

UNITED NATIONS
NEW YORK

UNITED NATIONS
ENVIRONMENT
PROGRAMME
NAIROBI

FOOD AND
AGRICULTURE
ORGANIZATION
OF THE UNITED
NATIONS
ROME

UNITED NATIONS
EDUCATIONAL,
SCIENTIFIC AND
CULTURAL
ORGANIZATION
PARIS

WORLD HEALTH
ORGANIZATION
GENEVA

WORLD
METEOROLOGICAL
ORGANIZATION
GENEVA

INTERNATIONAL
MARITIME
ORGANIZATION
LONDON

INTERNATIONAL
ATOMIC ENERGY
AGENCY
VIENNA



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

REPORTS AND STUDIES

No. 41

1990

REPORT OF THE TWENTIETH SESSION

Geneva, 7-11 May 1990



WORLD METEOROLOGICAL ORGANIZATION

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

REPORT OF THE TWENTIETH SESSION

Geneva, 7-11 May 1990

WMO, 1990

NOTES

1. GESAMP is an advisory body consisting of specialized experts nominated by the Sponsoring Agencies (IMO, FAO, Unesco, WMO, 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).
2. This report is available in English, French, Russian and Spanish from any of the Sponsoring Agencies.
3. The report contains views expressed by members of GESAMP who act in their individual capacities; their views may not necessarily correspond with those of the Sponsoring Agencies.
4. Permission may be granted by any one of the Sponsoring Agencies for the report to be wholly or partly reproduced in publications by any individual who is not a staff member of a Sponsoring Agency of GESAMP, or by any organization that is not a sponsor of GESAMP, provided that the source of the extract and the condition mentioned in 3 above are indicated.

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 SEA WATER AND REDUCTION OF AMENITIES."

For bibliographic purposes, this document may be cited as:

GESAMP - IMO/FAO/Unesco/WMO/WHO/IAEA/UN/UNEP Joint Group of Experts on the Scientific Aspects of Marine Pollution (GESAMP): Report of the twentieth session. Geneva, 7-11 May 1990. Rep. Stud. GESAMP No. 41. 32 p.p. 1990.

CONTENTS

	<u>Page</u>
1. Introduction	1
2. State of the marine environment	1
3. Strategies for marine environmental protection and management (Working Group 28)	2
4. Review of potentially harmful substances (Working Group 13)	2
4.1 Carcinogens	2
4.2 Organochlorine compounds	4
4.3 Oil, including used lubricating oils, oil spill dispersants and chemicals used in offshore exploration and exploitation	5
5. Coastal modelling (Working Group 25)	6
6. Evaluation of the hazards of harmful substances carried by ships (Working Group 1)	6
7. Comprehensive framework for the assessment and regulation of waste disposal in the marine environment (Working Group 29)	6
8. Impacts of anthropogenically mobilized sediments in the coastal environment (Working Group 30)	7
9. Future work programme	8
9.1 Establishment of new working groups	8
9.2 Intersessional work	9
10. Other matters	11
10.1 A proposal for reconsideration of the GESAMP definition of marine pollution	11
10.2 GESAMP booklet	11
10.3 1992 state of the environment report	12
11. Date and place of next session	12
12. Election of chairman and vice-chairman	12
13. Consideration and approval of the report of the twentieth session	12

	<u>Page</u>
ANNEXES	
I List of participants	13
II List of documents	19
III Extract from "The State of the Marine Environment, GESAMP Reports and Studies No. 39, 1990" (Executive Summary)	21
IV Protecting and managing the oceans: underlying principles and elements for the protection and management of marine and coastal environments	25

1. INTRODUCTION

- 1.1 The Joint Group of Experts on the Scientific Aspects of Marine Pollution (GESAMP) held its twentieth session at WMO Headquarters, Geneva, from 7 to 11 May 1990, under the Chairmanship of Mr. H.L. Windom. Mr. D. Calamari was Vice-Chairman of the session.
- 1.2 Mr. R. Czelnai, Assistant Secretary-General of WMO, welcomed the participants on behalf of the Secretary-General of WMO. The WMO from the very beginning in 1969 supported the idea of this Joint Group composed of scientists acting in their individual capacities and the advice and recommendations of GESAMP have always been appreciated and taken into account by its constituent bodies, such as the World Meteorological Congress, Executive Council, Regional Associations and Technical Commissions. At present WMO is particularly interested in studying the changing composition of the atmosphere which may result in climate changes and have consequences for the marine environment. In conclusion Mr. Czelnai wished GESAMP every success in the performance of its tasks.
- 1.3 A list of participants is shown in Annex I and a list of documents in Annex II.

2. STATE OF THE MARINE ENVIRONMENT

The Group decided that each year it would issue a consensus on the state of the marine environment as follow-up to its "Report on the State of the Marine Environment", the Executive Summary of which is attached as Annex III. The text of the Statement is as follows:

STATE OF THE MARINE ENVIRONMENT: 1990

"GESAMP reaffirms the importance of the concerns listed in paragraph 17 of the Executive Summary of its Report on the State of the Marine Environment. It also highlights the fact that global climatic change may be the most important environmental issue facing humankind, and notes with concern the uncertainties surrounding the role of the oceans in the global carbon cycle. It recognizes that potential impacts resulting from global climatic changes are almost certain to accentuate current coastal zone management problems.

GESAMP stresses the fact that most of the current marine and ocean problems are concentrated in coastal zones. By the year 2000 the global population will exceed 6500 million people of whom over half will live in tropical developing countries and more than half will be living in the coastal zones of the world. It is likely therefore that without appropriate management measures these problems will become worse.

The apparent increase in harmful algal blooms, eutrophication and associated regional anoxia, and fish diseases are highlighted as causes for immediate concern, while causes for longer term concern centre on the potential impacts of climatic change on coastal environments and resources.

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. Control of eutrophication problems for example may involve changes in agricultural practices and riverine transport of contaminants, modification of sewage treatment and discharge.

GESAMP advocates an integrated approach to marine environmental management which should include consideration of different environmental sectors and incorporate economic, social, scientific and technological considerations to provide balanced decision-making in achieving sustainable development."

3. STRATEGIES FOR MARINE ENVIRONMENTAL PROTECTION AND MANAGEMENT

3.1 The Working Group report contains a number of scientific elements which were endorsed by GESAMP. It was stressed that environmental management strategies should include a hazard assessment exercise based on sources and loads of contamination, and data on toxicity to marine organisms, using QSAR predictions where specific information is not available. Should this assessment, based on conservative estimates, indicate a potential pollution problem, then new information may have to be sought to improve the accuracy of the predictions. This will assist in the formulation of effective regulatory action to reduce the pollutant load and to minimize harmful effects.

3.2 If the assessment predicts that environmental problems are unlikely to occur, then routine monitoring is undertaken, specifically in the environmental compartment subject to the greatest exposure, in order to show that the prediction is confirmed. The report describes the hazard prediction for chemical pollutants, it was however agreed that the same approach mutatis mutandis can be applied for other potential hazards, e.g. man-made physical change of the coastal environment.

3.3 Building on the results of the Working Group 28, as well as on ideas developed by Working Group 29, the Group undertook to formulate the underlying principles and elements for the protection and management of marine and coastal environment and their resources as a contribution of GESAMP towards the preparations for the 1992 United Nations Conference on Environment and Development. The text of the agreed principles and elements is given in Annex IV.

4. REVIEW OF POTENTIALLY HARMFUL SUBSTANCES

4.1 Carcinogens

4.1.1 The Group received a draft report on various aspects of carcinogenic substances in marine biota, concerning both tumours in fish and cancer risk in humans due to seafood consumption. The Group concluded its deliberations on this topic by agreeing to the following summary statement:

- 4.1.2 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.
- 4.1.3 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.
- 4.1.4 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.
- 4.1.5 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.
- 4.1.6 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.
- 4.1.7 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.

4.2 Organochlorine compounds

- 4.2.1 The subgroup on chlorinated hydrocarbons reported to the twentieth session of GESAMP. It was agreed that the organochlorine compounds represented a group of substances which had widely diverse toxic properties; therefore, there was a need at the outset to separate the group into several clearly defined sub-groups. It was clear that the higher molecular weight chlorinated aromatic compounds such as PCBs and PCDDs formed a separate subgroup for special attention. Similarly, the highly toxic and persistent chlorinated insecticides such as DDT, lindane and chlordane required separate consideration, as did the chlorinated herbicides. Considerable information including comprehensive reviews exist for these substances, which will facilitate the production of comprehensive hazard assessments.
- 4.2.2 The remaining organochlorine compounds were divided into low molecular weight compounds (less than 3 carbon atoms), aliphatic and aromatic compounds (up to 6 carbon atoms) and long-chain chlorinated paraffins. There were 720 compounds within these 3 groups which were shown by a survey of existing literature to be relevant to the marine environment. These substances were subjected to a preliminary hazard assessment, based on scientifically accepted criteria for toxicity, persistence and bioaccumulation, to identify those compounds which may present the greatest environmental hazard. Adjustments were made to allow for those substances produced in large quantities. This led to the identification of 77 compounds which represented the most hazardous organochlorine compounds in these 3 groups. For some of the other substances, the data made available were insufficient for an assessment and where necessary the gaps will need to be filled by the use of QSARs and comparison with similar compounds. It was agreed that this approach was a necessary step towards the production of specific hazard profiles for those organochlorine compounds of known or suspected environmental importance.
- 4.2.3 It was agreed that the problem of complex effluents containing chlorinated compounds, such as those arising from certain paper mills, could not be incorporated into this programme, which was directed towards single substances; the solution to this problem does not depend solely on the isolation and removal of specific compounds known to be harmful. The general theory of the toxicity of mixtures of substances has been recently reviewed and the results are applicable to commonly-known organochlorine compounds.
- 4.2.4 It was decided to publish findings of the sub-group as GESAMP Reports and Studies No. 42. The work will be continued through the Working Group on Potentially Harmful Substances. The Working Group will endeavour to prepare specific hazard profiles for individual substances or groups of substances which appear to be of priority concern, based on quantities used and access to the marine environment, and to assess the risks and fates of such substances in the marine environment.

4.3 Oil, including used lubricating oils, oil spill dispersants and chemicals used in offshore exploration and exploitation

4.3.1 The Group considered the draft on the review of "used lubricating oils". At this time, the draft review on used lubricating oils has concluded that:

- (a) used crankcase oils are a major source of PAHs (polycyclic aromatic hydrocarbons), lead, and various compounds from oil additives to coastal and marine environments. However, concerns about crankcase oil pollution relate principally to urban and industrialized harbors, and embayments, due to inputs from sewer outfalls.
- (b) crankcase oils probably have negligible acutely toxic (lethal) effects in the marine environment.
- (c) chronic sublethal effects in marine organisms that may be caused by elevated levels of PAHs and lead in the nearshore sediments of confined harbors or bays are of primary concern and interest.
- (d) there is sufficient evidence to be concerned about carcinogenesis occurring in marine animals exposed to combustion sources of PAHs, including those found in used engine oil.
- (e) there is some evidence that combustion sources of PAHs in sediments in the 3 to 5 ppm range can produce adverse effects, including carcinogenesis in certain benthic species.
- (f) concentrations of PAHs found in some frequently consumed edible species taken from areas having high levels of sediment contamination by combustion/used engine oil sources may result in a slight risk of human carcinogenesis.
- (g) there appears to be insufficient evidence to suggest that inputs of lead into the marine environment from used engine oil are of ecotoxicological importance. Any acute or chronic toxic effects would be expected to occur only in areas under extreme levels of lead contamination.
- (h) overall evaluation: Harbor and other sediments contaminated with relatively high (>3-5 ppm) levels of crankcase oil can be expected to be sublethally toxic to marine biota, especially among the benthos. Similarly, any edible species taken from such areas may impose a slight risk of human carcinogenesis. However, in both cases, it is important to stress that any adverse effects would be associated with localized areas of contamination.

4.3.2 The Group noted that the above conclusions should be considered tentative pending completion and peer review of the oil review.

- 4.3.3 GESAMP expressed its expectation to consider the final draft of the review at its next session. It agreed to change the title of the report to "Oil and individual hydrocarbons, including used lubricating oils, oil spill dispersants and chemicals used in offshore exploration and exploitation".

5. COASTAL MODELLING

The Group considered the draft report prepared by the Working Group on Coastal Modelling. It proposed several editorial changes and the addition of a decision flow chart for the construction of specific models. The draft report, as amended, was approved for publication under GESAMP Reports and Studies No. 43.

6. EVALUATION OF THE HAZARDS OF HARMFUL SUBSTANCES CARRIED BY SHIPS

- 6.1 The Group noted that during the inter-sessional period approximately 200 substances which are carried by ships or are proposed for sea transport have been evaluated. The Group released the new hazard profiles for use by IMO for the development of the respective carriage and discharge requirements in accordance with MARPOL 73/78, Annexes II and III.

- 6.2 The Group agreed to the views expressed by its working group that there was no evidence of any human health problem arising from the arsenic content of consumed marine organisms. The Group further agreed that there was no evidence that zinc compounds are bioaccumulated with attendant risk to aquatic organisms or human health.

- 6.3 The Group noted that its Working Group upon request by IMO had considered the effects on the marine environment of discharges from sheep and cattle carriers. The Group concurred with the views of its Working Group that discharges from livestock carriers into the high sea and in areas 20 miles from the nearest land primarily add nutrients to the marine environment, but that, in the opinion of the Group, this input does not cause significant effects. The Group also agreed with the advice that the dumping overboard of dead livestock (slit to the extent that the thoracic and abdominal cavities are opened) should be carried out far away from fishing grounds.

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

- 7.1 GESAMP reviewed the progress made by this Working Group which had been established at its XIXth Session. The basis of the review was a document prepared by a small group of experts in February 1990 (GESAMP XX/7). This document elaborated an approach to the task which contained the following steps:

- (i) A review of the basic principles for environmental protection as adopted by the United Nations Conference on the Human Environment, 1972;

- (ii) Analysis of international agreements and approaches on marine environmental protection that aim to fulfill all or part of these basic principles;
- (iii) Identification of any deficiencies in technical and scientific elements of these agreements and approaches; and
- (iv) Preparation of a report that discusses the outcome of the analysis and identifies opportunities for improving the assessment and regulation of waste disposal in the marine environment. The report should take account of the need for a comprehensive framework for the protection and management of the marine environment that incorporates scientifically-based procedures for the assessment and control of marine pollution.

7.2 The Group endorsed the approach proposed by the Working Group in general but recommended that it should not allocate a disproportionate amount of time to the analysis of individual agreements on, or approaches to, marine pollution prevention. Priority should be given to the elements of these instruments that incorporated scientific concepts and principles. The Group agreed that the Working Group should submit a substantially-completed draft report for consideration by GESAMP at its twenty-first session.

8. IMPACTS OF ANTHROPOGENICALLY MOBILIZED SEDIMENTS IN THE COASTAL ENVIRONMENT

The Group agreed with the general conclusions set out in the progress report of the Working Group as follows:

- (i) the surveys carried out by Drs. Milliman and Pernetta show that Southern Asia and Oceania contribute 70% of the world flux, although comprising only 15% of the land area; north eastern South America contributes 11%; the large Oceania input is due to the small river basins having little capacity to store sediment and thus small rivers in some limited size islands contribute as much sediment to the ocean as the Mississippi; the data base for Asia (except China) and South America is, however, very poor.
- (ii) erosion rates are changing continuously with Asian and Oceanian rivers discharging today five times the values before deforestation began and due to deforestation in Nepal the sediment load of the Ganges is much increased in recent years. Yet due to damming the Rhone carries only 5% of the load carried in the 19th century and the Indus now carries only 20% of the load before construction of barrages in the late 1940's.
- (iii) the amount of sediment actually reaching the ocean is in dispute. Some authorities believe that sediment settles rapidly and rarely reaches the continental shelf, whereas others maintain that material reaches the continental slope. It is probable that fluvial sediments reaching broad continental shelves remain trapped whereas on narrow shelves material can reach the deep sea.

- (iv) the areas most at risk to changes in sediment flux are the areas of high urban concentrations and large rivers (Indus, Ganges-Brahmaputra, Irrawady, Mekong, Pearl, Changjiang) which are also most sensitive to sea-level changes.
- (v) effects of the Aswan Dam have led to destruction of the coastal fishery, erosion rates of hundreds of metres per year and increased subsidence rates, which combined with rising sea level suggests that 25% of Egypt's land area could be inundated by 2100.
- (vi) effects of increased sediment discharge in destruction of coral reefs have been documented in the Philippines and Kenya with a subsequent reduction in tourism and fisheries yield.
- (vii) repeated floods in Bangladesh may lead to the building of dams and dikes which would result in destruction of the coastal mangroves on which 30% of the population survive and would alter sediment flux rates with as yet unknown consequences for the coastal areas. There are also strong pressures to increase dam and irrigation projects in Asia and yet the consequences of altered sediment flux are not considered.

9. FUTURE WORK PROGRAMME

9.1 Establishment of new working groups

9.1.1 Environmental impacts of coastal aquaculture

Food production through aquaculture is rapidly increasing worldwide. Aquaculture development, and its sustainability, are however highly dependent on the environmental and socio-economic setting of each aquaculture enterprise. The expansion of coastal aquaculture could have severe consequences for the aquatic environment and for aquaculture itself due to water quality degradation and to contamination of the food produced. There is a vast potential for culture-based fisheries or open-water stocking of culture species especially in lagoons, enclosed bays and inland seas; the environmental impacts of such practices need to be addressed. Nevertheless, in many countries coastal aquaculture is contributing substantially to fish production and foreign-exchange earnings.

The Group decided to establish a Working Group on the Environmental Impacts of Coastal Aquaculture with the following 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.

9.1.2 Global change and the sea/air exchange of chemicals

One of the most urgent issues facing society over the next several decades is global environmental change, especially the change in composition of the atmosphere and related climate change resulting from the increasing atmospheric concentrations of greenhouse gases. Global climate change would cause the alteration of precipitation and wind flow regimes in some regions as well as atmospheric residence times of some species, thus changing the patterns of pollution transport and air/sea exchange. Other important global environmental changes include the increased production and emission to the atmosphere and the ocean of a variety of other harmful pollutants, the changing oxidizing capacity of the atmosphere and the ocean, and the present and future alteration of stratospheric ozone resulting in increased quantities of ultraviolet radiation reaching the earth's surface. The impact of global change on the coastal zone will be particularly important, putting increasing pressure on the part of the marine environment that is most biologically and economically productive.

The Group agreed to establish a Working Group on the Global Change and the Sea/Air Exchange of Chemicals and determined the following three main issues for the Working Group to deal with: exchange of nutrient nitrogen between the ocean and the atmosphere, global warming and sea/air exchange of gases and the changing oxidizing capacity of the atmosphere and the ocean.

The Working Group was requested to consider and evaluate the above issues at an expert meeting and to prepare a brief report by the next session of GESAMP in 1991.

9.2 Intersessional work

The Group noted that intersessional work is planned to be carried out on the following issues:

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 in 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 mutagenic substances (sub-group 1)

Lead agency: Unesco; co-sponsors: UNEP, WHO, FAO, IMO
Chairman: F. Wuergler
Preparation of an extended review paper by the chairman to be evaluated by the members of the sub-group and completed by correspondence. Concerning teratogenic substances, D. Calamari will provide information on feasibility of GESAMP evaluation and report to the WMO Technical Secretary.

2.2 chlorinated hydrocarbons (sub-group 2)

Lead agency: FAO; co-sponsors: UNEP, Unesco
Chairman: R. Lloyd; GESAMP member: D. Calamari
In case requests for reviews of specific organochlorine compounds are received in time from any of the co-sponsors, a meeting of this subgroup will be held in autumn 1990.

2.3 oil and other hydrocarbons, including used lubricating oils, oil spill dispersants and chemicals used in offshore exploration and exploitation (sub-group 3)

Lead agency: IMO; co-sponsors: UNEP, FAO, Unesco
Chairman: P. Wells
A meeting of the sub-group will be convened in January 1991 to finalize the review paper for consideration by GESAMP at its next session.

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
One meeting of the Working Group will be convened in late 1990 to evaluate the effectiveness, applicability and scientific viability of the current marine environmental protection framework. This will include:

- an analysis of the strategies and elements of existing international agreements and national approaches; and
- an examination of the extent to which the measures adopted for coastal and marine environmental protection comply with the provisions of relevant international agreements, and an estimation of additional expenditures necessary to overcome any deficits, including political and social implications.

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

Lead agency: Unesco; co-sponsors: UN, UNEP, FAO, IMO

Chairman: J. Gray

The Working Group will not meet before the next GESAMP session and will report to 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

A meeting of this Working Group is scheduled for December 1990.

6. Global Change and the Sea/Air Exchange of Chemicals (Working Group 32)

Lead agency: WMO; co-sponsors: UNEP, Unesco

Chairman: R. Duce

The Working Group will meet in December 1990 to evaluate:

- the exchange of nutrient nitrogen between the ocean and the atmosphere;
- the effect of global warming on sea/air exchange of gases, and
- the changing oxidizing capacity of the ocean and the atmosphere and its effect on destruction and residence time of organic substances in the oceanic and atmospheric environment.

A draft report will be submitted to GESAMP-XXI in 1991.

10. OTHER MATTERS

10.1 A proposal for reconsideration of the GESAMP Definition of Marine Pollution

A paper was presented to stimulate a discussion of the current Definition with a view to further analysis that might enable GESAMP to discuss the topic in greater detail.

It was concluded that further analysis of this issue would be undertaken within the activities of Working Group No. 29. A paper would accordingly be submitted to the XXIst Session of GESAMP presenting some options for the revision or replacement of the Definition that could be considered by GESAMP.

10.2 GESAMP Booklet

The Chairman informed the Group that a draft of his booklet "GESAMP: Two Decades of Accomplishment" which briefly describes what GESAMP is, how it operates and what it accomplishes, has been finalized. He invited all members of GESAMP to deliver their comments to him during this session.

10.3 1992 State of the Environment Report

The Group took note of the preparation of the State of the Environment Report by UNEP for the 1992 Conference on Environment and Development, and offered to assist in its preparation.

11. DATE AND PLACE OF NEXT SESSION

The Group noted that the twenty-first session of GESAMP will be hosted by the World Health Organization and held at its Regional Office for the Eastern Mediterranean in Alexandria (Egypt), from 17 to 21 February 1991.

12. ELECTION OF CHAIRMAN AND VICE-CHAIRMAN

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

13. CONSIDERATION AND APPROVAL OF THE REPORT OF THE TWENTIETH SESSION

13.1 The draft report of the twentieth session of the Group was considered by the Group on the last day of the session and was approved with amendments reproduced in this document.

13.2 The twentieth session of GESAMP was closed by the Chairman of the Group on 11 May 1990.

ANNEX I

LIST OF PARTICIPANTS

A. Members

Mr. J. Michael BEWERS
Head, Marine Chemistry Division
Bedford Institute of Oceanography
P.O.B. 1006
Dartmouth
Nova Scotia
Canada B2Y 4A2

Tel: 902 426 2371
Tlx: 019 31552 BIO DART
Fax: 902 426 2256

Mr. Jackson O. BLANTON
Skidaway Institute of Oceanography
P.O.B. 13687
Savannah, Georgia 31416
USA

Tel: 912 356 2457
Tlx: 258647 SKID UR

Mr. Rick G.V. BOELENS
Irish Science and Technology Agency
Shannon Town Centre
Shannon, County Clare
Ireland

Tel: 061 361499
Fax: 061 361979

Mr. Davide CALAMARI
Institute of Agricultural Entomology
Faculty of Agriculture
Via Celoria 2
20133 Milan
Italy

Tel: 2/2362880
Tlx: 320484 UNIMI
Fax: 2/26680320

* Unable to attend

Ms. Hansa CHANSANG*
Phuket Marine Biological Centre
P.O. Box 60
Phuket 83000
Thailand

Tel: 076 391 128
Fax: 076 391 127

Mr. CHUA Thia-Eng
International Centre for Living Aquatic
Resource Management (ICLARM)
P.O. Box 1501
Makati
Manila
Philippines

Tel: 8180466/8175163
Tlx: 45658 ICLARM PN (ITT)
or 64794 ICLARM PN (ETPI)
Fax: 632 816 3183

Mr. Robert A. DUCE
Graduate School of Oceanography
University of Rhode Island
Narragansett
Rhode Island 02882
USA

Tel: 1 401 792 6222
Tlx: 7400427 CRMP UC
Fax: 1 401 792 6160

Mr. Wolfgang ERNST
Alfred-Wegener-Institute for Polar
and Marine Research
Am Hang 16
2852 Bederkesa
Federal Republic of Germany

Tel: 49 471 4831500
Tlx: 238695 POLAR D
Fax: 49 471 4831149

Mr. John S. GRAY
Department of Marine Zoology and Chemistry
University of Oslo
P.B. 1064
0316 Blindern
Oslo 3
Norway

Tel: 02 454510
Fax: 02 45 44 38

Mr. Chidi IBE*
Physical and Chemical Oceanography Division
Nigerian Institute for Oceanography and
Marine Research
PMB 12729 Victoria Island
Lagos
Nigeria

Tel: 01 619 517
Tlx: Thru UNDP or Unesco Lagos
Cbl: OCEANOGRAP

Mr. José M. LOPEZ*
Centre for Energy and Environment Research
University of Puerto Rico
College Station
Mayaguez
Puerto Rico 00708

Tel: 809 832 2616
Tlx: 3854558 CEERMY

Mr. Paul A. GURBUFT
Directorate of Fisheries Research
Ministry of Agriculture, Fisheries and Food
Fisheries Laboratory
Lowestoft
Suffolk NR33 0HT
U.K.

Tel: 44 502 562244
Tlx: 97470
Fax: 44 502 513865

Mr. Lars LANDNER
Swedish Environmental Research Group
Götgatan 35
11621 Stockholm
Sweden

Tel: 46 8 43 3759
Fax: 46 8 43 3759

Mr. Richard LLOYD
"Wild Oaks"
Woodside
Little Baddow
Chelmsford
Essex CM3 4SR
U.K.

Tel: 024 541 2754
Tlx: 995543 FISHBUR G
Fax: 0621 784989

Mr. John C. PERNETTA
Environmental Impact Assessment
2 Thomas Street
King's Lynn
Norfolk PE30 5QP
U.K.

Tel: 0553 767081
Fax: 0553 692608

Mr. John E. PORTMANN*
Ministry of Agriculture,
Fisheries and Food
Fisheries Laboratory
Remembrance Avenue
Burnham-on-Crouch
Essex CM0 8HA
U.K.

Tel: 0621 782658
Tlx: 995543 FISHBUR G
Fax: 0621 784989

Mr. Philip TORTELL
Environmental Management Ltd.
P.O. Box 17391
Wellington
New Zealand

Tel: 644 769276
Fax: 644 728628

Ms. Alla V. TSYBAN
Laboratory for Environmental
and Climate Monitoring
USSR State Committee for
Hydrometeorology
Pavlik Morozov per. 12
Moscow 123376
USSR

Tel: 160 24 09
Tlx: 411117 RUMS SU

* Unable to attend

Mr. Peter G. WELLS
Marine Environmental Quality
45 Alderney Drive (15th floor)
Dartmouth
Nova Scotia B2Y 2N6
Canada

Tel: 902 426 9632
Tlx: 019 21566
Fax: 902 426 2690

Mr. Herbert L. WINDOM
Skidaway Institute of Oceanography
P.O. Box 13687
Savannah
Georgia 31416
USA

Tel: 912 356 2490
Tlx: 7407530 HERB UC
Fax: 912 356 2571

Mr. Friedrich WUERGLER
Institute of Toxicology
Swiss Federal Institute of Technology
Schorenstr. 16
8603 Schwerzenbach
Switzerland

Tel: 01 825 10 10
Fax: 01 825 04 76

B. Secretariat

United Nations (UN)

Ms. Gwenda MATTHEWS
UN Technical Secretary of GESAMP
Office for Ocean Affairs and the Law of the Sea
United Nations
1 UN Plaza
New York, N.Y. 10017
USA

Tel: 212 963 3977
Tlx: 023 62450 UNATIONS

United Nations Environment Programme (UNEP)

Mr. Stjepan KECKES
UNEP Technical Secretary of GESAMP
United Nations Environment Programme
P.O. Box 30552
Nairobi
Kenya

Tel: 333930 or 520824
Tlx: 22068 UNEP KE
or 25164 UNEPRS KE
Fax: 2542 520711

Food and Agriculture Organization of the United Nations (FAO)

Mr. Heiner NAEVE
FAO Technical Secretary of GESAMP
Food and Agriculture Organization of the United Nations
Fishery Resources and Environment Division
Via delle Terme di Caracalla
00100 Rome
Italy

Tel: 00396 5797 6442
Tlx: 610181 FAO I
Fax: 00396 5782 610

United Nations Educational, Scientific and Cultural Organization (Unesco)

Mr. Gunnar KULLENBERG
Unesco Technical Secretary of GESAMP
Intergovernmental Oceanographic Commission
United Nations Educational, Scientific and Cultural Organization
7 Place du Fontenoy
75700 Paris
France

Tel: 331 4568 3983
Tlx: 042 270602 Unesco F
Fax: 331 4567 1690

World Health Organization (WHO)

Mr. Richard HELMER
WHO Technical Secretary of GESAMP
Division of Environmental Health
World Health Organization
41 Avenue Appia
1211 Geneva 27
Switzerland

Tel: 7913761
Tlx: 415416
Fax: 7910746

World Meteorological Organization (WMO)

Mr. Alexander SOUDINE
WMO Technical Secretary of GESAMP
World Meteorological Organization
P.O. Box 2300
1211 Geneva 2
Switzerland

Tel: 022 7308111 or 7308420
Tlx: 23260 OMM
Fax: 022 7342326

International Maritime Organization (IMO)

Mr. Konstantin VOSKRESENSKY
Administrative Secretary of GESAMP
Marine Environment Division
International Maritime Organization
4 Albert Embankment
London SE1 7SR
U.K.

Tel: 071 735 7611
Tlx: 23588 IMO LON G
Fax: 071 587 3210

Mr. Manfred K. NAUKE
IMO Technical Secretary of GESAMP
International Maritime Organization
4 Albert Embankment
London SE1 7SR
U.K.

Tel: 071 735 7611
Tlx: 23588 IMO LON G
Fax: 071 587 3210

International Atomic Energy Agency (IAEA)

Mr. Dominique CALMET
IAEA Technical Secretary of GESAMP
International Atomic Energy Agency
Division of Nuclear Fuel Cycle and Waste Management
P.O. Box 100
1400 Vienna
Austria

Tel: 00431 2360 2667
Tlx: 1-12645
Fax: 00431 2345 64

C. Observers

Intergovernmental Oceanographic Commission (IOC)

Mr. Gunnar KULLENBERG
Intergovernmental Oceanographic Commission (IOC)
Unesco
7 Place Fontenoy
75700 Paris
France

Tel: 00331 4568 3983
Tlx: 042 270602 Unesco F
Fax: 00331 4056 9316

Mr. Alexandros BOUSSOULENGAS
Intergovernmental Oceanographic Commission (IOC)
1, rue Miollis
75015 Paris
France

Tel: 331 45683992
Fax: 331 40569316

International Commission for Scientific Exploration of the Mediterranean
Sea (ICSEM)

Mr. Gérard BELLAN
CIESM
Station Marine d'Endoume
Rue Batterie des Lions
13007 MARSEILLE
France

Tel: 91041612
Fax: 91041635

International Council for the Exploration of the Sea (ICES)

Mr. J. Michael Bowers
Head, Marine Chemistry Division
Bedford Institute of Oceanography
P.O.B. 1006
DARTMOUTH
Nova Scotia
Canada B2Y 4A2

Tel: 902 426 2371
Tlx: 019 31552 BIO DART
Fax: 902 426 2256

ANNEX II

LIST OF DOCUMENTS

Agenda Item	Document	Submitted by	Title
1.	GESAMP XX/1	Administrative Secretary	Provisional agenda
2.	GESAMP XX/2	Chairman	State of the Marine Environment
3.	GESAMP XX/3	Steering group of Working Group No. 28	Report of the steering group
	GESAMP XX/3/1	Working Groups No. 28 and 29	Joint report of the working groups
4.1	GESAMP XX/4.1	WHO and Unesco Secretaries	Review of potentially harmful substances: carcinogens
4.2	GESAMP XX/4.2	Working Group No. 13	Report on the ad-hoc meeting on chlorinated hydrocarbons
4.3	GESAMP XX/4.3	Working Group No. 13	Review of potentially harmful substances: oil etc.
5.	GESAMP XX/5	Working Group No. 25	Status report 1990
6.	GESAMP XX/6	Working Group No. 1	Report of the Working Group
7.	GESAMP XX/7	Working Group No. 29	Report of the Working Group
	GESAMP XX/7/1	IMO Secretary	Proposal for reconsideration of the GESAMP definition of marine pollution
8.	GESAMP XX/8	Working Group No. 30	Report of the Working Group
9.	GESAMP XX/9	FAO Secretary	Proposal on a new WG on the Environmental Impacts of Coastal Aquaculture
	GESAMP XX/9/1	WMO Secretary	Proposal on a new WG on the Impact of Global Atmosphere Change on Marine Pollution
10.	GESAMP XX/10	UNEP Secretary	Preparation of the 1992 state of the environment report.

Information documents

	GESAMP XX/INF. 1	Administrative Secretary	Provisional list of participants
	GESAMP XX/INF. 2	Administrative Secretary	Provisional list of documents
4.1	GESAMP XX/INF. 3	WHO Secretary	Environmental effects of genotoxicants
	GESAMP XX/INF. 4	UNEP, Unesco and UN Secretaries	Request for comments on "preliminary statement" to UNCED
	GESAMP XX/INF. 5	UNEP Secretary	Information on IHO activities
	GESAMP XX/INF. 6	UNEP Secretary	Information on UNEP ocean programmes
	GESAMP XX/INF. 7	UN Secretary	Law of the sea/Protection and preservation of the marine environment

ANNEX III

Extract from "The State of the Marine Environment,
GESAMP Reports and Studies No. 39, 1990"

EXECUTIVE SUMMARY

1. In 1989 man's fingerprint is found everywhere in the oceans. Chemical contamination and litter can be observed from the poles to the tropics and from beaches to abyssal depths. But conditions in the marine environment vary widely.
2. The open sea is still relatively clean. Low levels of lead, synthetic organic compounds and artificial radionuclides, though widely detectable, are biologically insignificant. Oil slicks and litter are common along sea lanes, but are, at present, of minor consequence to communities of organisms living in open-ocean waters.
3. In contrast to the open ocean, the margins of the sea are affected by man almost everywhere, and encroachment on coastal areas continues worldwide. Habitats are being lost irretrievably to the construction of harbours and industrial installations, to the development of tourist facilities and mariculture, and to the growth of settlements and cities. Although difficult to quantify, destruction of beaches, coral reefs and wetlands, including mangrove forests, as well as increasing erosion of the shore, are evident all over the world. If unchecked, this trend will lead to global deterioration in the quality and productivity of the marine environment.
4. The growing exploitation of the coast is a reflection of population increase, accelerating urbanization, greater affluence and faster transport - trends that will continue throughout the world. Controlling coastal development and protecting habitats will require changes in planning both inland and on the coast, often involving painful social and political choices.
5. A wide range of activities on land contributes to the release of contaminants to the sea either directly or carried by rivers and the atmosphere, while sea-borne activities make a minor addition. Only a small part of those contaminants has spread beyond the limits of the continental shelf. The bulk remains in coastal waters and, in places, particularly in poorly flushed areas, has built up to significant levels. Our views on these contaminants are summarized below in what is judged as their current order of importance.
6. The rate of introduction of nutrients, chiefly nitrates but sometimes also phosphates, is increasing, and areas of eutrophication are expanding, along with enhanced frequency and scale of unusual plankton blooms and excessive seaweed growth. The two major sources of nutrients to coastal waters are sewage disposal and agricultural run-off from fertilizer-treated fields and from intensive stock raising. The degree of damage varies from area to area, reflecting site conditions and nutrient load. Nutrient contamination is costly in terms of lost resources and spoiled amenity but effective remedial action is difficult. It will involve large investments in treatment plants and in sludge and effluent disposal, and major changes in agricultural practices. It is also difficult to relate these inputs to the occurrence of blooms because the quantitative relations between nutrient input and eutrophication are unclear and because of the confounding role of other ecological factors and of climatic variations.

7. Microbial contamination from sewage causes many human diseases, including cholera and hepatitis A. Control requires proper design and siting of outfalls, coupled with rigorous surveillance of shellfish beds and their marketed products and the timely banning of contaminated seafood. Microbial contamination of sea water is also responsible for widespread outbreaks of gastro-intestinal diseases at ill-protected and crowded beaches and is a suspected cause of respiratory, ear, and skin infections among bathers.
8. The haphazard disposal of plastic material on land and from ships results in littering of beaches and seriously damages marine wildlife, particularly sea mammals, diving birds and reptiles. These may be injured by the ingestion of plastic fragments, or entrapped in plastic packing and fishing gear. Enforcement of existing regulations on land and at sea, and increased public education, should reduce considerably the amount of plastic refuse, while better design and utilization of plastics for packing and fishing purposes would minimize the risk to marine organisms.
9. Among synthetic organic compounds of concern, chlorinated hydrocarbons, though still high in the sediments of industrial coastal areas and in fatty tissue of top predators such as seals, are now decreasing in some northern temperate areas where restrictions on their use have been enforced long enough. Current levels have not caused widespread harm to marine life so far, with the exception of impaired reproduction in some mammals and fish-eating birds. Contamination appears to be rising in tropical and sub-tropical areas owing to the continued use of chlorinated pesticides there. Because chlorinated hydrocarbons persist in sediments, from which they may be reintroduced to the wider ecosystem, monitoring of organisms and sediments should continue. Recent recognition of the toxicity of the anti-fouling agent TBT for a number of species has resulted in early action to control its use in a few countries, and this control should be extended.
10. Oil is a highly visible contaminant. Notwithstanding the impact of large accidental spills, its main global impact is due to tar balls which, although generally harmless to marine organisms, may foul beaches and interfere with recreational activities, sometimes with major economic consequences in tourist areas. The presence of petroleum hydrocarbons in sea water and particularly in sediments, however, continues to be a matter of concern locally after accidents have released large amounts of oil that accumulate in sheltered areas, affecting amenity and living resources, especially bird life. While the damage is not irreversible, recovery can be slow.
11. Trace elements such as cadmium, lead and mercury, which occur in the marine environment both naturally and as a result of human activities, are now of less concern, except where high levels occur near contamination sources. Their discharge, however, should be kept under surveillance and monitoring should be continued to ensure compliance with current acceptable limits.
12. Radioactive contamination generates widespread public fears. Although artificial radionuclides from a number of sources, including nuclear installations, fall-out from weapon testing and, more recently, from the accident at Chernobyl, have added to the levels naturally occurring in sea water, these additions have had insignificant effects on man and other organisms. Planned discharges of radioactive effluents (e.g. from reprocessing plants) are tightly regulated and monitored, and the amounts currently released are decreasing.

13. While attention is focused mainly on contaminants that are clearly detectable in the sea, there is concern that very low concentrations of toxic substances may produce effects at the sublethal level that could build up over long periods with significant damage to ecosystems. It is recommended that the special studies required to address this problem be encouraged.

14. The global yield of fisheries has continued to increase in the past decade partly by exploiting new stocks, but a combination of overfishing and stock fluctuations due to natural events has led to the decline of certain fisheries and to instability of others. Toxic and microbial agents have not so far affected exploitable living resources on a wide scale, although some stocks, especially of shellfish in limited areas, have been declared unfit for human consumption. However, coastal nursery grounds and shallow waters are being increasingly degraded, and marine resources, both wild and farmed, could eventually be damaged on a global scale. In addition, the exploitation of living marine resources may degrade the environment by damaging habitats and altering food webs, while mariculture, which is rapidly expanding, generates its own local pollution and may upset the ecological balance by the introduction of exotic species and diseases.

15. These are problems on which action can be identified now. There are additional issues that cannot at present be fully assessed in relation to the seas, namely, the effects of climate change, including a possible rise in sea level resulting from global warming due to increases in greenhouse gases, and the impact of a reduction of stratospheric ozone, which may affect marine resources through increased exposure to ultraviolet radiation.

16. A number of international agreements now supplement national regulations aimed at protecting the seas. They concern mainly pollution from sea-borne sources and have played a role in reducing ocean pollution, particularly by oil residues. However, much remains to be done to control land-based sources, the main contributors to contamination of the sea.

17. We conclude that, at the end of the 1980s, the major causes of immediate concern in the marine environment on a global basis are coastal development and the attendant destruction of habitats, eutrophication, microbial contamination of seafood and beaches, fouling of the seas by plastic litter, progressive build-up of chlorinated hydrocarbons, especially in the tropics and the subtropics, and accumulation of tar on beaches. However, concerns may differ from region to region, reflecting local situations and priorities. Furthermore, throughout the world, public perception may still accord greater importance to other contaminants such as radionuclides, trace elements and oil. These were highlighted in the 1982 GESAMP Review and are considered again in the present report, but we now regard them as being of lesser concern.

18. While no areas of the ocean and none of its principal resources appear to be irrevocably damaged, and most are still unpolluted, while there are encouraging signs that in some areas marine contamination is decreasing, we are concerned that too little is being done to correct or anticipate situations that call for action, that not enough consideration is being given to the consequences for the oceans of coastal development, and that activities on land continue with little regard to their effects in coastal waters. We fear, especially in view of the continuing growth of human populations, that the marine environment could deteriorate significantly in the next decade unless strong, co-ordinated national and international action is taken now. At the national level in particular, the concerted application of measures to reduce wastes and to conserve raw materials will be essential. The efforts will be great and the costs high, but nothing less will ensure the continued health of the sea and the maintenance of its resources.

ANNEX IV

PROTECTING AND MANAGING THE OCEANS

Underlying Principles and Elements for the
Protection and Management of Marine
and Coastal Environments

I. INTRODUCTION

The principles of environmental protection, as defined by the 1972 United Nations Conference on the Human Environment (Stockholm 1972), and since amplified by the World Commission on the Environment and Development, have led to the identification of principles and concepts which are now broadly accepted as underlying effective management of the environment and its resources.

Sustainable development implies that the present resources used by the population should neither be degraded nor exhausted to the point where they can no longer support future generations. This further implies that renewable resources which are currently used should be managed on an optimal yield basis.

To achieve sustainable development therefore development activities must be analysed from an integrated viewpoint including economic, social, cultural and environmental factors, and activities must be based on the sound use of the global resources. In the light of this it is important to consider the contributions which marine environmental assessment, monitoring, management and planning may make to sustainable development.

This document outlines principles and concepts that provide a rational basis for the sustained use of the marine and coastal environment including marine pollution control measures reflecting the generally accepted principles for marine environmental preservation and protection (e.g. UNCLOS Part XII). They should be considered for the formulation of appropriate strategies for marine protection and management, whether regional or global in scope, and serve as a background for the development of such strategies.

This document was prepared by the IMO/FAO/UNESCO/WMO/WHO/IAEA/UN/UNEP Joint Group of Experts on the Scientific Aspects of Marine Pollution (GESAMP) on the basis of intersessional work and agreed at the twentieth session of GESAMP in May 1990.

II. STATEMENTS OF PRINCIPLE

II.1 Implications of sustainable development for marine environmental protection and management

The concept of sustainable development implies that the present use of the marine environment and its resources shall not prejudice the use and enjoyment of that environment and its resources by future generations. Past practices that have neglected this principle are the fundamental cause of many current environmental problems.

II.2 The need for an 'holistic' approach

In order to prevent the transfer of environmental problems from one sector of the environment to another, all sectors need to be managed and protected on a holistic basis that minimizes the impact of anthropogenic activities on the environment as a whole. It is both scientifically unsound and ethically wrong to take measures to protect one sector of the environment without considering the implications of that action to other sectors or the costs and benefits attendant on that action. Thus, protection of the marine environment must include mechanisms for the comparison of benefits and detriments associated with options in other sectors.

II.3 The global perspective

The oceans constitute one global integrated system. There is consequently a need to consider the effects of anthropogenic activities on near-field and far-field scales. This dictates that any marine protection and management strategy should be regional in design but global in concept.

The scale of impacts resulting from present human activities, such as greenhouse gas production that may adversely affect global systems and processes, emphasizes the need for this global perspective.

II.4 Scientific basis of environmental protection

The effectiveness of management actions to protect the ocean cannot be assessed without scientific analysis and knowledge. Accordingly, comprehensive protection strategies should incorporate scientific principles; however, it is recognized that decision-making frequently involves considerations other than scientific arguments. Close interaction among scientists and decision-makers is essential.

The uncertainties inherent in predicting the consequences or effects of anthropogenic activity may lead to inadequate control measures, ranging from none to overly restrictive ones. However, despite such uncertainties, sufficient data and understanding frequently exist to allow conservative scientific predictions of the potential for environmental damage. Judicious application of available information will generally support the development and implementation of appropriate control measures. Where appropriate data do not exist, additional research is considered essential.

II.5 Important scientific concepts

The concept of assimilative capacity was advanced in the Declaration of the 1972 Stockholm Conference on the Human Environment. It reflects the fact that the environment can accommodate change providing this is not accompanied by deleterious effects. This concept must, however, be augmented with complementary measures to minimize adverse effects on the environment, including reduction of

inputs at source, to the extent commensurate with social, economic and political circumstances. It must also be used within a mechanism for sound comparison among alternative options for the disposal of substances; this requires a multi-disciplinary approach.

Adoption of the assimilative capacity concept implicitly requires acceptance of a distinction between contamination and pollution with only the latter implying adverse effects on the environment or human health.

The concept of precaution is intrinsic to scientific prediction and allows the inherent uncertainties associated with scientific analysis and assessment to be accommodated. This concept has recently been adopted as a specific instrument of environmental protection policy under the titles of "the principle of anticipatory environmental protection" and the "precautionary approach". The assimilative capacity concept does not conflict with these expressions of precaution; indeed advice on the application of the assimilative capacity concept previously developed by GESAMP clearly emphasizes the need for the adoption of a precautionary approach using scientific conservatism to allow for uncertainty.

Several recent interpretations of the precautionary principle would seem to imply that protection of the marine environment can be attained solely by progress towards a zero discharge policy. This is a flawed approach; rejection of scientifically based impact assessments will prevent proper allocation of priorities and rational evaluation of alternative options.

III. SCIENTIFIC ELEMENTS OF STRATEGY

III.1 Environmental management and planning

Development inevitably implies environmental change. The challenge for marine and coastal zone management is to balance short-term development needs against the long term sustainability of ecosystems, habitats and resources such that the range of choices and opportunities available to future generations is not diminished by the consequences of present development choices.

Comprehensive area-specific marine management and planning is essential for maintaining the long-term ecological integrity and productivity and economic benefit of coastal regions. Such management must incorporate comprehensive planning of waste management, including reduction of wastes, beneficial use or recycling of wastes, and treatment and disposal options that result in minimum harm to the environment and human health. It should also include local and regional management plans supported by quality criteria, assessments, monitoring and research.

III.2 The need for cleaner technologies

Considerable degradation of the coastal marine environment has resulted from the use of manufacturing processes now seen to be wasteful and environmentally-hostile. While the problem has been exacerbated by poor waste management, even the best treatment and disposal practices cannot be guaranteed to protect the environment against a constantly increasing quantity of substances and wastes that cannot be productively recycled.

Progress in the fields of industrial design and chemical engineering now afford the opportunity to use manufacturing technologies that substantially reduce waste production and facilitate the containment of harmful substances. These technologies are applicable both to the development of new processes and to the up-grading of existing ones. Their application must be seen as an integral part of national and international programmes for the protection of the marine and all other sectors of the environment. To this end, greater attention must be given to the establishment of advisory services for the transfer of clean technologies into national programmes for industrial development. Such services should be linked to regulatory systems that provide for periodic waste audits and environmental impact assessments for all major industrial developments. A number of information centres on clean technologies have already been established.

III.3 Impact prediction and assessment

Impact prediction is an essential component of the broader Environmental Impact Assessment (E.I.A.) process.

The concerns regarding the effects of anthropogenic activities on the environment and human health comprise: physical alteration and disturbance of the natural environment; modification of natural biological systems; and the dispersion, fate and effects of chemicals into the environment. Impact prediction is the process whereby the potential effects or risks of anthropogenic activities on the marine environment are defined and quantified. Factors that need to be considered in an effect or risk prediction are: the scale (load) of the disturbance (physical, biological or chemical); identification of the critical components and processes of the system; and determination (modelling) of the fate and effects on the components which are potentially affected (hazard assessment). All of these factors embody a degree of uncertainty which usually can be quantified, and conservatively allowed for, in the assessment. Such predictions can be used to compare different development options on a common basis.

When an assessment reveals a potential problem, the relative scale of impact must be compared with those of alternative options. One of these options will be that of the abandonment of the proposed development. The assessment also provides a basis for a clearly-defined and well-focussed monitoring programme for ensuring that the consequences do not exceed those predicted.

Periodic reassessment of potential impact and of prevailing conditions in the affected environment is essential.

III.4 Classification of substances

Substances vary widely in the concentrations at which they can exert toxic effects on organisms. Their potential for transfer through food chains to predators, including humans, depends in part on their capacity for bioaccumulation. The extent to which a substance is distributed in the environment depends in part on its persistence. The three properties of toxicity, bioaccumulation and persistence in combination represent the hazardous properties of a substance and can be used as the basis for classification systems.

Such systems can be enlarged to include the risk of the substance appearing in certain environmental compartments at significant concentrations; relevant factors are the production, use, disposal and environmental distribution of the substance.

Existing classification systems vary in the extent to which these various properties and factors are utilized. Sub-division into classes is achieved by using arbitrary boundary criteria. Difficulties in allocation occur with chemicals whose attributes lie close to a class boundary. The accuracy of the relevant data available for each substance may be limited.

Classification systems provide only very crude guides to the potential harmfulness of substances. The classification of individual properties may be useful in the context of labelling, packaging and transport of substances, but inadequate as a basis for their environmental control and regulation. For this latter purpose, the totality of the relevant information on the individual properties and potential loads of each substance has to be subjected to critical scientific evaluation before an allocation to any grouping within a regulatory framework can be made.

III.5 Comparison of options

Marine environmental management implicitly requires that choices be made between various actions. Any decision to adopt a particular management strategy, technology or procedure should be preceded by a comparison of the advantages and disadvantages of realistically available alternatives. This does not mean that every conceivable alternative should be subject to detailed assessment.

While emphasis needs to be placed on the environmental advantages of the options considered, comparisons must also take account of economic and socio-political factors. This will require a systematic evaluation of scientific and technical alternatives and the integration of the findings of this evaluation with non-technical evaluations. This involves careful balancing of the overall costs and benefits taking account of inherent uncertainties. Preferred options will be those which provide for sustainable uses of the environment and resources while ensuring adequate protection of the environment and human health.

Actions designed to protect or manage the marine environment should also be evaluated for their potential to affect other sectors of the environment. Such evaluations should also take into account measures that prevent trans-frontier pollution or the unequal sharing of costs and benefits among neighbouring States.

It must be accepted that the relative state of knowledge on alternative approaches or technologies will vary. For this reason, direct comparisons between environmental and economic and socio-economic factors may sometimes prove difficult or impossible. These imbalances and associated uncertainties, as well as the steps required to reduce them, should be addressed within the comparative assessment process.

III.6 Monitoring

Considerable advances have been made in developing chemical and biological effects monitoring techniques. However, the potential for technically efficient and focussed monitoring has not yet been fully exploited.

Many current monitoring programmes have neither provided the required information on the state of the marine environment nor adequately determined the effects of anthropogenic activity that they were ostensibly designed to do. A further criticism is that monitoring programmes often continue without the periodic scientific and administrative reviews essential for ensuring their effectiveness.

Greater emphasis needs to be given to the specification of goals and objectives, the formulation of testable hypotheses, consideration and linkages between environmental compartments, quality control procedures and the statistical design of monitoring programmes.

When a well-designed monitoring programme results in unanswered questions about environmental impacts or early warnings of likely effects are detected, supportive research needs to be provided.

Monitoring programmes must also be tied to an a priori commitment for action when pre-determined consequences appear likely to be exceeded. Monitoring programmes must also be subject to regular assessment as to their effectiveness and revised or terminated if this is warranted.

IV. ORGANIZATIONAL ELEMENTS OF STRATEGY

IV.1 Institutional arrangements

The effective implementation of any strategy, or elements thereof, for marine environmental protection and management, at regional, national or international levels, depends upon cooperation and coordination among many agencies and jurisdictions.

Implementation of the strategy requires clear national policies based on international obligations, a sound legal basis, and opportunities for wide input and participation from all sectors of society. It must involve processes for planning and consultation between parties both at the onset and throughout the conduct of coastal management programmes.

Agreement between parties on the objectives and design of parts of the strategy is essential for achieving its goals. This is especially true for scientifically-based parts of the strategy such as monitoring.

A lead agency and committed cooperating agencies in each country, responsible and accountable for all policies, programmes and actions leading from the strategy, are also clearly required.

IV.2 Public awareness and participation

The ability of the public to distinguish between the relative importance of marine environmental issues needs strengthening. It is equally important that decision-makers are fully aware of public aspirations.

Many wrongly assume that public participation means decision-making by the public. On the contrary, the roles of the public and decision-makers are distinct.

Public participation in the process of decision-making should be encouraged and facilitated. Those who receive public input have an obligation to publicly indicate whether, how, and to what extent, public views have been taken into account when the final decisions are made.

IV.3 Data and information management

Effective marine and coastal environmental management requires the acquisition, storage, retrieval, exchange, quality assessment and application of appropriate data and information.

Information management facilitates the storage and access of data and reduces duplication and loss. It provides opportunities for the use of standard procedures of measurement and the efficient collection, compilation and storage of data, preferably in electronic form. It must incorporate quality assurance, the adoption of compatible data formats and ensure data retrieval in a form suitable for synthesis, evaluation, reporting and planning.

Integrated environmental databases, especially Geographic Information Systems (GIS), are essential for long-term coastal zone management. They readily assist in the translation of data of various types into accessible information useful for decision-makers.

IV.4 Legal obligations and enforcement

The obligations to protect the marine and coastal environment assumed by States through existing national legislation, as well as through regional and global agreements, must be implemented and enforced in a more effective way.

GESAMP REPORTS AND STUDIES PUBLICATIONS

These Reports may be obtained from any of the
Sponsoring Agencies in the Language(s) indicated:
English, French, Russian, Spanish

Rep. & Stud. No.	Title	Date	Language
1.	Report of the Seventh Session	1975	E,F,R,S
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 (Published also as UNEP Regional Seas Reports and Studies No. 42)	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
10.	Report of the Eleventh Session	1980	E,F,S
11.	Marine Pollution Implications of Coastal Area Development	1980	E
12.	Monitoring Biological Variables related to Marine Pollution	1980	E,R
13.	Interchange of Pollutants between the Atmosphere and the Oceans (First report)	1980	E
14.	Report of the Twelfth Session	1981	E,F,R
15.	The Review of the Health of the Oceans (Published also as UNEP Regional Seas Reports and Studies No. 16)	1982	E
16.	Scientific Criteria for the Selection of Waste Disposal Sites at Sea	1982	E
17.	The Evaluation of Hazards of Harmful Substances Carried by Ships	1982	E
18.	Report of the Thirteenth Session	1983	E,F,R,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,F,R,S
22.	Review of Potentially Harmful Substances	1985	E
23.	Interchange of Pollutants Between the Atmosphere and Oceans (Second report)	1985	E
24.	Thermal Discharges in the Marine Environment	1984	E

Rep. & Stud. No.	Title	Date	Language
25.	Report of the Fifteenth Session	1985	E,F,R,S
26.	Atmospheric Transport of Contaminants into the Mediterranean Region (Published also as UNEP Regional Seas Reports and Studies No. 68)	1985	E
27.	Report of the Sixteenth Session	1986	E,F,R,S
28.	Review of Potentially Harmful Substances. Arsenic, Mercury and Selenium (Published also as UNEP Regional Seas Reports and Studies No. 92)	1986	E
29.	Review of Potentially Harmful Substances. Organosilicon Compounds (Silanes and Siloxanes) (Printed in limited number by IMO and published also as UNEP Regional Seas Reports and Studies No. 78)	1986	E
30.	Environmental Capacity. An approach to Marine Pollution Prevention (Published also as UNEP Regional Seas Reports and Studies No. 80)	1986	E
31.	Report of the Seventeenth Session	1987	E,F,R,S
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	1989	E
36.	Pollutant Modification of Atmospheric and Oceanic Processes and Climate: Some Aspects of the Problem (Printed in limited number by WMO and published also as UNEP Regional Seas Reports and Studies No. 117)	1989	E
37.	Report of the Nineteenth Session	1989	E, F, R
38.	Atmospheric Input of Trace Species to the World Ocean	1989	E
39.	The State of the Marine Environment (Published also as UNEP Regional Seas Reports and Studies No. 115)	1990	E
40.	Long-Term Consequences of Low-Level Marine Contamination	1989	E
41.	Report of the Twentieth Session	1990	E

