, Benefits and Challenges (August 1997) should identify weaknesses and gaps in studies of cold climate processes and the role of the cryosphere in climate variability and issue a relevant statement.

(ii) The second ACSYS science conference on "Polar Processes and Global Climate" (November 1997) should provide input from the broader polar/cryospheric community. Its results would be considered by the ACSYS SSG immediately following the Conference.

(iii) The WMO/ICSU/IOC Joint Scientific Committee (JSC) for WCRP should decide, at its nineteenth session (1998), how to integrate cryospheric components of the climate system in a smooth manner into existing WCRP programmes without disrupting successful structures.

JSC-XVIII (March 1997) reviewed and endorsed the findings of the Cambridge meeting. The Committee agreed that a project entitled "Cold Climate Processes" or "Cold Regions/Climate Interactions (CReCI)" might be a more suitable framework for WCRP research on cryosphere and climate than the "Role of the Cryosphere in Climate".

ANNEX 20 - Acronyms and Abbreviations

ACC	Anthropogenic Climate Change
ACFM	Advisory Committee on Fisheries Management (of ICES)
ACSYS	Arctic Climate System Study
ANTIME	Antarctic Ice Margin Evolution
AOSB	Arctic Ocean Science Board
ASI	Advanced Study Institute
ASPECt	Antarctic Sea Ice Processes, Ecosystems and Climate
ATOC	Acoustic Thermometry of Ocean Climate
BASS	Basin Studies (of CCCC)
BEP	Benguela Ecology Program
CALCoFI	California Cooperative Fisheries Investigation
CCAMLR	Commission on the Conservation of Antarctic Marine Living Resources
CCC	Cod and Climate Change Program
CCCC	Climate Change and Carrying Capacity
CDIAC	Carbon Dioxide Data and Information Center
CFC	Chlorofluorocarbon
CLIVAR	Climate Variability and Predictability
CMAS	Confédération des Activités Subaquatiques
CMIP	Coupled Model Intercomparison Experiment
COADS	Comprehensive Ocean-Atmosphere Data Set
DAC	Data Analysis Center
DecCen	Decadal to Centennial time scales
DMS	Dimethylsulfide
DOVETAIL	Deep Ocean Ventilation Through Antarctic Intermediate Layers
DSDP	Deep Sea Drilling Program
EASIZ	Ecology of the Antarctic Sea Ice Zone
ECMWF	European Centre for Medium Range Weather Forecasting
ECOHAB	A US program on the Ecology and Oceanography of Harmful Algal Blooms
ECOR	Engineering Committee on Oceanic Resources
ERS	Earth Remote Sensing (satellite)
ESA	European Space Agency
FCCC	Framework Convention on Climate Change
GCM	Global Coupled Model
GCOS	Global Climate Observing System
GEBCO	General Bathymetric Chart of the Ocean
GESAMP	Group of Experts of the Scientific Aspects of Marine Environmental Protection
GEWEX	Global Exchange of Water Experiment
GIWA	Global International Waters Assessment
GLOBEC	Global Ocean Ecosystem Dynamics
GLOCHANT	Global Change in Antarctica
GODAE	Global Ocean Data Assimilation Experiment
GOEZS	Global Ocean Euphotic Zone Study
GOOS	Global Ocean Observing System
GSFC	Goddard Space Flight Center
HAB	Harmful Algal Blooms
HNLC	High Nutrient - Low Chlorophyll
IABO	International Association of Biological Oceanography
IAMAS	International Association of Meteorology and Atmospheric Sciences
iAnZone	International Antarctic Zone
IAPSO	International Association for the Physical Sciences of the Ocean

ICES	International Council for the Exploration of the Sea
ICSOS	International Conference on Satellites, Oceanography and Society
ICSU	International Council of Scientific Unions
IGAC	International Global Atmospheric Chemistry program
IGBP	International Geosphere-Biosphere Program
IGFA	International Group of Funding Agencies for Global Change Research
IHO	International Hydrographic Organization
IMAGES	International Marine Aspects of Global Change program
IMO	International Maritime Organization
INQUA	International Quaternary Association
InterRidge	International RIDGE studies
IOC	Intergovernmental Oceanographic Commission
IOCCG	International Ocean Colour Coordinating Group
IPCC	Intergovernmental Panel on Climate Change
IPHAB	Intergovernmental Panel on Harmful Algal Blooms
IPO	International Project Office
IRONEX	Iron Fertilization Experiment
ISRS	International Society for Reef Studies
IUCN	International Union for the Conservation of Nature
IUGG	International Union of Geodesy and Geophysics
IUPAC	International Union of Pure and Applied Chemistry
IUPAP	International Union of Pure and Applied Physics
IUTAM	International Union of Theoretical and Applied Mathematics
IWCO	Independent World Commission on the Oceans
J-GOOS	Joint Scientific and Technical Committee for GOOS
JGOFS	Joint Global Ocean Flux Study
JGR	Journal of Geophysical Research
JSC	ICSU/WMO/IOC Joint Scientific Committee for the WCRP
LME	Large Marine Ecosystems
LOICZ	Land-Ocean Interactions in the Coastal Zone
MIP	Model Intercomparison Experiment
MPA	Marine Protected Area
NAO	North Atlantic Oscillation
NASA	US National Aeronautic and Space Agency
NATO	North Atlantic Treaty Organization
NEG	Numerical Experimentation Group
NOAA	US National Oceanic and Atmospheric Administration
ODP	Ocean Drilling Program
OOPC	Ocean Observations Panel for Climate
PAGES	Past Global Changes
PI	Principal Investigator
PICES	North Pacific Marine Sciences Organization
PML	Plymouth Marine Laboratory
REX	Regional Experiments (of CCCC)
RIDGE	Mid-Ocean Ridge Interdisciplinary Studies
SAC	Special Analysis Center
SAHFOS	Sir Alistair Hardy Foundation for Ocean Science
SCAR	Scientific Committee on Antarctic Research
SCOPE	Scientific Committee on Problems of the Environment
SCOR	Scientific Committee on Oceanic Research
SICB	Society for Integrative and Comparative Biology
SMIP	Seasonal Model Intercomparison Experiment

SOLAS	Surface Ocean - Lower Atmosphere Study
SOO	Ship of Opportunity
SOOP	Ship of Opportunity Program
SOPG	Southern Ocean Planning Group
SPACC	Small Pelagic Fishes and Climate Change
SSC	Scientific Steering Committee
SSG	Scientific Steering Group
TEMA	Training, Education and Mutual Assistance
TOGA	Tropical Ocean - Global Atmosphere
TOS	The Oceanography Society
TWAS	Third World Academy of Sciences
ULS	Upward Looking Sonar
UNCED	United Nations Conference on Environment and Development
UNEP	United Nations Environment Program
UNESCO	United Nations Educational, Scientific and Cultural Organization
URSI	Union Radio Scientifique Internationale
VOS	Voluntary Observing Ship
WCRP	World Climate Research Program
WG	Working Group
WHP	WOCE Hydrographie Program
WMO	World Meteorological Organization
WOCE	World Ocean Circulation Experiment
WWF	World Wildlife Fund
WWW	World Wide Web
XBT	Expendable Bathythermograph