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**IMO / FAO / UNESCO / WMO / WHO / IAEA / UN / UNEP
JOINT GROUP OF EXPERTS ON THE SCIENTIFIC ASPECTS
OF MARINE POLLUTION
- GESAMP -**

REPORTS AND STUDIES

No. 44

1991

**Report of the
Twenty-first Session
London, 18-22 February 1991**



WORLD HEALTH ORGANIZATION

**IMO/FAO/Unesco/WMO/WHO/IARA/UN/UNEP Joint Group of Experts
on the Scientific Aspects of Marine Pollution (GESAMP)**

REPORT OF THE TWENTY-FIRST SESSION

London, 18-22 February 1991

WHO, 1991

NOTES

- 1 GESAMP is an advisory body consisting of specialized experts nominated by the Sponsoring Agencies (IMO, FAO, Unesco, WHO, WHO, IAEA, UN, UNEP). Its principal task is to provide scientific advice on marine pollution problems to the Sponsoring Agencies and to the Intergovernmental Oceanographic Commission (IOC).
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Definition of marine pollution by GESAMP:

"POLLUTION MEANS THE INTRODUCTION BY MAN, DIRECTLY OR INDIRECTLY, OF SUBSTANCES OR ENERGY INTO THE MARINE ENVIRONMENT (INCLUDING ESTUARIES) RESULTING IN SUCH DELETERIOUS EFFECTS AS HARM TO LIVING RESOURCES, HAZARDS TO HUMAN HEALTH, HINDRANCE TO MARINE ACTIVITIES INCLUDING FISHING, IMPAIRMENT OF QUALITY FOR USE OF SEAWATER AND REDUCTION OF AMENITIES."

* * *

For bibliographic purposes, this document should be cited as:

GESAMP - IMO/FAO/Unesco/WHO/WHO/IAEA/UN/UNEP Joint Group of Experts on the Scientific Aspects of Marine Pollution (GESAMP): Report of the twenty-first session. London, 18-22 February 1991. Rep. Stud. GESAMP no.44. 53 p.p. 1991.

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**GESAMP XXI
(18-22 February 1991)**

REPORT

1 INTRODUCTION

1.1 The Joint Group of Experts on the Scientific Aspects of Marine Pollution (GESAMP) held its twenty-first session at the Headquarters of the International Maritime Organization (IMO), London, from 18 to 22 February 1991, under the Chairmanship of Mr. D. Calamari. Mr. J. Gray was Vice-Chairman of the session.

Opening of the session

1.2 Mr. K. Voskresensky, Director of the Marine Environment Division of IMO, welcomed the participants, noting that the session had originally been planned to be held at the WHO Regional Office for the Eastern Mediterranean in Alexandria (Egypt), from 17 to 21 February 1991. Due to unforeseen events, the session venue had been moved to IMO Headquarters.

1.3 Mrs. H. Galal-Gorchev, International Programme on Chemical Safety, WHO, welcomed the participants on behalf of the Director-General of the World Health Organization. She thanked the IMO Secretariat for the assistance provided in making available meeting facilities and secretarial services for the twenty-first session of the Group. In addressing the genuine interests of WHO in marine pollution issues, Mrs. Galal-Gorchev confirmed that support would continue to be provided in the future. In particular, the chemical contamination of edible marine organisms is an issue with far-reaching consequences. Finally, Mrs. Galal-Gorchev wished the Group every success at this session.

1.4 The Chairman thanked Mrs. Galal-Gorchev on behalf of the participants for her good wishes for the success of the session.

Adoption of the agenda

1.5 The agenda for the session as adopted by the Group is given in Annex I. The list of documents submitted to the session is given in Annex II. The list of participants is shown in Annex III.

2 STATE OF THE MARINE ENVIRONMENT

2.1 The Group discussed issues to be included in its assessment of the state of the marine environment. The text of a statement agreed by GESAMP is as follows:

REASSESSMENT OF THE STATE OF THE MARINE ENVIRONMENT: 1991

"GESAMP reaffirms the overall conclusions of its most recent review of the 'State of the Marine Environment' (GESAMP Reports and Studies No.41, section 2).

Marine pollution is primarily linked to coastal development. The most serious problems are those associated with inadequately controlled coastal development and intensive human settlement of the coastal zone. GESAMP emphasizes the importance of the following problems and issues:

In the coastal zone:

- major habitat disruption by physical development and increased sediment mobilization;
- changes to coastal ecosystems caused by enhanced nutrient inputs from both terrestrial and atmospheric sources, though the detailed linkage between nutrient inputs, algal blooms and ecosystem changes is not clearly understood;
- increased threats to human health associated with indiscriminate municipal waste discharges;
- changes in global climate and rapid growth of coastal populations will accentuate the extent and slow the resolution of coastal zone management problems;
- increased extent of anoxia events in poorly flushed coastal marine areas;
- increased human health impacts of phycotoxins;
- scientific knowledge does not yet allow us to quantify the concerns associated with the widespread dissemination of persistent and bioaccumulative xenobiotics;
- oil releases to the marine environment associated with shipping have decreased over the last decade;
- oil releases to the marine environment from land are becoming of increasing concern, but the effects of these discharges are yet to be quantified;
- the data on consumption of carcinogens via marine fish and shellfish are reassuring for many of the substances considered at normal levels of consumption and contamination, but at higher levels of consumption and contamination some substances, particularly PAH's, may increase the risk to human health;
- there is no basis for concern for the survival of marine fish populations, even at local levels, from carcinogens in the marine environment.
- there have been substantial socio-economic benefits arising from the expansion of coastal aquaculture, which in some coastal regions, has caused significant ecological changes.

At a global scale:

- due to changes in stratospheric ozone, small UV-B radiation increases in the tropics but greater increases at high latitudes in the southern hemisphere have occurred; and
- there are considerable quantitative uncertainties in the estimates of present and future sea/air exchange of CO₂.

GESAMP considers that existing pollution control measures need to be more rigorously and consistently applied.

GESAMP recognizes that many of the mitigation measures necessary to address these problems involve management actions and decisions affecting areas at some distance from the marine environment.

GESAMP advocates an integrated approach to marine environmental management which includes consideration of different environmental sectors and incorporates economic, social, scientific and technological considerations to provide balanced decision-making in achieving sustainable development. To this end a comprehensive framework for the assessment and regulation of waste disposal in the marine environment has been developed."

The Gulf war and its effects on the environment

2.2 In view of the Gulf war and its effects on the environment, a representative from IMO and the UNEP Technical Secretary of GESAMP informed the Group of the situation and relevant events.

2.3 IMO informed the Group of its efforts concerning the oil spill in the Gulf. IMO, at the request of the Government of Saudi Arabia and other governments in the Gulf region, and pursuant to the International Convention on Oil Pollution Preparedness, Response and Co-operation, had taken prompt action to co-ordinate offers of international assistance made in response to the oil spill. It had established a co-ordination centre at its headquarters which was liaising with the Saudi Arabian Meteorological and Environmental Protection Administration (MRPA) and with other governments in the region and around the world, offering their assistance. The Co-ordinating Centre provided a clearing house that collated specific offers of assistance received. The Group was further informed of action taken, current position and state of the spill as well as of IMO's published first issue of the Gulf spill information bulletin.

2.4 The UNEP Technical Secretary informed the Group of the Inter-Agency Consultation on Environmental Consequences of the Gulf War (Geneva, 5-6 February 1991) which was convened by the Executive Director of UNEP and attended by representatives of FAO, IAEA, IMO, IOC/UNESCO, UNCED, UNDP, UNDRO, UNEP, WHO, WMO, IUCN and ROPME. The Consultation considered the current Gulf oil spill problem and noted with interest IMO's action on the spill. Other potential environmental impacts including the problems of oil fires and chemical, biological and nuclear contaminants were addressed. In addition, UNEP was asked to co-ordinate the development of the long-term action plan which addresses in a holistic and co-ordinated way the potential long-term ecological consequences on the terrestrial, coastal and marine environment. Such a plan is to include both provisions for a long-term monitoring programme and the means of its implementation. Also urgent need was expressed to support the Kuwait Action Plan of 1978 through the revitalization of its Regional Organization for the Protection of the Marine Environment (ROPME) and Marine Emergency Mutual Aid Centre (MEMAC).

2.5 In response to the information given, the Group expressed its support for all action planned and undertaken.

3 COMPREHENSIVE FRAMEWORK FOR THE ASSESSMENT AND REGULATION OF WASTE DISPOSAL IN THE MARINE ENVIRONMENT

Global strategies for marine environmental protection

3.1 The IMO Technical Secretary recalled that GESAMP at its nineteenth session (Athens, 8-12 May 1989) established a working group to develop a common, comprehensive and holistic framework for the regulation of waste inputs into the sea. It was noted that GESAMP at its twentieth session reviewed the progress of the Working Group and provided specific guidance on the approach that the Working Group should take.

3.2 The Chairman of the Working Group, Mr. R. Boelens, introduced the report of the Working Group and highlighted its main conclusions and recommendations. The Chairman informed the Group that the second meeting had been held from 17 to 21 September 1991 to prepare, as instructed by GESAMP XX, a substantially-completed draft report for consideration by GESAMP at its twenty-first session. An editorial group met from 10-14 December 1990 to finalize the document.

3.3 Several members of the Group commented on the report, generally expressing satisfaction with the approach while offering specific comments on areas that should be improved.

3.4 Some reservations were expressed regarding the anthropocentric versus ecocentric focus of the document, the analysis of international protocols and agreements on marine pollution prevention, and whether the document would be of use to developing countries.

3.5 A small group of experts was convened to prepare modifications to the report. The revised text was endorsed by the Group for publication as GESAMP Reports and Studies No.45. The conclusions of the study are reproduced in Annex IV.

Review of the GESAMP definition of "marine pollution" and the changing role of GESAMP

3.6 GESAMP at its twentieth session had in general been receptive to a proposal to consider a revision of the GESAMP definition of marine pollution. It had agreed that further analysis of this issue should be undertaken jointly by Mr. J. M. Bowers and Mr. R. G. Boelens in conjunction with the work on global strategies for marine environmental protection.

3.7 The Group considered a document prepared in pursuance of the above mandate. It noted the criteria that were used in revising the definition and possible options for a new definition.

3.8 The Group noted that the sponsoring agencies in 1969 had developed and GESAMP had agreed to a working definition of marine pollution. The Stockholm Conference also adopted this definition in 1972. The definition has formed a framework and a constraint under which GESAMP had operated over the past 22 years. This definition deals with the introduction of substances into the marine environment with consequential adverse effects. However, it was noted

that in recent years there have been increasing requests for advice which had required the review of topics falling outside the existing definition of marine pollution.

3.9 After lengthy discussion the Group agreed that for a variety of reasons the definition should not be changed at this time. Although there was general understanding regarding the weaknesses of the existing definition of marine pollution, the Group considered that the options presented for the revision of the definition did not remedy its weaknesses and introduced other elements that could not be immediately resolved.

3.10 A discussion was held that focused not only on the definition of marine pollution, but also addressed the unresolved issues in marine environment protection as well as what the Group perceived to be the evolving role of GESAMP in the light of major developments within the United Nations, e.g. the forthcoming UN Conference on Environment and Development.

4 PREPARATIONS FOR THE 1992 UN CONFERENCE ON ENVIRONMENT AND DEVELOPMENT (UNCED)

4.1 Considering the broad significance of several recent activities of GESAMP, e.g. the preparation of the studies on the State of the Marine Environment and on Scientific Strategies for Marine Environmental Protection, the Group welcomed the opportunity afforded by the presence of the observer from the Secretariat for UNCED to be briefed on the main issues currently being dealt with by the Preparatory Committee for the Conference and the manner in which the necessary work is being conducted.

4.2 The observer stressed that because of its very purpose, viz. the linking of environment and development, the Conference will not only be concentrating on making linkages between the different subjects (e.g. oceans, hazardous wastes) and sectors (e.g. human settlements), but also between these and the cross-sectoral issues, viz. legal, institutional, financial and technological issues.

4.3 The outcome of the Conference is expected to consist of a basic document (a Charter); new legal instruments on global climate and biodiversity; and the outline of future work (an "Agenda 21"), specifying priorities, targets, costs, and institutional responsibilities and modalities.

4.4 The work needed for the agenda item "Oceans" is being handled by a special Working Party, consisting of the relevant UN agencies and organizations, as well as experts from other bodies. The forthcoming expert meeting on Land-Based Sources of Marine Pollution in May 1991 in Halifax, Canada, is part of the preparatory work on the Oceans item.

4.5 The UNCED observer expressed a strong interest in posing certain questions to GESAMP, so that its advice could be taken into account in finalizing the basic documents currently being prepared by the Working Party.

4.6 The Group proposed that one useful tool in response to the needs of UNCED would be to prepare a synthesis of the most important points arising from

previous GESAMP reports and studies. Arrangements were subsequently made to ensure a GESAMP input (See paragraph 8.1 below).

5 REVIEW OF POTENTIALLY HARMFUL SUBSTANCES

5.1 Carcinogenic substances

5.1.1 Mr. J. Portmann, Chairman of the sub-group on Carcinogenic Substances, presented to the Group the document "Carcinogens: Their Significance as Marine Pollutants". This document consists of two main components: one dealing with carcinogenic effects in marine fish and shellfish and the other one dealing with assessment of risks associated with exposure to carcinogenic substances in seafood. The document had been reviewed by the twentieth session of GESAMP and revised during the intersessional period to take into account the comments made at that session.

5.1.2 The Group agreed to the following:

- .1 the Executive Summary is to consist of the statement made on carcinogens as contained in the report of the twentieth session of GESAMP (Reports and Studies No.41);
- .2 certain amendments, mainly of an editorial nature, will be made to the document by the Chairman of the sub-group;
- .3 the document will then be sent for comments to GESAMP members and Technical Secretaries and a deadline for receipt of such comments specified;
- .4 comments received will be incorporated as appropriate, a final text prepared and sent for approval to GESAMP experts and Technical Secretaries; and
- .5 the document, if approved, is then to be published by WHO as GESAMP Reports and Studies No.46.

5.1.3 The conclusions of the report are shown in Annex V.

5.2 Mutagenic substances

5.2.1 Concerning the document on mutagens in the marine environment, the WHO Secretariat informed the Group that this was in the final stage of preparation. Due to unforeseen circumstances it had not been possible to finalize the document for this session, but it will be presented to the twenty-second session of GESAMP.

5.3 Teratogenic substances

5.3.1 Concerning teratogenic substances, the feasibility of a GESAMP evaluation has still to be verified. In this respect the Group welcomed the information given by the UNEP Technical Secretary that a document on "Assessment of the state of pollution of the Mediterranean Sea by carcinogenic/mutagenic/ teratogenic marine pollutants" was under preparation.

5.3.2 The Group will consider the feasibility of a GESAMP evaluation of teratogenic substances in light of the results of a study to be prepared by WHO, as well as the UNEP document mentioned above.

5.4 Organochlorine compounds

5.4.1 The FAO Technical Secretary of GESAMP recalled that at the twentieth session of GESAMP it was agreed that during the inter-sessional period the sub-group on organochlorine compounds should endeavour to prepare specific hazard profiles for individual substances which appeared to be of priority concern, based on quantities used and access to the marine environment. It was felt that, among others, UNEP Regional Seas Programmes might be in need of such hazard profiles. Accordingly, the agencies were approached for information but to date no specific requests had been received; consequently the sub-group did not meet during this inter-sessional period.

5.4.2 The Chairman of the sub-group, Mr. R. Lloyd, pointed out that his working group was still prepared to deal with specific hazard profiles where these were needed. On the other hand, reports could also be prepared on, for example, the group of PCBs or on the problem of chlorinated effluents from pulp and paper mills or from sewage outfalls, to highlight the variation in ecological importance of different organochlorine compounds. The Group added dioxins and toxaphenes to this list of alternative tasks.

5.4.3 During the discussion it was stressed again that the reason behind the establishment of this sub-group of Working Group No.13 was to challenge decisions taken by some governments and regional bodies to consider all organochlorine compounds to be of equal potential harm to the marine environment. It was therefore decided to repeat the request to the sub-group on organochlorine substances to prepare hazard profiles for some specific substances, based on perceived concerns substantiated by information of extent of use and estimated loads in specific water bodies. In this context it was suggested that the Paris Commission should be approached for information on organochlorines discharged to estuaries and coastal waters. Agencies and members of the Group were again invited to pass relevant information to the chairman of the sub-group in due course.

5.5 Impact of oil, individual hydrocarbons, and related chemicals on the marine environment, including used lubricating oils, oil spill control agents and chemicals used offshore

5.5.1 The IMO Technical Secretary recalled that GESAMP at its nineteenth session agreed that a study should be prepared on the major new facts pertaining to marine pollution by petroleum oils, used lubricating oils, chemicals used in offshore exploration and exploitation and spill control agents. The IMO Technical Secretary further recalled that a report reflecting the outcome of the first meeting of the sub-group had been considered by GESAMP at its twentieth session, and that GESAMP expressed its expectation that it would consider the final draft of the report at its twenty-first session.

5.5.2 The Chairman of the sub-group, Mr. P. Wells, noted that his group met from 7 to 11 January 1991 and completed considerable parts of the draft report, including an Executive Summary. Several small sections needed to be completed and a thorough editorial and technical review made.

5.5.3 The Chairman introduced the Executive Summary of the report. Comments and suggestions made by the Group included the following:

- .1 an imbalance exists in that land-based sources are identified as the major input of oils to the marine environment, yet the report deals mainly with effects from marine-based inputs;
- .2 besides crankcase oils, available information on other lubricating oils and oil-based agents (cutting oils, hydraulic oils, degreasing agents) should be considered further, including estimates of their discharges into the sea;
- .3 a recommendation in the oil section should be made regarding allocation of resources for research needs versus methods to improve environmental protection (containment, response, etc.);
- .4 the report should evaluate whether the currently documented decreasing trend of input of oil into the marine environment is supported by information from the developing world;
- .5 North American and some European literature seems to be frequently cited; other references from Norway and developing countries need to be considered for inclusion;
- .6 the report should include a short section on the role of contingency planning and sensitivity mapping regarding oil spills;
- .7 the listing of dispersants may not be helpful and should be revised; the efficiency of various dispersants should be summarized;
- .8 several recommendations and statements in the Executive Summary would be strengthened if they were quantified;
- .9 the issue of recovery of ecosystems from the effects of spills needs clarification in terms of the length of time needed for recovery; and
- .10 the report could be strengthened with additional information on oil effects in tropical and semi-tropical areas.

5.5.4 The Chairman of the sub-group noted the constructive comments and made a request that GESAMP members and Technical Secretaries provide additional information on land-based sources of oil and effects of oil on tropical and semi-tropical environments. He further stressed that the report would be finalized in 1991 and submitted for approval at GESAMP XXII.

5.5.5 A summary of the report is shown in Annex VI.

6 ENVIRONMENTAL IMPACTS OF COASTAL AQUACULTURE

6.1 The Secretary of the Working Group on Environmental Impacts of Coastal Aquaculture, Mr. U. Barg, informed the Group on the preparation of the report of the first session of the Working Group.

6.2 A preparatory meeting took place in Rome (25-26 September 1990) where the scope and the structure of the document were discussed between the Chairman of the Working Group, Mr. Chua Tnia-Eng, a member of the Working Group and the FAO Secretariat. The Working Group then met in Kiel, Germany, from 7 to 11 January 1991.

6.3 Mr. Chua presented the report of the Working Group entitled "Reducing Environmental Impacts of Coastal Aquaculture". He pointed out that the purpose of this document was to provide guidance towards environmentally acceptable development of coastal aquaculture, particularly as taking place in developing countries. He stated that the strategies and actions recommended by the Working Group should be considered as operational steps towards the integration of coastal aquaculture development efforts into coastal zone management plans. These guidelines were worked out by analyzing the ecological impacts of coastal aquaculture developments and the implications on human health as well as considering relevant socio-economic issues. However, it was emphasized that there was a lack of background information in the various areas on human health and environmental valuation, particularly pertaining to conditions prevailing in developing countries.

6.4 The Group generally appreciated the report. Discussions by the Group focussed around issues related to the administrative designation of aquaculture sites. It was proposed that areas be defined for exclusive use by aquaculture operations. General limitations in the potentials for aquaculture development were also emphasized. Further comments were given as to the use of the terms eutrophication, hyper-nutrication as well as carrying and holding capacities.

6.5 After inclusion of the amendments proposed by the Group, the report was approved for publication as GESAMP Reports and Studies No.47. A summary of the report is shown in Annex VII.

6.6 The Chairman of the Working Group also presented recommendations for future work of the Working Group, i.e.:

- .1** the preparation of a comprehensive review on viral, bacterial and parasitic human diseases associated with coastal aquaculture operations, covering potential health risks, prophylactic measures and hygienic surveillance schemes;
- .2** the establishment of monitoring procedures for aquaculture-specific pollutants leading to the assessment of the environmental capacity of aquaculture operations;
- .3** the formulation of guidelines for the safe use of chemicals in coastal aquaculture based on drug-specific information, including mode of use, drug withdrawal times and environmental fate; and

- .4 the formulation of a preliminary aquaculture-specific contingency plan for red-tide outbreaks.

6.7 The Group felt that the areas for future work could not be covered within the next intersessional period. The WHO Secretariat will give support to Mr. Chua, by providing background information as to the potential human health risks and safety of aquaculture products (recommendation .1). Close collaboration will be established with the FAO/WHO expert groups on food additives and pesticide residues, as related to the use of chemicals in coastal aquaculture (recommendation .3). Recommendations .2 (monitoring of aquaculture-specific pollutants) and .4 (phycotoxin occurrence and management of red tide outbreaks) will be further followed up by the Chairman. Mr. Chua was requested to approach experts in the respective areas for the preparation of a scoping document on the feasibility of undertaking the above recommended activities for submission to the next session of GESAMP.

7 GLOBAL CHANGE AND THE AIR/SEA EXCHANGE OF CHEMICALS

7.1 The WMO Technical Secretary recalled that the Working Group on Global Change and the Air/Sea Exchange of Chemicals had been established at the twentieth session of GESAMP in 1990. The terms of reference of the Working Group as determined by GESAMP XX were also reiterated. To fulfil its tasks the Working Group met from 17 to 21 December 1990 at the University of Rhode Island, USA and the draft report submitted to the present session was prepared before the middle of January 1991. It was noted that the work on the report was being continued to include additional comments both from GESAMP members and outside experts, and if the draft report was approved in principle by GESAMP, it would be finalized later in 1991.

7.2 The Chairman of the Working Group introduced the report. The report addressed the following issues:

- global change and the air-sea exchange of the nutrients nitrogen and iron;
- global change and the air-sea exchange of gases (mainly carbon dioxide and dimethyl sulphide); and
- responses of the oceanic system to radiative and oxidative changes in the atmosphere.

7.3 During the discussion it was pointed out that the conclusions to Chapter III were somewhat incomplete in relation to the potential impacts of physical and chemical changes in the sea/surface layer caused by CO₂ changes on the marine ecosystems, and in relation to the role of marine biological processes in CO₂ exchange across the air/sea interface. It was also pointed out that Δ pCO₂ at ice edges in polar regions might be much higher than in other regions and that the importance of this effect should be noted.

7.4 With regard to Chapter IV, the opinion was expressed that it needed clarification and improved organization. It was suggested that discussion of the types of impact on biota by increasing UV-B radiation be expanded and that there be a discussion on the residence time of plankton at various vertical levels in the ocean. It was also suggested that a wavelength attenuation curve for UV-B in sea water be introduced into Section IV.C to allow a more informative evaluation of the implications of the dependence of primary production on the total dose of UV-B radiation.

7.5 The Group approved the report and recommended that it be published as GESAMP Reports and Studies No.48. It was agreed that the members of GESAMP should submit their additional comments on the report by the end of April 1991 and the Working Group was requested to finalize the report at a small meeting in summer of 1991.

7.6 A summary of the report is given in Annex VIII.

8 FUTURE WORK PROGRAMME

8.1 Preparatory work for UNCED

The Group recalled that the observer from the UNCED Secretariat had asked for advice on a number of questions which would assist in the preparatory work for UNCED (see paragraphs 4.5 and 4.6 above), and agreed that a small ad hoc group comprised of the Chairman and members of GESAMP should meet following the Intergovernmental Meeting of Experts on Land-based Sources of Marine Pollution (Halifax, Canada, 6-10 May 1991). The ad hoc group would prepare responses and collate material on the questions and problem issues that will be introduced by the UN Technical Secretary of GESAMP. The results of the ad hoc group meeting will be distributed to all GESAMP members asking for additional comments, and then submitted to the UNCED Secretariat. The Chairman will present the findings of the Group to meetings of the UNCED working party on oceans.

8.2 Impacts of anthropogenically mobilized sediments in the coastal environment

8.2.1 The Unesco Technical Secretary informed the Group of the activities carried out during the intersessional period with regard to "impacts of anthropogenically mobilized sediments in the coastal environment" (Working Group No.30). A revised questionnaire had been distributed and the replies strengthened the conclusion that anthropogenically derived sediments pose a severe problem to many coastal States. Problems are most acute in Asia, Oceania and probably South America and Africa. However, data are still lacking or inadequate from the most critical areas.

8.2.2 The Group further noted that it is planned to hold an IOC-WESTPAC Workshop during autumn 1991 in Thailand or Malaysia on River Input of Nutrients to the Marine Environment in the WESTPAC Region, addressing questions which are closely related to the problems of anthropogenically mobilized sediments. The Chairman of the Working Group, Mr. J. Gray, therefore proposed that a meeting of his Working Group be convened after the IOC-WESTPAC Workshop.

8.2.3 The Group agreed to this proposal. The terms of reference of the Working Group were confirmed as adopted at the nineteenth session of GESAMP (Athens, 1989) as follows:

- .1 to evaluate the geographic extent and distribution of problems resulting from anthropogenically mobilized sediments in the world's coastal zones;
- .2 to review and assess available data on the volumes and fluxes of sediments in coastal zones, resulting from natural and human activities, including sediment starvation;
- .3 to review the causes of anthropogenic sediment flux by geographic area and/or country, as appropriate;
- .4 to evaluate the impacts of anthropogenically mobilized sediments in the coastal and nearshore environments;
- .5 to identify inadequacies in the existing data and make recommendations for action in the implementation of future national and regional research and monitoring programmes;
- .6 to assess the economic costs of anthropogenically caused sedimentation in coastal zones;
- .7 to evaluate the efficacy of measures currently employed to control problems caused by sediments in coastal areas;
- .8 to recommend policies and courses of action for handling the problems at both the national/international level; and
- .9 to identify any aspects of the above items which might be applicable to sea-bed areas beyond the coastal nearshore zone.

8.3 Indicators of marine ecosystem health

8.3.1 The Chairman informed the Group of a proposal received from a GESAMP member concerning the need to elaborate "marine environmental quality criteria", and their application in marine environmental management.

8.3.2 Several members of GESAMP supported the proposal. The Technical Secretaries of UNEP, FAO and Unesco expressed the interest of their Organizations that such work be initiated.

8.2.3 The Group agreed that a small group of GESAMP members should meet before GESAMP XXII to prepare a feasibility study or scoping document on "indicators of marine ecosystem health" for submission to the Group, taking into account the results of Working Group 27 (Long-term consequences of low-level contamination of the marine environment), Working Group 28 (Scientifically-based strategies for marine environmental protection and management) and Working Group 29 (Comprehensive framework for the assessment and regulation of waste disposal in the marine environment). The Group requested its Vice-Chairman, Mr. J. Gray, to act as rapporteur of the

meeting. He will, in co-operation with the sponsoring agencies, select members of GESAMP who he wishes to participate in the preparation of the preliminary study.

8.4 Intersessional work

Taking into account the decisions of the Group, intersessional work will be carried out in the framework shown below. The Organizations supporting the intersessional work, as well as the members of the Group participating in it, are listed as agreed by the intersecretariat meeting of agencies sponsoring GESAMP.

1 Evaluation of the hazards of harmful substances carried by ships (Working Group 1)

Lead agency:	IMO	Co-sponsor:	UNEP
Chairman:	W. Ernst	GESAMP member:	P. Wells

A meeting of the Working Group will be convened 8-12 April 1991 to:

- evaluate substances listed in the International Maritime Dangerous Goods (IMDG) Code, in particular class 3 (flammables);
- evaluate solid bulk cargoes transported by ships;
- evaluate hazards to the marine environment caused by copper compounds used in anti-fouling paints;
- review bioaccumulation and tainting ratings of the existing hazard profiles.

2 Review of potentially harmful substances (Working Group 13)

Lead agency:	Unesco	Co-sponsors:	UNEP, FAO, WHO, IMO
Chairman:	L. Landner		

2.1 carcinogenic substances (sub-group)

Lead agency:	Unesco	Co-sponsors:	WHO, FAO, IMO
Chairman:	J. Portmann		

The chairman will finalize the study in light of comments made by GESAMP XXI. After approval by GESAMP members during the intersessional period, the report will be published.

2.2 mutagenic substances (sub-group)

Lead agency:	WHO	Co-sponsors:	UNEP, Unesco, IMO
Chairman:	F. Würigler		

Preparation of an extended review paper on mutagenic substances by the chairman to be evaluated by GESAMP members during the intersessional period and completed by correspondence.

2.3 teratogenic substances (sub-group)

Lead agency: WHO Co-sponsors: UNEP, Unesco, IMO

Preparation of a feasibility study by WHO.

2.4 chlorinated hydrocarbons (sub-group)

Lead agency: FAO Co-sponsors: UNEP, Unesco
Chairman: R. Lloyd GESAMP members: D. Calamari, L. Landner

Preparation of study on organochlorine compounds selected by the chairman on the basis of material to be submitted by sponsoring agencies and members of GESAMP. A meeting will be held in autumn 1991, pending the availability of background material.

2.5 oil and other hydrocarbons, including used lubricating oils, oil spill dispersants and chemicals used in offshore exploration and exploitation (sub-group)

Lead agency: IMO Co-sponsors: UNEP, FAO, Unesco
Chairman: P. Wells

After outside review of the draft paper a meeting of the sub-group will be convened from 4 to 8 November 1991 to finalize the study.

3 Comprehensive framework for the assessment and regulation of waste disposal in the marine environment (Working Group 29)

Lead agency: IMO Co-sponsors: UN, UNEP, Unesco, IAEA
Chairman: R. Boelens GESAMP members: J.M. Bowers, R. Lloyd,
P. Tortell and P. Wells

The meeting of a small group will be convened in late 1991 to prepare a short document based on the study adopted by GESAMP XXI, addressing the questions raised by the Inter-Governmental Panel of Experts on Radioactive Waste Disposal at Sea.

4 Impacts of anthropogenically mobilized sediments in the coastal environment (Working Group 30)

Lead agency: Unesco Co-sponsors: UN, UNEP, FAO, IMO
Chairman: J. Gray GESAMP members: J. Pernetta, H. Windom

After the IOC-WESTPAC Workshop on River Input of Nutrients in Thailand or Malaysia in November 1991, a GESAMP working group meeting will be arranged to prepare a report for GESAMP XXII.

5 Environmental impacts of coastal aquaculture (Working Group 31)

Lead agency: FAO Co-sponsors: UNEP, Unesco, WHO
Chairman: Chua Thia-Eng GESAMP member: P. Tortell

Preparation by the chairman of the sub-group of a scope paper/feasibility study on proposed future work on "reducing environmental impacts of coastal aquaculture".

6 Global change and the sea/air exchange of chemicals (Working Group 32)

Lead agency: WHO **Co-sponsors:** UNEP, Unesco
Chairman: R. Duce

An editorial group will meet in summer 1991 to prepare the final report.

7 Activities in preparation for UNCED

Lead agency: UN **Co-sponsors:** UNEP, FAO, Unesco, WHO,
Chairman: D. Calamari **WHO, IMO, IAEA**

Meeting of a small ad hoc group (4-5 experts) from 11 to 13 May 1991 following the Intergovernmental Meeting of Experts on Land-based Sources of Marine Pollution, Halifax, Canada, to prepare material in response to issues raised by the UNCED Secretariat concerning scientific aspects of marine protection.

8 Indicators of marine ecosystem health

Lead agency: UNEP Co-sponsors: UN, FAO, Unesco, WHO,
Rapporteur: J. Gray WHO, IMO, IAEA

Meeting of a small ad hoc group (5-6 experts) on 7 and 8 March 1992 preceding GESAMP XXII at IAEA Headquarters, Vienna, Austria, to prepare a feasibility study on work related to the development of indicators of marine ecosystem health.

9 OTHER MATTERS

Future assessments of the state of the marine environment

7.1.1 The Group considered a mechanism on how to facilitate the future preparation of short annual statements on the State of the Marine Environment. The Group had been requested at the nineteenth session of GESAMP to prepare such statements at its annual sessions under a standing item of the agenda.

9.1.2 The Group agreed that each member should during the intersessional period review the current situation and prepare a list of issues that he or she feels to be appropriate for inclusion in a statement. This should be supported by background information, highlighting the sources, causes, significant effects, and actions that might be necessary to mitigate effects and potential damage.

9.1.3 The Chairman undertook to co-ordinate the collation of the material and the preparation of a statement during GESAMP sessions.

10 DATE AND PLACE OF NEXT SESSION

The Group noted that the twenty-second session of GESAMP will be hosted by the International Atomic Energy Agency (IAEA) and held at IAEA Headquarters, Vienna, from 9 to 13 March 1992.

11 ELECTION OF CHAIRMAN AND VICE-CHAIRMAN

The Group unanimously re-elected Mr. D. Calamari as Chairman and Mr. J. Gray as Vice-Chairman for the next intersessional period and for the twenty-second session of GESAMP.

12 CONSIDERATION AND APPROVAL OF THE REPORT OF THE TWENTY-FIRST SESSION

12.1 The draft report of the twenty-first session of the Group was considered by the Group on the last day of the session and was approved with amendments as reproduced in this document. It contains, in Annexes IV to VIII, summaries or conclusions of reports prepared by the Working Groups and their sub-groups. This material is included for information only and was not considered by the Group with a view to approval. The Terms of Reference of the Working Groups and lists of members or contributors are also provided in the Annexes.

12.2 The twenty-first session of GESAMP was closed by the Chairman of the Group at 12.15 p.m. on 22 February 1991.

ANNEX I

AGENDA

- 1 Adoption of the provisional agenda
- 2 State of the marine environment
- 3 Comprehensive framework for the assessment and regulation of waste disposal in the marine environment
- 4 Information on preparations for the United Nations Conference on Environment and Development
- 5 Review of potentially harmful substances:
 - .1 Carcinogenic substances
 - .2 Mutagenic substances
 - .3 Teratogenic substances
 - .4 Organochlorine compounds
 - .5 Oil, and other hydrocarbons including used lubricating oils, oil spill dispersants and chemicals used in offshore oil exploration and exploitation
- 6 Environmental impacts of coastal aquaculture
- 7 Global change and the air/sea exchange of chemicals
- 8 Future work programme
- 9 Other matters
- 10 Date and place of next session
- 11 Election of Chairman and Vice-Chairman
- 12 Consideration and approval of the report of the twenty-first session

ANNEX II

LIST OF DOCUMENTS

Agenda item	Document	Submitted by	Title
1	GESAMP XXI/1/Rev.1	Administrative Secretary	Provisional agenda
2	GESAMP XXI/2	Chairman	State of the marine environment
3	GESAMP XXI/4	IMO	Comprehensive framework for the assessment and regulation of waste disposal in the marine environment
	GESAMP XXI/4/1	J.M. Bewers and R.G. Boelens	Options for the revision of the GESAMP definition of marine pollution
5.1	GESAMP XXI/7/1	WHO	Carcinogens - their significance as marine pollutants
5.3	GESAMP XXI/7/3	IMO	Impact of oil, individual hydrocarbons, and related chemicals on the marine environment, including used lubricating oils, oil spill control agents and chemicals used offshore - Progress of work
	GESAMP XXI/7/3/1	IMO	Ditto - Preliminary report
6	GESAMP XXI/8	FAO	Reducing environmental impacts of coastal aquaculture
	GESAMP XXI/8/Add.1	FAO	Environmental impacts of coastal aquaculture - recommendations for future work
7	GESAMP XXI/9	WHO	Global change and the air/sea exchange of chemicals
9	GESAMP XXI/11	Unesco	Report of the Working Group on impacts of anthropogenically derived sediments in the coastal environment

Agenda item	Document	Submitted by	Title
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<u>Information documents</u>			
	GESAMP XXI/INF.1	Administrative Secretary	Members of GESAMP
	GESAMP XXI/INF.2	Administrative Secretary	List of documents
	GESAMP XXI/INF.3	UN	Extracts from the Annual Report on the Law of the Sea to the forty-fifth session of the UN General Assembly (A/45/721)

ANNEX III

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ANNEX IV

GLOBAL STRATEGIES FOR MARINE ENVIRONMENT PROTECTION

Report of the Working Group on a Comprehensive Framework for the Assessment and Regulation of Waste Disposal in the Marine Environment (Working Group No.29)

The Working Group met from 17 to 21 September 1990 under the chairmanship of Mr. R. G. Boelens (Ireland). The conclusions of the report prepared by the Working Group are reproduced as follows:

"6 CONCLUSIONS

The analysis of existing international agreements for marine environmental protection reveals the piecemeal and unco-ordinated system of control strategies currently in place. The thesis of this document is that the parallel aims of further human development and environmental protection can only be satisfied through the adoption of an integrated and comprehensive management strategy, based on common principles, a single overall goal, and scientific methods.

6.1 Principles

The following principles, derived from the 1972 Stockholm Conference on the Human Environment, the Law of the Sea Convention and the Brundtland Report, should form the basis for comprehensive protection and management of the marine environment.

- .1 Sustainable development: Social and economic development must be pursued in a manner that does not prejudice options available to future generations for the use of the sea and its amenities.
- .2 Prevention of harm: All practical steps shall be taken to prevent, and correct, the harmful effects of anthropogenic activities on human health, on living resources, marine life, marine amenities and other legitimate uses of the sea.
- .3 Holistic considerations: Measures taken to mitigate harm, or to reduce the risks of harm, to the marine environment must not result in the transfer of, directly or indirectly, of damage or hazards to other sectors of the environment.
- .4 International co-operation: Co-operation among States, including the harmonization of protection measures, mutual exchange of information, co-ordination of monitoring and the provision of technical and financial assistance, is essential for achieving regional and global objectives for the preservation and protection of the marine environment.

6.2 Goal

The overall goal for protection and management of the marine environment should be:

To protect the marine environment and its amenities from the adverse effects of human activities and human development so as to safeguard human health and to preserve the resources and amenities of the marine environment for future generations.

A number of subordinate goals can be formulated to deal with various types of physical, chemical and biological modifications to the marine environment by man. Accordingly, an appropriate goal for the prevention of pollution by substances and wastes introduced to the marine environment would be:

To manage human activities and social and economic development in a manner that limits contamination of the marine environment by substances and wastes, thereby ensuring that the viability of marine ecosystems and the legitimate uses of the sea are sustained for the benefit of present and future generations.

6.3 Comprehensive and integrated (holistic) management

There is a need to manage all forms of human activity which potentially affect the marine environment, whether these occur at sea, in coastal areas, in the atmosphere, or in the hinterland of continents. It implies that management should aim for better integration of the design, as well as the implementation, of environmental protection measures. Accordingly:

Effective marine environmental protection requires the adoption of a global and holistic environmental protection strategy that deals with all sectors of the natural environment. This strategy should embody a common set of fundamental principles, goals and major policy elements.

A central theme of comprehensive and integrated management, implicit in the strategy presented here, is that where there are choices with regard to the location or environmental medium to be used for necessary development or waste disposal purposes, all identifiable options should be considered.

6.4 Essential Elements of Management and Science

GESAMP concludes that inadequate use of basic environmental management procedures, and a tendency to manage environmental sectors and practices separately, are indirectly responsible for much of the continued degradation of the environment. These deficiencies outweigh any existing inadequacies in national and international instruments for marine environmental protection. Thus, GESAMP specifically draws attention to the management framework depicted in Figure 1. It should be appreciated that this framework and the management processes it describes are continuous institutional functions and not functions that are triggered only by individual development proposals.

It should be evident that a number of management and scientific requirements are built into this framework. Most important among these are:

- .1 **Environmental planning:** There is a requirement for co-ordinated multi-sectoral planning of developments that have the potential to affect the marine environment. This should include the assignment of environmental goals and priorities, resource allocations, and the preparation of integrated management plans for all relevant environmental sectors.
- .2 **Environmental impact assessments:** All proposed developments and large-scale investments that are likely to have direct or indirect effects on the marine environment must be subject to a prior assessment. This assessment should encompass physical, chemical and biological changes, risks to human health, amenities and resources and, particularly, the benefits and detriments of the proposal to the satisfaction of environmental and development goals. Where transboundary impacts are likely to occur, notification and opportunities for consultation should be provided to the affected States.
- .3 **The need for precaution:** Precaution is integral to scientific risk assessment in that a pessimistic approach is essential to allow for uncertainties in measurements and calculations incorporated into predictions. Science should be used to resolve and reduce these uncertainties by providing accurate information on the relationship between the practice and its effect on marine resources. In this way, science is a component of environmental management. A further, and entirely complementary, use of precaution is to take all practical and economically feasible measures to minimize environmental contamination through inter alia good housekeeping and the application of efficient and low-waste technologies. Such approaches are the basis of a management system that protects the marine environment while providing for rational uses of the environment that are necessary for social and economic development.
- .4 **Acceptance of change:** Implicit in this framework is an acceptance that change is both a feature of the natural environment and an inevitable consequence of human activities and social development. Human intervention to limit and control such changes is therefore necessary and legitimate."

Terms of Reference

- 1 To analyse existing regulatory mechanisms, and their underlying concepts and principles, that are currently employed at both national and international levels, to protect the marine environment against the adverse effects of anthropogenic activities.
- 2 To determine the advantages, limitations and compatibility of these various mechanisms in terms of their practicality and effectiveness in protecting the environment on a sectoral and contaminant-specific basis and in providing a scientifically-defensible and holistic approach to pollution prevention.
- 3 To take account of experience with the assessment of environmental problems, and recent scientific advances in the field of hazard assessment, with a view to their application in a marine environmental management context.
- 4 To prepare a report synthesizing current pollution/prevention mechanisms, identifying the components and interrelationships of those frameworks best suited to harmonized implementation and, if deemed necessary, to specify a new framework for achievement of sustainable development and protection of the marine environment.

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ANNEX V

CARCINOGENS: THEIR SIGNIFICANCE AS MARINE POLLUTANTS

Report of the Working Group on the Review of Potentially Harmful Substances: Sub-Group on Carcinogenic, Mutagenic and Teratogenic Substances (Working Group No.13)

Summary

There have been many suggestions that cancers in fish and other marine organisms are commonplace and are attributable to chemical pollution. There is also concern that as a number of known carcinogens are accumulated by marine organisms that are commercially exploited as human food, they may as a result present a risk to man.

A critical review of the European and North American literature concerning cancer in fish and shellfish shows that, although there are indeed many reports of "cancers" and "precancerous" lesions in fish and shellfish, there is considerable evidence to suggest that due to improper use of terminology, some of the reports are erroneous or misleading. There is some evidence, especially from North America, that polycyclic aromatic hydrocarbons and a few other hydrocarbons may cause liver cancer in fish. However, there is very little unambiguous evidence to suggest that other cancers in fish are associated with chemical contaminants. Although the adverse effect on individual fish is undisputed, the review identifies no substantial basis for concluding that the cancer problem in fish is serious enough to prejudice the survival of exposed populations of the species affected, even at the local level.

From a human health standpoint, the review of available data on concentrations of a few organic chemicals and elements linked with cancer and known to be accumulated by marine organisms is rather reassuring. It shows that for most substances for which an assessment was made (cadmium, mercury, lead, arsenic and the pesticides: aldrin, dieldrin, DDT, chlordane, heptachlor and hexachlorocyclohexane) the consumption of seafood is unlikely to pose undue cancer risks.

For a few substances (nickel, PCB's and nitrosamines) no conclusion could be reached. In certain instances, polycyclic aromatic hydrocarbons in seafood could present an increased cancer risk.

Therefore, there is a need for continued vigilance and control over the disposal of known carcinogens into the environment. More research is necessary to establish cause and effect relationships between carcinogens and marine species. Thus far it is assumed that only chemicals which induce cancer in terrestrial mammals are likely to be the causative agent of cancers in marine organisms. This may or may not be correct.

The review suggests that discharges of carcinogens into the marine environment should be kept as low as possible, taking into account technical and economic circumstances. The present risk is small but the potential one is real enough to predicate the restrictions currently applied to carcinogens in general and particularly to those specifically identified in this review as potential carcinogenic agents.

Terms of Reference

The following general terms of reference adopted for Working Group No.13 apply for the work of the sub-group:

- 1 To prepare short referenced reviews on selected substances which include an assessment of the following factors:
 - (a) the total of particular substances which reach the marine environment (on a local, regional and global scale) with particular attention being given to the relative importance of land-based sources;
 - (b) the fate (transfer, distribution and transformation) of these substances in the marine environment;
 - (c) the effects of these substances on the marine environment and adjacent coastal areas, both direct and indirect, on living resources, human health and amenities.
- 2 To produce a scientific evaluation of the harmful effects of substances released into the marine environment on living resources, human health, aesthetics and other legitimate uses of the marine environment and adjacent coastal areas.

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ANNEX VI

IMPACT OF OIL, INDIVIDUAL HYDROCARBONS, AND RELATED CHEMICALS ON THE MARINE ENVIRONMENT, INCLUDING USED LUBRICATING OILS, OIL SPILL CONTROL AGENTS AND CHEMICALS USED OFFSHORE

Report of the Sub-Group on the Review of Potentially Harmful Substances: Sub-Group on Oil, and Other Hydrocarbons, Including Used Lubricating Oils, Oil Spill Dispersants and Chemicals Used in Offshore Oil Exploration and Exploitation (Working Group No.13)

Summary

1 The sub-group met under the chairmanship of Mr. P. Wells (Canada) from 7 to 11 January 1991. A description of the contents of the draft report is shown in the following paragraphs.

2 The draft report consists of six chapters plus the executive summary. The introduction to the report (Chapter 1) notes that the report updates the previous GESAMP (1977) review on oil and summarizes the significant new information and understanding of the past one and a half decades. The report covers composition, sources and inputs, fate in the marine environment, ecological and human health effects, and effects on man's use of the sea. The report addresses several key questions, pertaining to our degree of understanding, levels of marine impacts caused by hydrocarbons and related chemicals, present situation regarding the degree of pollution, recovery potential of marine systems exposed to these chemicals, new principles and concepts emerging from recent work, level of protection required for known vulnerable and sensitive marine ecosystems, and recommended research or other actions to fill gaps in knowledge.

3 Chapter 2 discusses oils and individual hydrocarbons and notes that the input of oil from anthropogenic sources into the marine environment has decreased continuously during the past three decades, largely due to measures required by international conventions on the prevention of marine pollution by oil. However, recent estimates (1981) show that approximately 3.2 million metric tons of oil per year enter marine environments from all sources, and this amount can vary greatly, depending upon accidents and events of war. The report notes that oil from land-based sources is the predominant input to the marine environment. The physical, chemical and biological fates of such oil and its components are better understood in qualitative terms in 1990 compared to 20 years ago. The ecological impacts of oil are also better understood - many biological effects induced by hydrocarbons have been measured and some toxicological patterns are apparent. Marine wildlife are very visible victims of oil spills, but chronic sublethal effects caused by spills in low-energy, shallow coastal waters remain a concern. Some habitats, such as exposed rocky shorelines, recover quickly from oiling events, but other ecosystems such as mangroves, salt marshes, sea grasses and coral reefs are particularly vulnerable and sensitive to oil spills, and may take years to recover to their

pre-spill states. Oil can affect man's use of the sea; spills have low or negligible impacts on fish stocks, and there is no evidence of significant amounts of tainting of fish and shellfish from such events, but shorelines, boats and fishing gear may be oiled during spills. The impacts of spills, large or small, are clearly better understood now than in the mid-70's, and it is generally acknowledged that prevention is the best way of reducing the known impacts of oil on the marine environment and its resources.

4 Chapter 3 addresses used lubricating oils and notes that crankcase oils are an important source of PAH and lead, as well as trace levels of other contaminants such as chlorinated dibenzodioxins, in the environment. Sediments contaminated with relatively high levels of crankcase oils are expected to be toxic to selected marine species, especially species associated with sediments. The risk of either chemical contamination or the tainting of seafood by crankcase oil is expected to be low or negligible. With respect to both environmental and human health, any concerns should be confined principally to areas such as urban/industrial harbours. Bilge waters containing, besides fuel oil, used crankcase and other lubricating oils are likely to be responsible for many bird kills and may be important contributors of beach tar in some regions. It is expected that industrial oils other than used lubricating oils are of minor environmental importance.

5 Chemical spill control agents including dispersants, demoussifiers, solidifiers, shoreline washing agents, herders, sinking agents and biodegradation enhancers are considered in Chapter 4. Essentially all research has concentrated on chemical dispersants; very little information on research, particularly on field tests, has been published on any other agents. Solidifiers improve the efficiency of mechanical cleanup of small spills, particularly in enclosed areas. Demoussifiers have a specialized use in breaking viscous water-in-oil emulsions (mousse). Shoreline washing agents likewise are useful in final cleaning of seawalls and vessels. Herders are only momentarily effective, sinking agents are harmful to benthic organisms, biodegradation enhancers have shown good performance in the laboratory but irreproducible performance in the field, often indistinguishable from controls.

6 The report notes that assessments of effectiveness of dispersants in responding to real spills have shown that the amount of oil removed from the sea surface is highly variable, and never 100%. However, the reduced adhesion to surfaces and reduced biological impact in some situations (e.g. low energy coastlines) makes dispersed oil a generally less harmful pollutant than untreated oil. The impact of oil spills on marine ecosystems has not significantly diminished since the early 1970's. Their impact is understood in more detail, and substantial efforts have been made to improve response techniques; however, oil spills still cause serious harm to shallow benthic and intertidal habitats and communities. Dispersants may contribute to a reduction of harm in some cases where they are applied to oil before it reaches sensitive coastal habitats; this fact was not known 15 years ago.

7 Impacts from the discharge of chemical wastes, originating from oil and gas exploration and production activities are evaluated in Chapter 5. The evaluation addresses environmentally significant factors such as relative quantities of discharge, differences between single-well exploration drilling and multi-well development and production activities, a real extent of effects, potential for recovery, and special environmental sensitivities.

8 The various discharges are described in accordance to their chemical composition. Particular attention is given to hydrocarbons in drilling muds and production water, heavy metals from drilling wastes, surfactants, and biocides. The toxicity of the various waste streams and their chemical components is discussed in relation to both acute toxicity using established GESAMP toxicity criteria and longer term environmental toxicity. Environmental effects are described in relation to uptake of contaminants by biota (in particular hydrocarbons from drilling and production discharges), ecological changes, areal extent of effects about the discharge site, and potential for recovery. The ongoing debate on defining the absolute extent of effect around production sites is mentioned in the review. Effects on human health from discharges are evaluated. The important ongoing concern over tainting of fish is discussed in relation to hydrocarbon discharges from drilling and production facilities.

9 Chapter 6 of the report provides a summary of the report and recommendations for future research to fill gaps in knowledge as well as actions that can be taken to control inputs of oil to the marine environment.

Terms of Reference

The following general terms of reference adopted for Working Group No.13 apply for the work of the sub-group:

- 1 To prepare short referenced reviews on selected substances which include an assessment of the following factors:
 - (a) the total of particular substances which reach the marine environment (on a local, regional and global scale) with particular attention being given to the relative importance of land-based sources;
 - (b) the fate (transfer, distribution and transformation) of these substances in the marine environment;
 - (c) the effects of these substances on the marine environment and adjacent coastal areas, both direct and indirect, on living resources, human health and amenities.
- 2 To produce a scientific evaluation of the harmful effects of substances released into the marine environment on living resources, human health, aesthetics and other legitimate uses of the marine environment and adjacent coastal areas.

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ANNEX VII

REDUCING ENVIRONMENTAL EFFECTS OF COASTAL AQUACULTURE

Report of the Working Group on Environmental Impacts of Coastal Aquaculture (Working Group No.31)

Summary

- 1 There have been substantial socio-economic benefits arising from the expansion of coastal aquaculture. However, in some coastal regions, this has caused significant ecological changes.
- 2 The type and scale of any ecological change associated with coastal aquaculture development will depend on the method of aquaculture, the level of production and the physical, chemical and biological characteristics of the coastal area. Ecological change has been associated with the large-scale production of bivalves and seaweeds and the release of dissolved and particulate waste from fish, shrimp, and bivalve culture. Destruction of productive wetland habitats has resulted in the disturbance of wildlife and uncontrolled introductions and transfers have altered or impoverished the biodiversity of the receiving ecosystem. Some ecological change such as the impact of organic waste on the sea-bed ecosystem can limit production.
- 3 The indiscriminate use of bioactive compounds, including pesticides and antibiotics, has caused concern about their release into the aquatic environment. The health implications of the use of chemicals and the consumption of seafood grown in contaminated waters are problems of growing concern, especially in relation to intoxication by phycotoxins and infectious diseases such as typhoid fever, cholera and hepatitis.
- 4 Some of the ecological and socio-economic problems encountered are due to the market failure to reflect the true cost of resource depletion and environmental change. The solution to this problem requires policy intervention at national and local levels, particularly in regard to the issues of common property rights and economic incentives and deterrents needed to minimize environmental change.
- 5 Sustainable coastal aquaculture requires adequate consideration of the interactions among the social, economic and ecological changes. This can be achieved through an integrated approach to planning and management of coastal aquaculture within the framework of integrated coastal zone management.
- 6 Specific actions are essential to effectively utilize the environmental capacity of the coastal ecosystem for food production and generation of income, reducing resource use conflicts, and minimizing health risks to human consumers and adverse ecological impacts. These activities include the formulation of coastal aquaculture development and management plans, application of environmental impact assessment to aquaculture proposals, development of criteria for site selection, determination of the carrying

capacity of ecosystems, establishment of guidelines governing the use of mangrove wetlands, bioactive compounds, transfers and introductions, improvements in farm operation and management, regulation of farm discharges and monitoring ecological changes, and application of regulatory measures and economic incentives or deterrents to promote sound environmental management.

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Terms of Reference

To prepare a 20-25 page document containing:

- (a) an analysis of impact of present coastal aquaculture practices on the marine and coastal environment as well as on human health; and
- (b) guidelines for environmentally sound management of coastal aquaculture

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ANNEX VIII

GLOBAL CHANGE AND THE AIR/SEA EXCHANGE OF CHEMICALS

Report of the Working Group on Global Change and the Air/Sea Exchange of Chemicals (Working Group No.32)

Summary

1 The report was developed during and following a meeting of Working Group 32 at the University of Rhode Island in December 1990. Work was continuing on the document at the time of its presentation to GESAMP XXI. It is expected that the document will be finalized in 1991.

2 The report consists of a brief introductory chapter which outlines the three issues to be addressed: global change and the air/sea exchange of the nutrients nitrogen and iron; global change and the air/sea exchange of gases; and oceanic responses to radiative and oxidative changes in the atmosphere. The subsequent three chapters contain a detailed discussion of each of these issues.

3 Chapter 2 addresses the atmospheric input of nitrogen species and iron to the ocean. It is likely that the input of atmospheric nitrogen species has increased the biological productivity in some coastal regions and possibly in the mid-North Atlantic Ocean. Future increases in population and industrialization in areas of Asia, Africa and South America suggest that increased transport of atmospheric nitrogen compounds could lead to increases in productivity in open ocean regions downwind from these continents in the future. Atmospheric iron may be an important nutrient in certain open ocean regions, and its source strength may be altered by future changes in the aridity of the source regions. Current climate models cannot adequately predict changes in atmospheric transport paths for nitrogen and iron to the world ocean as a result of future climate change.

4 Chapter 3 addresses the air/sea exchange of gases, in particular carbon dioxide and dimethyl sulfide (DMS). It is noted that there are several areas with significant uncertainties. For example, small scale (10-100km) variability of $p\text{CO}_2$ is $\sim 30 \mu\text{atms}$, while a systematic error of $1 \mu\text{atm}$ over the world ocean would lead to an error in the integrated CO_2 flux of 0.3 GT yr^{-1} . Calculations of the global CO_2 flux that ignore the ocean skin temperature effect may be in error by $0.5-1 \text{ GT yr}^{-1}$. It is likely that estimates of the global air/sea exchange of CO_2 are still uncertain by approximately a factor of 2. Improved estimates require a substantial increase in both the geographical coverage and density of oceanic $p\text{CO}_2$ measurements. The most important future effects on surface oceanic $p\text{CO}_2$ are likely to be caused by changes in oceanic circulation. There is increasing evidence that the oceans are an indirect source for cloud contamination nuclei (CCN) through the production, and subsequent oxidation, of DMS. CCN are a factor in controlling cloud albedo, but it is as yet not possible to predict the sign of any feedback mechanism in the DMS-climate link.

5 Chapter 4 addresses the oceanic responses to radiative and oxidative changes in the atmosphere. Due to expected decreases in stratospheric ozone, there will probably be a few percent increase in the UV-B reaching the ocean surface in the tropics, with more substantial increases in higher latitudes. Tropospheric ozone is expected to continue to increase in the northern hemisphere outside the tropics, but may well decrease in the southern hemisphere. The changes in atmospheric hydroxyl radical (OH) are uncertain, but it also may increase in the northern hemisphere and decrease in the southern hemisphere. Changes in OH concentrations would affect the lifetimes and transport to the ocean of a number of atmospheric gases. Increased UV-B could result in decreased primary productivity in the sea surface, particularly at high latitudes. Changes in photochemical processes, including the formation of highly reactive species, could have significant effects, including air/sea exchange, on a number of compounds in the carbon, nitrogen, sulphur and halogen cycles.

Terms of Reference

- 1 To evaluate the potential impact of the input of pollution-derived atmospheric nitrogen species on biological productivity and eutrophication in the coastal zone and in the open ocean. As a consequence of this evaluation, recommend what types of changes, if any, in the emission of nitrogen species to the atmosphere from pollution sources are needed.
- 2 To assess the extent to which various sea surface warming and pH change scenarios being developed by the climate modelling community would affect the exchange of trace gases such as oxygen, dimethyl sulfide, chlorinated hydrocarbons, etc. between the ocean and atmosphere and evaluate the impact and importance of these altered exchange rates.
- 3 To assess the effect of decreasing stratospheric ozone and increasing ultraviolet radiation on the oxidizing capacity of the atmosphere and ocean, and evaluate the consequent impact on reaction rates and residence times of pollutants in these reservoirs.
- 4 To evaluate whether these changes would result in significant alterations in the geographical distribution and air/sea exchange of these chemical substances and potential effects on biological systems.

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2.	Review of Harmful Substances	1976	E
3.	Scientific Criteria for the Selection of Sites for Dumping of Wastes into the Sea	1975	E,F,R,S
4.	Report of the Eighth Session	1976	E,F,R
5.	Principles for Developing Coastal Water Quality Criteria	1976	E
6.	Impact of Oil on the Marine Environment	1977	E
7.	Scientific Aspects of Pollution Arising from the Exploration and Exploitation of the Sea-bed	1977	E
8.	Report of the Ninth Session	1977	E,F,R,S
9.	Report of the Tenth Session	1978	E,F,R,S
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14.	Report of the Twelfth Session	1981	E,F,R
15.	The Review of the Health of the Oceans	1982	E
16.	Scientific Criteria for the Selection of Waste Disposal Sites at Sea	1982	E
17.	The Evaluation of the Hazards of Harmful Substances Carried by Ships	1982	E
18.	Report of the Thirteenth Session	1983	E,F,S
19.	An Oceanographic Model for the Dispersion of Wastes Disposed of in the Deep Sea	1983	E
20.	Marine Pollution Implications of Ocean Energy Development	1984	E
21.	Report of the Fourteenth Session	1984	E,R,S
22.	Review of Potentially Harmful Substances. Cadmium, Lead and Tin	1985	E
23.	Interchange of Pollutants Between the Atmosphere and the Oceans (Second report)	1985	E
24.	Thermal Discharges in the Marine Environment	1984	E
25.	Report of the Fifteenth Session	1985	E,F,R,S
26.	Atmospheric Transport of Contaminants into the Mediterranean Region	1985	E
27.	Report of the Sixteenth Session	1986	E,F,R,S
28.	Review of Potentially Harmful Substances. Arsenic, Mercury and Selenium	1986	E
29.	Review of Potentially Harmful Substances. Organosilicon Compounds (Silanes and Siloxanes)	1986	E

Rep. & Stud. No.	Title	Date	Language
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30.	Environmental Capacity. An Approach to Marine Pollution Prevention	1986	E
31.	Report of the Seventeenth Session	1987	E,F,R
32.	Land-Sea Boundary Flux of Contaminants: Contributions from Rivers	1987	E
33.	Report of the Eighteenth Session	1988	E,F,R,S
34.	Review of Potentially Harmful Substances. Nutrients	1990	E
35.	The Evaluation of the Hazards of Harmful Substances Carried by Ships: Revision of GESAMP Reports and Studies No.17	1990	E
36.	Pollutant Modification of Atmospheric and Oceanic Processes and Climate: Some Aspects of the Problem	1989	E
37.	Report of the Nineteenth Session	1989	E,F,R,S
38.	Atmospheric Input of Trace Species to the World Ocean	1989	E
39.	The State of the Marine Environment	1990	E
40.	Long-Term Ecological Consequences of Low-Level Contamination of the Marine Environment	1989	E
41.	Report of the Twentieth Session	1990	E,F,S
42.	Review of Potentially Harmful Substances. Choosing Priority Organochlorines for Marine Hazard Assessment	1990	E
43.	Coastal Modelling	1990	E
44.	Report of the Twenty-first Session	1991	E,F,R,S
45.	Global Strategies for Marine Environmental Protection (in press)	1991	E
46.	Carcinogens: Their Significance as Marine Pollutants (in press)		E
47.	Reducing Environmental Impacts of Coastal Aquaculture (in press)		E
48.	Global Change and the Air/Sea Exchange of Chemicals (in press)		E
