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IMO/FAO/UNESCO-IOC/WMO/WHO/IAEA/UN/UNEP
Joint Group of Experts on the Scientific Aspects
of Marine Environmental Protection (GESAMP)

Report of the twenty-fifth session of GESAMP

Rome, 24-28 April 1995

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- GESAMP -

REPORT OF THE TWENTY-FIFTH SESSION

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FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS

Rome, 1995

NOTES

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32. Land-sea boundary flux of contaminants: contributions from rivers. (1987). Rep.Stud.GESAMP, (32):172 p.
33. Report on the eighteenth session, Paris, 11-15 April 1988. (1988). Rep. Stud.GESAMP, (33):56 p. Available also in French, Spanish and Russian
34. Review of potentially harmful substances. Nutrients. (1990). Rep.Stud. GESAMP, (34):40 p.
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40. Long-term consequences of low-level marine contamination: An analytical approach. (1989). Rep. Stud.GESAMP, (40):14 p.
41. Report of the twentieth session, Geneva, 7-11 May 1990. (1990). Rep. Stud.GESAMP, (41):32 p. Available also in French, Spanish and Russian
42. Review of potentially harmful substances. Choosing priority organochlorines for marine hazard assessment. (1990). Rep.Stud. GESAMP, (42):10 p.
43. Coastal modelling. (1991). Rep.Stud.GESAMP, (43):187 p.
44. Report of the twenty-first session, London, 18-22 February 1991. (1991). Rep.Stud.GESAMP, (44):53 p. Available also in French, Spanish and Russian

15. The review of the health of the oceans. (1982). Rep.Stud.GESAMP, (15):108 p.
16. Scientific criteria for the selection of waste disposal sites at sea. (1982). Rep.Stud.GESAMP, (16):60 p.
17. The evaluation of the hazards of harmful substances carried by ships. (1982). Rep.Stud.GESAMP, (17):pag.var.
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19. An oceanographic model for the dispersion of wastes disposed of in the deep sea. (1983). Rep.Stud. GESAMP, (19):182 p.
20. Marine pollution implications of ocean energy development. (1984). Rep. Stud.GESAMP, (20):44 p.
21. Report of the fourteenth session, Vienna, 26-30 March 1984. (1984). Rep.Stud.GESAMP, (21):42 p. Available also in French, Spanish and Russian
22. Review of potentially harmful substances. Cadmium, lead and tin. (1985). Rep.Stud.GESAMP, (22):114 p.
23. Interchange of pollutants between the atmosphere and the oceans (part II). (1985). Rep.Stud. GESAMP, (23):55 p.
24. Thermal discharges in the marine environment. (1984). Rep.Stud. GESAMP, (24):44 p.
25. Report of the fifteenth session, New York, 25-29 March 1985. (1985). Rep.Stud.GESAMP, (25):49 p. Available also in French, Spanish and Russian
26. Atmospheric transport of contaminants into the Mediterranean region. (1985). Rep.Stud.GESAMP, (26):53 p.
27. Report of the sixteenth session, London, 17-21 March 1986. (1986). Rep. Stud.GESAMP, (27):74 p. Available also in French, Spanish and Russian
28. Review of potentially harmful substances. Arsenic, mercury and selenium. (1986). Rep.Stud. GESAMP, (28):172 p.
29. Review of potentially harmful substances. Organosilicon compounds (silanes and siloxanes). (1986). Published as UNEP Reg.Seas Rep.Stud., (78):24 p.

1 INTRODUCTION

1.1 The Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection (GESAMP) held its Twenty-fifth Session at the Headquarters of the Food and Agriculture Organization of the United Nations, in Rome, Italy, under the Chairmanship of Mr O. Osibanjo. Ms H.Yap was Vice-Chairman of the Group.

Opening of the Session

1.2 Mr W. Krone, Assistant Director-General a.i. of the Fisheries Department of FAO, welcomed the Group to the Session on behalf of the Director-General of FAO, Mr Jacques Diouf. In referring to the important contributions GESAMP had made during the preparatory process for the Rio Summit and to the role GESAMP could possibly play in the implementation of programmes of the Global Environment Facility (GEF) and other activities aiming at the implementation of Agenda 21, he welcomed that GESAMP had moved from an advisory body dealing strictly with marine pollution problems to a group dealing also with scientific aspects of marine environmental management. Mr Krone expressed his hope that GESAMP, after having convened for the twenty-fifth time, will continue to play its important role for many more years.

1.3 The Chairman thanked Mr Krone on behalf of the participants for his good wishes for the success of the meeting and declared the Session open.

1.4 The Group then rose in silence to pay respect to the late Mr R. Lloyd, former member of GESAMP, who had passed away during the last intersessional period.

Adoption of the Agenda

1.5 The agenda for this Session as adopted by the Group is reproduced in Annex I. The list of documents considered at the Session is given in Annex II. Participants of the Session are listed in Annex III.

2 REPORT OF THE ADMINISTRATIVE SECRETARY

2.1 The Administrative Secretary of GESAMP informed the Group on the IMO activities related to the mandate of GESAMP. Particular reference was made to the amendment process embracing major international conventions, e.g., London Convention 72 (Amendment Group, 24-28 April 1995), MARPOL 73/78 (regulations for the prevention of air pollution from ships), SOLAS 74, etc.

2.2 In his statement, the Administrative Secretary touched upon such important items of the agenda as 'Future work programme' and 'Integrated coastal management'. In relation to the latter, he briefed the Group on the developments under two major technical cooperation projects financed by GEF and implemented by IMO:

- Programme for the Prevention and Management of Marine Pollution in the East Asian Seas, and
- Wider Caribbean Initiative for Ship-generated Wastes.

3 EVALUATION OF HAZARDS OF HARMFUL SUBSTANCES CARRIED BY SHIPS

3.1 Mr P. Wells, Chairman of the Working Group on Evaluation of Hazards of Harmful Substances Carried by Ships, informed GESAMP that the Thirtieth Session of the Working Group had been held during the intersessional period (27 February-3 March 1995). The main achievements at that session were a consideration of hazard profiles of chemicals, a preliminary review of GESAMP hazard evaluation rationale and parameters linked to the harmonization process for the classification of toxic chemicals requested by UNCED's Agenda 21 chapter 19, and a consideration of an IMO/GESAMP review panel to examine the classification criteria used by the Working Group. Mr Wells noted with deep regret the passing away of Ms Thea Adema, a valued member of the Working Group, and expressed his great appreciation for her contributions to the Working Group since its formation.

3.2 Mr Wells described briefly the work of the Working Group. White spirits were reinstated in the composite listing. The IMO Sub-Committee on Bulk Chemicals (BCH) had informed the Group about regrouping pollution categories and considering cleaning agents and the need for tests of biodegradability. The Marine Environment Protection Committee (MEPC) of IMO recommended that a panel of experts be established to review the current hazard evaluation procedure. The chemical data base was now available on disc for beta-testing. Several background papers had been prepared by the Working Group, preparatory to the revision of GESAMP Reports and Studies No. 35.

3.3 The Working Group's primary task was accomplished: it conducted eight revisions of previous profiles, assessed 15 substances submitted by nine companies, making a number of decisions on specific chemicals, and evaluated 34 substances proposed for inclusion in the IMO Chemical Codes. The Group was informed about ongoing efforts towards a globally applicable harmonized chemical classification and labelling system, and the request made by MEPC to set up a panel to review the GESAMP hazard evaluation scheme. The Working Group also started discussions on how to modify the scheme, adding new parameters and subdividing columns within the current scheme.

3.4 GESAMP was invited to comment on the Working Group's progress, especially on the recommendation to establish an IMO/GESAMP Review Panel on the hazard evaluation criteria. GESAMP members noted that the Working Group was fulfilling its terms of reference and conducting appropriate hazard evaluations, based on the intrinsic properties of chemicals. The Group indicated that the review panel's composition and function was the responsibility of IMO and that it should employ appropriate experts independently, not as GESAMP members. Several members stressed the need for a clear understanding of the distinction between hazard and risk assessment as reflected in GESAMP Reports and Studies No. 45. Accordingly, GESAMP adopted the following statement:

3.5 "Hazards relate to substances and are assessed solely on the basis of physical and chemical properties. Risk is a term that involves a combination of hazard of a substance and exposure of organisms to it. Risk therefore refers to the probability of adverse effects occurring. The relationship between hazard and risk is illustrated by Figure 3 of GESAMP Reports and Studies No. 45. It should be noted, however, that, as reflected in the footnote to this figure, there are no generally accepted definitions of the terms 'hazard' and 'risk' but, because distinction is essential, GESAMP has adopted the usage described above."

Reports and Studies GESAMP

The following reports and studies have been published so far. They are available from any of the organizations sponsoring GESAMP.

1. Report of the seventh session, London, 24-30 April 1975. (1975). Rep. Stud.GESAMP, (1):pag.var. Available also in French, Spanish and Russian
2. Review of harmful substances. (1976). Rep.Stud.GESAMP, (2):80 p.
3. Scientific criteria for the selection of sites for dumping of wastes into the sea. (1975). Rep.Stud.GESAMP, (3):21 p. Available also in French, Spanish and Russian
4. Report of the eighth session, Rome, 21-27 April 1976. (1976). Rep. Stud.GESAMP, (4):pag.var. Available also in French and Russian
5. Principles for developing coastal water quality criteria. (1976). Rep.Stud.GESAMP, (5):23 p.
6. Impact of oil on the marine environment. (1977). Rep.Stud.GESAMP, (6):250 p.
7. Scientific aspects of pollution arising from the exploration and exploitation of the sea-bed. (1977). Rep.Stud.GESAMP, (7):37 p.
8. Report of the ninth session, New York, 7-11 March 1977. (1977). Rep. Stud.GESAMP, (8):33 p. Available also in French and Russian
9. Report of the tenth session, Paris, 29 May - 2 June 1978. (1978). Rep. Stud.GESAMP, (9):pag.var. Available also in French, Spanish and Russian
10. Report of the eleventh session, Dubrovnik, 25-29 February 1980. (1980). Rep.Stud.GESAMP, (10):pag.var. Available also in French and Spanish
11. Marine Pollution implications of coastal area development. (1980). Rep. Stud.GESAMP, (11):114 p.
12. Monitoring biological variables related to marine pollution. (1980). Rep. Stud.GESAMP, (12):22 p. Available also in Russian
13. Interchange of pollutants between the atmosphere and the oceans. (1980). Rep.Stud.GESAMP, (13):55 p.
14. Report of the twelfth session, Geneva, 22-29 October 1981. (1981). Rep.Stud.GESAMP, (14):pag.var. Available also in French, Spanish and Russian

4.4 Scientific Needs for Marine Biological Conservation and Management [5]

See 4.3 above. This section will be the response to one of the main justifications for GESAMP undertaking such a report -- providing guidance on the scientific aspects of biological diversity conservation to various international agencies (*esp* GESAMP sponsors), programmes and conventions related to biological diversity.

V. PREVENTION AND CONTROL OF MARINE BIOLOGICAL DIVERSITY LOSSES

5.1 Strategic approaches-direct [15-20]

Control of pollution from land-based activities; integrated coastal area management including establishment of protected areas; action strategies for conservation of species; fisheries management strategies.

5.2 Strategic approaches-indirect [10]

Socio-economic; economic incentives and disincentives; institutions; education and training

5.3 International institutions and regulations [10-12]

General: Review of relevant clauses and articles of the most important legal instruments that can contribute to conservation of biological diversity such as UNCLOS, UN Convention on Biological Diversity, regional marine conventions and protocols, CITES, fisheries commission; IWC, etc. This review would also highlight gaps where noted, eg small marine mammals. [to be cross-referenced to 4.2]

Relationships between the various international institutions and regulations

VI. Conclusions and recommendations [6]

3.6 The Group endorsed the report of the Thirtieth Session of the Working Group, and, in particular, approved the hazard profiles that had been reviewed or established during the intersessional period.

3.7 A summary of the report of the Thirtieth Session of the Working Group, including its terms of reference and its members is presented in Annex IV.

4 ENVIRONMENTAL IMPACTS OF COASTAL AQUACULTURE

4.1 The FAO Technical Secretary of GESAMP Working Group 31 briefly described the background for the preparation of document GESAMP XXV/4, entitled "Monitoring of ecological effects of coastal aquaculture waste". He recalled that the first draft of this document, prepared by the Working Group during a meeting held 17-21 January 1994, had been presented and discussed at the Twenty-fourth Session of GESAMP (March 1994). Following the recommendations by that session, the report was reviewed and amended during a second meeting of the Working Group in Victoria, Canada (19-23 September 1994), to include all comments and suggestions received from experts, who had reviewed the first draft, as well as from GESAMP members. A summary of this report is given in Annex V.

4.2 The Chairman of the Working Group, Mr R. Gowen, introduced the second draft of the report, which provides an assessment of monitoring the effects of aquaculture waste. He emphasized the importance of viewing monitoring as part of the mechanism for managing aquaculture development, and the use of Environmental Impact Assessment (EIA) as a means of defining the potential effects of aquaculture waste and in the design of appropriate monitoring programmes.

4.3 Mr Gowen drew the attention of the Group to a chapter on "The use of models in environmental impact assessment" which is new to the report. The section discusses the use of models and presents details of models which have been used to predict the effects of aquaculture waste. He informed the Group that the section on "General principles of monitoring" has been modified in the light of comments made at the Twenty-fourth Session of GESAMP and comments received by invited experts.

4.4 Mr Gowen reiterated the difficulty in designing specific standardized monitoring programmes. To illustrate how monitoring programmes can be designed, the report details the variables which are commonly used in monitoring the effects of aquaculture waste, and presents five scenarios. Scenarios 1 and 3 are examples where the expectation is for a low level of impact with a corresponding low level of monitoring. Scenarios 2 and 4 attempt to show how modelling can be used to predict the effect of aquaculture waste and aid in developing a monitoring programme. Scenario 5 is an example of how evaluation of impact is used to limit development.

4.5 The final section of the report identifies key issues which need to be resolved if programmes to monitor effects of aquaculture waste are to be successfully implemented.

4.6 In the ensuing discussion, the Group provided numerous technical and editorial comments and suggestions on the report. Main discussion points focused on the use of impact prediction models, the utility of power analysis in statistical determination of required monitoring effort, the number of spatial and temporal replicates of sampling and

control sites, and on the relevance of pre-operational baseline studies and environmental auditing. It was also emphasized that monitoring should be seen as an integral part of EIA, and that EIA should also address positive and negative economic and social consequences of proposed developments. Where relatively large areas are designated under coastal management programmes for use exclusively by aquaculture, the design of monitoring programmes, in particular sampling strategies, should be adjusted accordingly. Some GESAMP members agreed that greater emphasis should be given to the use of models in predicting the ecological effects of aquaculture wastes.

4.7 It was noted that there are potential ecological and human health effects due to chemicals used by aquaculturists. However, the Chairman of GESAMP explained that this issue will be addressed by the Working Group when it tackles the issue of chemical usage in coastal aquaculture. It was felt that the introduction of this report should contain a section on its specific scope, to provide readers with a clear focus on the subject of this report. The introduction should also emphasize possible benefits of ecological monitoring for aquaculture, and highlight that any environmental assessment and monitoring effort be related to the scale of perceived impact of a given aquaculture operation.

4.8 The Technical Secretary of this Working Group introduced an addendum to section 8: "Perspectives", which contained primary features of ecological monitoring for consideration by farm managers, administrators and scientists when developing aquaculture-specific guidelines. In response, it was suggested to further emphasize the comparatively high costs of monitoring programmes designed to detect small ecological changes in contrast to those which require detection of big impacts.

4.9 In view of the discussion on this report, the Group agreed that the following steps should be completed before a decision on publication is taken:

- GESAMP members will provide their written comments on the report to Mr Gowen by the end of the current Session;
- Mr Gowen will revise the report accordingly, and send the report to all members of GESAMP as well as to all Sponsoring Agencies, and
- the decision on publication as GESAMP Reports and Studies No. 57 will be taken by the Chairman of GESAMP on the basis of the reactions of GESAMP members and Sponsoring Agencies.

4.10 With respect to the terms of reference relating to chemical usage, the Technical Secretary of this Working Group informed the Group of related discussions the Working Group had during its meeting in Victoria. The Working Group agreed to address a number of issues including quantities and types of chemicals used in coastal aquaculture, toxicity to non-target organisms, persistence in aquatic environments, stimulation of drug resistance, residues in non-cultured organisms, residues in aquaculture products, human health risks, on-farm management and regulation of chemical usage. GESAMP Working Group 31 would meet in December 1995 in conjunction with a regional workshop on chemical use in Asian aquaculture in order to benefit from the numerous presentations and discussions at this workshop.

3.2 Biological diversity in coastal systems [10]

Benthic: rocky intertidal and subtidal; sandy shores and mudflats; estuaries and wetlands; coral reefs and mangroves; subtidal shelves; Coastal pelagic and basin systems.

3.3 Biological diversity in the open ocean [10]

Deep sea benthic systems: general; hydrothermal vents; submarine canyons; sea mounts.

Open ocean pelagic systems: general; major ocean basins (Pacific, Indian, Atlantic), enclosed and semi-enclosed seas, tropic, sub-tropic, temperate, polar, etc.

[The foregoing sections to be highly illustrated with diagrams and accompanied by "boxes" and tables.]

IV. THREATS TO MARINE BIOLOGICAL DIVERSITY AND THEIR CONSEQUENCES

4.1 What causes loss of marine biological diversity? [15]

Direct: pollution (including marine debris); habitat loss; introductions of alien species; overexploitation; global climate change.

Indirect: economics; trade patterns; social systems; aid and loan systems; lack of institutions for management and regulation.

4.2 Overview of threats to marine biological diversity and their consequences [60]

This section will constitute the greatest amount of material to be presented in the document. For each of a number of geographic areas there will be a description of the marine biodiversity resources of the region; uses and exploitation of those resources; the threats to marine biological diversity of the region; and a brief discussion of the institutional framework related to marine biodiversity conservation and management; and suggestions for future action [these will be cross-referenced to section 5.3].

Geographic regions will include: Mediterranean, Black Sea, Baltic, North Atlantic and North Sea, North West Atlantic, South West Atlantic, West and Central Africa, East Africa, South Asia, Northwest Indian Ocean, etc. [sections will be based on a series of regional overviews]

Discussion of threats to biological diversity that do not fall easily into the regional approach.

4.3 Summary of threats and consequences [8]

The summary will contain not only an assessment of what is "known" or within the realm of intelligent speculation, but also an explanation of what is not known. This will be taken into account in formulating the following sections which address needs for management in particular in relation to scientific research and monitoring.

II. BIOLOGICAL DIVERSITY AND ITS VALUE

2.1 Definitions [3]

Genetic diversity; taxonomic diversity; ecosystem diversity; functional diversity; species richness, interspecific interactions, stability, resistance, variability, etc. This section needs to be a basic, but brief primer on terminology.

2.2 Keystone species [2]

Certain species have more importance than their abundance or biomass suggests (eg, sea otters-kelp-abalone; *Acanthaster*; etc); the relative importance of keystone species within the overall level of a community must be taken into account.

2.3 Taxonomic and functional diversity [2]

Different species and different assemblages of species may or may not perform the same ecological functions (eg fixation of carbon may be just as efficient in a system with low species diversity as in one with high species diversity). Thus the argument here would lead to the conclusion that it does not necessarily follow that systems with high taxonomic diversity are more important than those with a low diversity.

2.4 Genetic diversity [2]

Genetic variation that occurs among members of the same species. How genetic diversity affects the ability of populations to adapt to environmental changes. Long term evolution, adaptation to environmental changes versus short term changes, extinctions.

2.5 Why is diversity so important ? [5-7]

Loss of genetic diversity weakens a population's ability to adapt; loss of species diversity weakens a community's ability to adapt; loss of functional diversity weakens an ecosystem's ability to adapt; loss of ecosystem diversity weakens the biosphere's ability to adapt. Since biological processes and physical processes are interactive, losses of biological diversity may lead to environmental change. There is a circularity in that this may lead to further impoverishment of biological systems [not to be mistaken with the Gaia hypothesis]

III. MARINE BIOLOGICAL DIVERSITY

3.1 The nature of marine systems [10-15]

Time and spatial scales of marine systems; physical properties of marine environments; chemical properties of marine environments. How marine systems differ from terrestrial systems; physical, chemical and biochemical. Biological interactions between marine organisms. Gradients of marine biodiversity. Biological diversity in different marine systems: biotic and physical control mechanisms. Biomes and biogeographic provinces.

4.11 With regard to the terms of reference relating to the integration of aquaculture into coastal area management schemes it was recommended that the members of the Working Group continue to compile and review relevant information with particular emphasis on related experiences worldwide.

5 OPPORTUNISTIC SETTLERS AND THE PROBLEM OF THE CTENOPHORE *MNEMIOPSIS LEIDYI* IN THE BLACK SEA

5.1 The UNEP Technical Secretary of GESAMP reminded the participants that the Working Group on opportunistic settlers and the problem of the ctenophore *Mnemiopsis leidyi* in the Black Sea had been established by GESAMP at its Twenty-third Session at the request of UNEP. The main task of the Working Group was to advise Black Sea countries and UNEP on possible courses of actions to manage the problem of the massive population explosion of *Mnemiopsis leidyi* in the Black Sea. IMO, FAO and Unesco-IOC had agreed to support activities of the Working Group. Messrs Y. Sorokin and P. Wells were requested to co-chair the Working Group. A first meeting of the Working Group was convened in Geneva from 10 to 14 January 1994.

5.2 The report of the first meeting was considered at the Twenty-fourth Session of GESAMP. It was agreed that the Working Group should continue its work under the following modified terms of reference:

- to assess the occurrence, distribution, reproductive biology and physiological features of the intruder ctenophore, its ability to compete for food with pelagic fish, and control of its population by predators in its natural habitat;
- to assess the probable causes of the ctenophore outbreaks and their connection with other destabilizing factors and developments in the Black Sea region;
- to assess the impact of the ctenophore on pelagic and benthic communities and its consequence for fisheries, and
- to develop a strategy, and to recommend measures, to overcome the ctenophore and similar invasions in other parts of the world, using the Black Sea region as an example.

5.3 Taking into account this instruction, two members of the Working Group were requested by UNEP to formulate possible strategies prior to the second meeting of the Group. They suggested that in order to prevent further damage by *Mnemiopsis leidyi* to the pelagic ecosystem of the Black Sea, and to restore it to a commercially productive state, a strategy based on the biological control of population of *Mnemiopsis leidyi* must be exercised. Their analyses facilitated substantially further deliberations of the Working Group.

5.4 The second meeting of the Working Group was convened in Geneva from 20 to 24 March 1995. The membership of the Working Group was extended by inclusion of several new members from the region to enlarge its expertise in the state of Black Sea ecological system and biology and distribution of *Mnemiopsis leidyi*. As a result much more factual data were used to support suggested strategy. The meeting prepared the final report of the Working Group for consideration and eventual approval by GESAMP.

5.5 The report was presented to this Session by Messrs P. Wells and Y. Sorokin, Co-Chairmen of the Working Group.

5.6 Mr Wells described the approach taken in the report, stating that it covered the topics of distribution and ecology of the comb-jelly, the causes of the outbreak, the alteration of the Black Sea ecosystem, its impact on Black Sea fisheries, the needs for monitoring and modelling, and the choice of appropriate control strategies. The report was improved over previous versions, due to the substantial efforts and contributions of Working Group members.

5.7 Mr Sorokin stated that the invasions by exotic species into coastal areas and inland seas is becoming extremely common and causes a drastic transformation of the ecosystem. It contains a list of recent invasions among which the ctenophore *Mnemiopsis* invasion into the Black Sea and adjacent seas was most pronounced and caused more drastic economical and environmental losses. In detail the report analyses the time scale of this invasion, the spatial distribution of the invading ctenophore in the Black, Azov and Marmara Seas, and gives information regarding long-term fluctuation of its population density (biomass). In the Black Sea, after peaking in 1988-90, the ctenophore population decreased, but it started to rise again in 1994.

5.8 The invasion of *Mnemiopsis* correlates with a drastic alteration of the whole pelagic ecosystem in the basins of the Black Sea area and even affected the benthic fauna. The basic aspects of such alteration and its impact upon the fishery is treated in the report in detail, showing grave losses to the fisheries and economies of the Black Sea countries. The report analyses the causes of this vigorous outbreak of the invader, concluding that it was preconditioned by the recently anthropogenic transformation of the Black Sea ecosystem.

5.9 Mr Wells then continued, describing how the most feasible strategy for eradicating or controlling the introduced species, i.e., the comb-jelly was chosen. The Working Group considered that ecological control by species introduction or enhancement, i.e., biological control, had a realistic chance of success. This control strategy could be deployed by enhancing local fisheries (creating new fishery resources, rehabilitating pelagic fish stocks, and developing alternative mariculture facilities), in particular, by improving the horse mackerel stocks and introducing both vertebrate (fish) and invertebrate (comb-jelly) predators. It was noted that such a recommended biological control programme, including fisheries enhancement, required a cautious approach and the agreement by Black Sea coastal states as to its benign nature. Such a strategy should also be accompanied by appropriate research and monitoring, as described in the report.

5.10 Consideration of the report by GESAMP members resulted in a number of points. These were:

- The problem of invading species is not unique to the Black Sea region, but is a global problem. Not only have invasions occurred naturally over millions of years, they have become common in recent years due to human activities. Such invasions have often led to dramatically altered ecosystems, with severe economic effects.

Appendix 3

Draft Annotated Outline for the report

Note: The report would be about 180 - 200 pages not counting annexes. The numbers given in [] is the estimated page count for the relevant section. The report would have an Executive Summary at the beginning which would be written in such a way that it could be printed and circulated under separate cover. The annotations are provided as a general "stream of consciousness" set of statements to help the reader of this proposal understand the suggested approach; obviously one of the first tasks of the Working Group would be to agree on a working outline for the report, it being accepted that the present outline is somewhat optimistic in its proposed content. Nonetheless:

EXECUTIVE SUMMARY [8]

I. INTRODUCTION

1.1 Biological Diversity Conservation: an emergent global issue [4]

Taxonomists *crie du couer* concerning cataloguing of species and genes, eg E.O. Wilson and others; concern for the rights to benefits from genetic resources and biologically active substances(eg, concern of plant breeders, FAO; the 1960s "drugs from the sea" initiatives; and others) which led to the basis for initial drafts of the biodiversity convention); the conservation movement (endangered species and protected areas); Stockholm - 1972, Brundtland Commission, World Conservation Strategy, Biodiversity Conservation Strategy; Caring for the Earth; UNCED and the signing of the Biodiversity Convention.

Antecedent and concurrent initiatives relevant to the emergence of the biodiversity issue: fisheries management approaches (MSY, etc); UNCLOS; CITES; Bern Convention; regional marine conventions, esp protocols on protected areas and species; formulation and adoption of Agenda 21, Chapter 17; GESAMP 39, State of the Marine Environment; etc.

1.2 Current Trends in Biological Diversity Conservation [4]

Implementation of the Biological Diversity Convention, including what specific actions are intended and the basis for these actions (eg workplan of the Subsidiary Body on Scientific, Technical and Technological Advice of the Biological Diversity Convention); follow-up to the 1995 Washington meeting on the "protection of the marine environment from land-based activities"; steps toward the implementation of UNCLOS and regional seas conventions (in particular protocols concerning land-based pollution, species and protected areas). Future directions and concerns including relationships between various international legal instruments, action plans and programmes of nations, regional and international institutions.

2. Working Group Membership Profiles

Described below are several areas of expertise needed for inputs to the report of the Working Group. If the Working Group is to be limited to about seven members then it is obvious that some individuals will have to be knowledgeable in more than one area. How this expertise is represented within the individuals eventually nominated for the working group will have to be decided by the Chair, GESAMP and the Technical Secretaries of the sponsoring agencies. The profiles that follow are given as a guide to the decision-making process.

2.1 Marine Functional Diversity: working knowledge and grasp of the time and spatial scales of oceanic physical and chemical processes; understanding of how changes in these processes affect populations and communities of marine organisms.

2.2 Marine Ecology: basic working knowledge of trophodynamics of marine ecosystems; food-webs; understanding of the variety and types of marine biological communities; interactions between marine organisms; energy flows; understanding and experience with the Large Marine Ecosystem (LME) approach.

2.3 Marine Species: working knowledge of threatened and endangered marine species; access to networks of individuals that can be accessed for this knowledge.

2.4 Marine Genetic Diversity: understanding of how losses of genetic diversity are brought about and what this means in terms of adaptability of a population to changes in its environment

2.5 Marine Pollution: understanding of origins of marine pollutants and their effects on marine organisms and communities; familiar with extent of different types of pollution on a region-by-region and global basis.

2.6 Fisheries Management and Statistics: familiarity with changes in catches of various species in various fisheries world-wide; working knowledge of management approaches to fisheries (MSY; OSY; Precautionary Principle, etc); knowledge of how diversity of various fisheries are being affected.

2.7 Marine and Coastal Habitats: working knowledge of various kinds of coastal systems and habitats, rocky shores, sandy beaches, mud-flats, estuaries, coral reefs, mangroves, sea-grasses, open ocean benthic and pelagic systems; knowledge of how and where these systems are being threatened.

2.8 Coastal Area Management: familiarity with approaches to management of coastal areas and how current practices impinge on marine biodiversity;

2.9 Legal and Institutional Arrangements: experience with scientific, management and legal institutions and their relevance or approaches to marine biological diversity conservation and management (*esp* regional and international treaties and programmes of the international agencies); and

2.10 Socio-economic Aspects: familiarity with global and regional funding mechanisms related to marine biological diversity (*eg*, bilateral and multilateral banks, GEF, trust-funds, etc); and social policy approaches to marine resource management.

- The Working Group has recommended that biological control appears to be the most appropriate strategy to combat the introduction of the comb-jelly and contribute to restoring the Black Sea. GESAMP urged caution in implementing introductions of alien species (including biological controls) because of ecological concerns and also in light of general international legal rule.
- At the same time the Group believes that restoration of high water quality in the Black Sea by reduction of nutrient and chemical inputs will also play a major part in re-establishing fish stocks that are natural predators or competitors with the comb-jelly. This re-establishment of fish stocks can be achieved by reducing fishing effort, by fish releases from aquaculture and by restoring habitats.
- The Group believes that there is considerable data available which would allow modelling of the dynamics of the system which will include predator-prey relationships. Such modelling should not preclude remedial actions being undertaken.
- The Group urges that more efforts be devoted to focused monitoring of environmental conditions and the distribution of the comb-jelly.
- The Group recommends that cost-benefit analyses should be carried out on each of the control strategies suggested.

5.11 Suggestions were also made to correct and improve the report by (not in priority): ensuring full editorial corrections, including a change in title to "The Invasion of the Ctenophore *Mnemiopsis leidyi* in the Black Sea"; listing action items as immediate, short- or long-term; expanding the section on monitoring; adding a suitable photograph of *M. leidyi*; ensuring that all feasible control options are discussed; making suitable reference to the Bucharest Convention and its role in controlling pollutants from the Danube River system; omitting misleading statements on cause and effects; mentioning appropriate international law relating to introduced species, especially in ballast water; and including an executive summary in the report.

5.12 The Group agreed that the report should be published after editing as GESAMP Reports and Studies No. 58, incorporating comments provided by GESAMP members at this meeting and reformatting it into standard GESAMP publication style. The Executive Summary is attached to this Report as Annex VI.

6 SEA-SURFACE MICROLAYER

6.1 The WMO Technical Secretary of GESAMP recalled that Working Group 34 on the Sea-Surface Microlayer was established by the Twenty-third Session of GESAMP in April 1993 to prepare a report on current understanding of the physics, chemistry and biology of the sea-surface microlayer with particular reference to its role in global environmental change and as a marine habitat. A draft report prepared at the Working Group meeting in February 1994 had been submitted to the Twenty-fourth Session of GESAMP, which in the course of lengthy and detailed discussion of the draft, made many comments with regard to some assumptions, statements and conclusions in the report, and proposed what additional considerations should be taken into account. The Group had agreed that a core group of Working Group 34 should meet in summer 1994 to complete and revise the

report taking into account the GESAMP comments (as reflected in GESAMP Reports and Studies No. 53) and to present the final report to GESAMP in 1995 for approval. The Core Group met in Norwich, UK, from 21 to 24 August 1994 and the revised report was submitted to the present Session as document GESAMP XXV/6.

6.2 The Chairman of the Working Group, Mr R.A. Duce, noted that the Core Group was confronting a difficult task in balancing the conflicting arguments and viewpoints regarding a number of issues, especially in Chapter 3 on biological effects of chemical changes, and trying to avoid any speculations not based on proved scientific evidence and reliable data. He also noted that GESAMP comments had been taken into account to the extent as deemed appropriate by the Core Group and that additional information (e.g., on TBT in the sea-surface layer) was also added to the report. Finally he expressed hope that the amended report would be agreeable in essence to the GESAMP members and to all the experts involved in the preparation of the report.

6.3 In the subsequent discussion, the Group noted the scientific value of and essential progress in improving the report. At the same time it was noted that the report still required some clarifications and corrections. In particular, the Group was of the opinion that the Executive Summary did not reflect the tasks which were put forward to the Working Group, the present state of knowledge of the sea-surface microlayer and the GESAMP conclusions on this matter. Other comments were related to the following:

- overstatements of the importance of the sea-surface microlayer in Chapter 3 on biological effects of chemicals (sections 3.1 and 3.4);
- clarification of the use of the word "bioavailability" in section 3.7 on effects of chemical contamination;
- clarification with respect to biological effects for dependent vs opportunistic species in the microlayer (in section 3.4);
- phase out of tributyl tin (TBT) use in small boats in restricted coastal regions (section 3.7);
- inconsistencies in the discussions of poly-aromatic hydrocarbons (PAHs) in the section on the effects of chemicals (section 3.7), and
- more emphasis on the role of the microlayer in sea-to-air transport of materials, especially those harmful to human health (section 2.3).

6.4 The Group agreed that an *ad hoc* group be established during the Session to revise the Executive Summary of the report on the sea-surface microlayer. It was also agreed that some minor corrections, including editorial ones, would be given to Mr Duce, the Working Group Chairman by the GESAMP members during the present Session, and that the report will be revised taking the comments and corrections into account. The revised Executive Summary was later considered and adopted by GESAMP (see Annex VII). The Group also agreed that the revised report on the sea-surface microlayer and its role in global change be published as GESAMP Reports and Studies No. 59, and that abstracts of papers presented at the Working Group meeting in 1994 should not appear as an Annex in the final report since they would be published in full in a separate book.

While undertaking its task, especially in formulating its recommendations, the Working Group will take into account the various global and regional conventions and actions plans as well as other initiatives which are concerned with the management, use and conservation of marine biological diversity. These should include:

- The United Nations Convention of the Conservation of Biological Diversity (with special reference to the work of the Subsidiary Body on Scientific, Technical and Technological Advice);
- The United Nations Convention on the Law of the Sea;
- the various Regional Seas and other regional conventions (eg the Antarctic Treaty System), in particular their protocols on protected areas and species;
- The Convention on International Trade in Endangered Species;
- global conventions related to marine protection (eg MARPOL);
- treaties and agreements related to fisheries, marine mammals, and highly migratory species; and
- others as deemed appropriate by the Working Group.

The Working Group will deliberate through correspondence amongst themselves and with established regional and specialist networks and through consultations during two or three Working Group meetings. Observers may be invited to participate in meetings.

Appendix 2

Suggestions for composition of the Working Group

1. General

It is proposed that the Working Group consist of about 7 persons including those members of GESAMP that would be co-opted to the group. Each member would be chosen on the basis of:

- demonstrated knowledge and background required for the various sections of the proposed report;
- an individual's access to a network of others that could be called upon to provide inputs to the report, in particular for regional reviews and specialist topics;
- working from an established institutional base which would facilitate making a contribution to the review and consultation process and the report; and
- commitment (time, energy and intellect) to participation in, and contribution to, the tasks of the Working Group.

Appendix 1

Draft Terms of Reference

1. Background

During the 25th Meeting of GESAMP (FAO Headquarters, Rome, 24-28 April 1995) a request was made by the UNEP Technical Secretary to establish a "Working Group on the Threats to Marine Biodiversity and their Consequences". The terms of reference for the Group were proposed as follows.

2. General

The purpose of the Working Group is to review the status of threats to marine biological diversity especially at the genetic, taxonomic, community, ecological and functional levels. This assessment will be used as the point of departure for making recommendations concerning the amelioration of the threats to marine biological diversity.

The Working Group will pay particular attention to articulating the scientific foundation for their assessment of threats which in turn will be based on a review of current scientific literature covering the concepts and definitions concerning biological diversity.

3. Specific

The Chair, to be designated by GESAMP, in consultation with Members and Technical Secretaries of GESAMP, will nominate about seven members for the Working Group. These will be drawn from existing GESAMP Members as well as individuals that are not members. The aim will be to ensure that the Working Group represents a wide range of backgrounds that are related to an understanding of the concepts of biological diversity, threats to biological diversity and the institutions concerned with biological diversity conservation and management. A suggestion for the general composition of the group is presented in Appendix 2.

The Working Group will review the literature and practices concerning marine biological diversity and prepare a report of about 180 pages which will aim to:

- articulate the current scientific understanding of biological diversity and its importance, as well as the application of biological diversity concepts;
- review the threats to biological diversity, both globally and regionally; and
- to make recommendations concerning actions that can be taken to better protect, conserve and manage biological diversity.

As a point of departure for the Working Group a draft outline for an eventual report is presented in Appendix 3. The Working Group may wish to alter the proposed approach on the basis of its deliberations and the results of its findings.

7 INTEGRATED COASTAL MANAGEMENT

7.1 The FAO Technical Secretary of the Task Force on Integrated Coastal Management (ICM) established by GESAMP during its Twenty-fourth Session, in introducing this agenda item, noted that the Task Force has been formed by the Co-Chairmen, Messrs J. Gray and S. Olsen, and had met in Rome, 28 November-2 December 1994. Following this meeting, sections of the proposed report had been drafted. A summary of the report is attached as Annex VIII.

7.2 Mr S. Olsen, in introducing the draft sections, noted that a valuable contribution which GESAMP can make to the continuing debate on the attributes and scope of integrated coastal management is to review experience in selected developing and developed countries in order to identify the characteristics of viable approaches to resolving important coastal issues. He noted that four case studies had been selected which met the following criteria: addressed multiple sectors; had advanced into the implementation phase, and were representative of a range of scientific inputs. It was apparent in retrospect that the work of the Task Force would have been facilitated if a conceptual framework to provide a basis for an analysis of the case studies had been prepared prior to the meeting. The draft made available to GESAMP represented an attempt to provide such a framework. Mr Olsen emphasized that this document was not intended to be reviewed formally, but to provide a basis for reviewing progress to date.

7.3 In the discussion of the draft sections of the report, there were differences of view with regard to the direction which had been taken by the Task Force. Many members expressed concern that the approach did not as yet give sufficient attention to the roles of science. Some members, however, found merit in the draft, noting that it was a basis for identifying the contributions of natural and social scientists to the integrated coastal management process. A number of detailed comments were made with regard to how the text might be improved.

7.4 During the discussions, it became evident that a clear and concise description of the ICM process would be needed as a foundation for any work by GESAMP on scientific contributions to ICM projects.

7.5 GESAMP recommended that for the continuance of the study of integrated coastal management, the Terms of Reference should be better focused. GESAMP appreciates that ICM cannot be successfully implemented without the incorporation of appropriate science. Accordingly, the purpose of this study is to enhance the utilization of science in the protection and management of the coastal area by preparing concise guidance on applications of science to integrated coastal management.

7.6 The revised Terms of Reference of this study are as follows; they should be dealt with consecutively:

- present a concise description of the structure of ICM emphasizing its scope and objectives;
- identify and evaluate the scientific elements (social and natural) required to support the stages of the ICM process drawing on an analysis of ICM case studies, and

- identify factors and approaches that have either facilitated or impeded the incorporation of science into ICM.

8 MATTERS OF CONCERN WITH REGARD TO THE STATUS OF THE MARINE ENVIRONMENT

Matters of Concern

8.1 Since the phasing out of tributyl tin (TBT) as an antifouling agent, companies had turned to copper-based substitutes. These, however, were not particularly effective and now paint manufacturers are incorporating triazine-based herbicides as extra additives. High concentrations of products of these substances have been found at several kilometres from marinas where they are used. These may lead to inhibition of growth in natural phytoplankton and algal communities. The Group requested the Working Group on the Hazards of Harmful Substances Carried by Ships to evaluate all available data and to report on its results to the Twenty-sixth Session of GESAMP.

8.2 Recent open-literature data from freshwater environments show that a range of substances (including DDT, PCB, dioxins, PAH) have oestrogenic effects on fish where male fish develop female organs. The finding is that a wide variety of different chemicals have the same effect even though they are greatly different from natural oestrogens. Concern is also being expressed about the action of these "oestrogenic mimic" chemicals in humans where they have been implicated in falling sperm counts. GESAMP believes that this is a matter of potential concern and urge that research efforts be devoted to the study of potential effects of oestrogenic mimic chemicals in the marine environment.

State of the Marine Environment

8.3 The Sponsoring Agencies asked the Group to consider the feasibility of preparing a "State of the Marine Environment" for the year 2000, advising that if such a project were to be undertaken, it would almost certainly call for a new concept and approach, if only in view of the more limited resources now at their disposal.

8.4 The Group noted with satisfaction, the wide use made of the 1990 "State of the Marine Environment" report (GESAMP Reports and Studies No. 39) by UNCED and other recent policy-making fora, and the continuing emphasis on the fundamental importance of periodic review, assessment, and specification of problems and priorities. This is the basic mission of GESAMP and is laid down in its Terms of Reference.

8.5 The Group emphasized the importance of ensuring that a contemporary and coherent analysis of the state of the marine environment is available to the international community to underpin the development of policies and programmes relating to marine environmental protection and the sustainable use of marine and coastal resources. The Group agreed that while the 1990 "State of the Marine Environment" continued to serve this purpose, it could not be expected to do so beyond the year 2000, and that steps would have to be taken as soon as possible to commence a new assessment.

8.6 The Group also concluded that it was not only necessary, but highly desirable that the next "State of the Marine Environment" should be based on a new concept and be prepared under a new approach. In reaching this conclusion, the Group pointed *inter alia*

Convention itself but also for the initiatives being carried out under the auspices of other legal agreements and by other institutions.

6. As stated earlier, concerns with biodiversity including those issues that have led to the formulation and adoption of the Biological Diversity Convention have been heavily biased toward the terrestrial. It is reasonable to assume that very little effort was made during the negotiation of the Convention to extrapolate these terrestrial concerns and their perceived solutions to the marine environment. It may turn out therefore that the charge given to the SBSTTA will involve some nearly intractable work. Much of the past experience and outputs of GESAMP could contribute to facilitating that work in particular in terms of providing a basic understanding of the role and importance of marine biodiversity and concerning the threats to marine biodiversity and their consequences. At the same time such an effort would also contribute to underpinning the work of other institutions and legal regimes concerned with marine biodiversity. This would include the agencies sponsoring GESAMP which are not only concerned with how their own programmes and member states relate to the Biodiversity Convention but also how they both relate to other regimes and international programmes, as well.

7. Traditionally, GESAMP has been concerned with the scientific aspects of marine pollution in the strictest sense; in particular with the sources and distribution of pollutants and their effects, and mostly at the level of species and communities. More recently GESAMP has taken a broader point of view in keeping with the recognition that protection of the marine environment from pollutants requires not only prevention, but better and more integrated management of marine resources and their environments.

8. Presented briefly in the previous sections is an analyses of some current issues concerning biodiversity conservation and conclusions about gaps in concepts and knowledge. In keeping with its newly adopted mandate GESAMP has a role to play which would provide scientific underpinning to the efforts of a number of institutions and legal regimes, in particular the Biodiversity Convention, with regard to conceptual approaches to marine biodiversity conservation as well as valuable information concerning the threats to marine biodiversity and its consequences.

9. It is therefore proposed that GESAMP establish a new Working Group which would prepare a review of "The Threats to Marine Biodiversity and their Consequences". Respectively, Appendices 1-3 present draft Terms of Reference, suggestions of profiles of expertise needed within the composition of the proposed Working Group and a draft annotated outline for the report of the proposed Working Group.

THREATS TO MARINE BIOLOGICAL DIVERSITY AND THEIR CONSEQUENCES

Summary of a proposal for a new Working Group

1. Note: These are the extracts from the paper prepared by Mr D. Elder on behalf of the United Nations Environment Programme. It represents the views of the author only; it does not necessarily reflect the opinions or policies of the United Nations Environment Programme, nor of any of the sponsoring agencies of GESAMP. The full document was presented to this session of GESAMP as document GESAMP XXV/9.2

BACKGROUND.

2. There is a broad lack of precision in definitions and usage of terminology concerning *biodiversity* and *biological diversity* which is due to a lack of a clear scientific understanding of biodiversity concepts and reasoning which should be the basis for articulating the importance of biodiversity and determining priorities for its conservation and management. In addition most of the emphasis in the scientific literature and application of concepts concerning *biodiversity* concerns the terrestrial environment. Little concerns the marine environment.

3. Most information and scientific analyses of the importance of biodiversity by individual scientists and by groups synthesizing scientific results for managers of biodiversity concentrates on terrestrial literature and in that context at the level of species and communities. By contrast there is very little synthesis useful to managers concerning marine biodiversity, the time and spatial scales of the environmental or biological processes that occur in the marine environment (eg recruitment, migrations, tides, currents, etc) and therefore of the importance of maintaining marine functional and ecological diversity. This latter approach may be more important to decision makers, since endangering an ecosystem function may be viewed as more important than endangering a species for which nobody has a particular use.

4. The report of GESAMP on the State of the Marine Environment is an accurate reflection of the work undertaken by many scientists and institutions to document the sources, types, distribution and (mostly) direct effects of marine pollutants which had been reported on during the 1970s to the late 1980s. It also indirectly highlights the fact that biodiversity, and the effects of human induced losses of biodiversity as a focal issue was practically non-existent at the time, and certainly did not figure in the area of pollution research and monitoring which was the major pre-occupation for marine scientists and environmentalists working during that era. A new look at effects of human activity on the marine environment but with a focus on threats to marine biodiversity and its functions would be timely.

5. For the last 25 years, the notions concerning the importance of conserving marine biodiversity have been increasing in prominence. The formulation, adoption and implementation of the Biodiversity Convention provides a new focus for bringing about the conservation of marine biodiversity not only for those directly concerned with the

to the rapidly growing requirement for more focused, prioritized guidance, more multidisciplinary and integrated approaches, and for assessments which identify trends and are generally more predictive in character.

8.7 Various suggestions were made in respect of the nature and scope of the new assessment, the process for selecting main subjects and areas of focus, the building-blocks (existing, planned and yet to be identified) needed for its preparation and organization of the Group's work. It was the general perception that it would be best to aim at a synthesizing document - not one containing detailed and comprehensive coverage of all marine environmental issues - and to focus particularly on the status of and trends in such main areas as resource exploitation, coastal development, habitat modification and contamination and its effects (i.e., pollution).

8.8 The Group readily acknowledged that the preparatory process would not be the same as that for the 1990 report. While the amount and quality of new data and information that could be assembled was an open question, it was noted that some new, comparable data could be generated through the use of its Guidelines for Marine Environmental Assessments (GESAMP Reports and Studies No. 54). The Group consequently urged the Sponsoring Agencies to ensure that the Guidelines were widely circulated and that their use regionally was actively encouraged.

8.9 It was generally recognized that considerable effort would have to be devoted to involving a variety of organizations and individuals, at global and regional level, in the process. One possible element in the organization of work, it was suggested, would be to identify experts in the regions who will be assigned the task of identifying, collecting and collating documents relevant to conditions and issues in their respective regions and to catalogue information for focused review and synthesis by GESAMP, or a core group thereof, on the basis of topics, themes and criteria specified by GESAMP.

8.10 Subsequent to this discussion, the Sponsoring Agencies informed the Group that they would examine in detail the feasibility of preparing a new assessment, taking into account available financial resources, in order that all the interested bodies could be informed of the result in a timely way, especially the United Nations Commission on Sustainable Development and the governing bodies of the UN system, and plans put in place for GESAMP's consideration at its next session.

9 FUTURE WORK PROGRAMME

Oil in the Marine Environment: New Tanker Designs

9.1 The Administrative Secretary / Acting IMO Technical Secretary introduced document GESAMP XXV/9 containing a modified request from the IMO Marine Environment Protection Committee (MEPC) which originally was submitted to the Twenty-fourth Session of GESAMP for advice on the severity of ecological damage caused by accidental spills from tankers of different new designs. It was emphasized that the primary purpose of asking GESAMP's assistance was to permit IMO to evaluate the equivalency of new designs to the double hull tanker, as well as to make it possible to assess the relative environmental significance of the different outflow characteristics.

9.2 Document GESAMP XXV/9 presents a set of four revised questions accompanied by a more explanatory text. The Group considered the document and found that conditions of hypothetical incidents are still not specified and there were too many uncertainties to produce scientific advice. Responses to these questions will be fundamentally and critically dependent on the physical and biological characteristics of the receiving environment and the specific composition of the oil considered. Accordingly, any answers to these questions would have to be developed in the context of a set of very detailed specifications of all these variables in the form of a range of scenarios. These could not be comprehensive enough to address the global situation that implicitly forms the basis of the questions posed by IMO. In essence, the risk (i.e., the product of frequency of spill occurrence and the associated potential damage) from a single large spill compared with that of several small spills, of equal aggregate volume, for a single specified oil composition, will vary according to the ecological characteristics of the specific environment into which the spill, or spills, take(s) place. This implies that the analysis that might be undertaken by GESAMP would have inherent limitations and would yield projections that would be too specific.

9.3 The Group agreed, however, to assist IMO regarding the main scientific elements of comparisons of tanker design. GESAMP would therefore recommend opening a dialogue with IMO's Marine Environment Protection Committee (MEPC) to define appropriate questions that are both answerable in scientific terms and supportive of the comparison of tanker design features relating to oil spill probability and their associated ecological consequences.

Oil in the Marine Environment: Discharges from Maritime Activities

9.4 The Group briefly considered document GESAMP XXV/9/Add.1 submitted by IMO on arrangements to review the accuracy of estimates of amounts of oil input into the marine environment, specifically from shipping sources. The Group was informed that some of the assessments will be made by correspondence and in addition to this a small task force will address the issue. A meeting of this task force could be organized in conjunction with other IMO activities in August 1995. GESAMP noted the above information.

Proposal for a Working Group on Biodiversity

9.5 During the Twenty-fourth Session of GESAMP held in New York (21-25 March 1994) the UNEP Technical Secretary had informed the participants of the interest of UNEP in establishing a Working Group on marine biodiversity. After a short discussion GESAMP decided to consider this matter at its Twenty-fifth Session and requested the UNEP Technical Secretary to provide a background paper for this purpose.

9.6 The background paper containing:

- draft terms of reference of the Working Group;
- a workplan and time-table;
- suggestions for membership profiles, and
- a draft outline for the eventual report;

was presented to this Session by the UNEP Technical Secretary as document GESAMP XXV/9.2 (summarized in Annex IX).

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Terms of Reference

1. To review and compare policies and approaches to integrated coastal management as expressed by Chapter 17 of Agenda 21 of UNCED and promoted by the UN system and other relevant international organizations.
2. To critically review experience with the application of integrated approaches to coastal management in representative national, developmental and environmental contexts. This will include, *inter alia*: (a) the effectiveness of management and scientific institutions in influencing the development process and its consequences, and (b) the time, funds and skills available for this purpose.
3. To prepare a general strategic approach to integrated coastal management, and identify therein the scientific knowledge and capabilities (from natural and social sciences) that are critical to each step in the process.

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9.7 The Group considered that establishment of a full scale GESAMP Working Group with the suggested terms of reference is not warranted at this time. The overview of the situation with regards to threats to marine biological diversity and recommendations concerning actions that can be taken to better protect, conserve and manage biological diversity can be prepared by an expert of GESAMP.

9.8 GESAMP accepted Mr J. Gray's offer to prepare a peer-reviewed, 12-15 page document covering the geographical distribution of marine biodiversity, the key regions and/or habitats, the threats to marine biodiversity (including exploitation of living resources) and what strategies need to be adopted to best conserve marine biodiversity. The paper will be presented at the Twenty-sixth Session of GESAMP. This overview would provide the necessary working paper for GESAMP, at its next session, to prioritize its future work on marine biodiversity and, particularly, the integration of biodiversity issues in its work. The Group also noted that the subject would be considered by the Sponsoring Agencies in the context of their study of the feasibility of a new State of the Marine Environment assessment.

Intersessional Activities of Working Groups

9.8 Taking into account the above decisions of the Group, intersessional work will be carried out in the framework shown below:

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

Lead agency: IMO
Co-sponsor: UNEP
Chairman: P. Wells

Two meetings of the Working Group are planned - one from 28 August to 1 September 1995, one in February 1996.

2. Environmental impacts of coastal aquaculture (Working Group 31)

Lead agency: FAO
Co-sponsors: UNEP, Unesco-IOC, WHO
Chairman: R. Gowen

A meeting of the Working Group will be held in December 1995.

3. Input of oil into the marine environment from shipping (Task Force)

Lead agency: IMO
Chairman: P. Wells (first meeting only)

A meeting of four to five experts will be convened in late August 1995. Work will be initiated by correspondence with a view to evaluate available data sources on input of oil from shipping into the marine environment and to consider approaches that might be used to produce reliable input estimates.

4. Integrated coastal management (Task Force)

Lead agency: FAO
 Co-sponsors: All GESAMP Sponsoring Agencies
 Chairmen: J. Gray and S. Olsen

A meeting of four to five experts will be convened during the intersessional period.

10 OTHER MATTERS

Definition of "Marine Pollution"

10.1 The Group considered Section 1 of paper GESAMP XXV/10 which raises a question about the inclusion of the word 'energy' in the context of the GESAMP Definition of 'pollution':

"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."

The specific question raised is whether the term 'or energy' needs to be included in the definition of pollution under the London Convention 1972.

10.2 Following discussion, GESAMP concluded that it was desirable that definitions of pollution adopted within specific fora, such as global and regional agreements like the London Convention, be not only equivalent but ideally identical. Accordingly, a definition under the London Convention should conform, and ideally be identical, to both the definition under the Convention on the Law of the Sea (UNCLOS) and the long-standing definition of GESAMP.

10.3 The inclusion of the word 'energy' in the original GESAMP definition was primarily to reflect the potential impact of thermal energy discharges to the marine environment. An ancillary consideration was the effects of energy emitted by radioactive substances. Since the latter is no longer permitted to be dumped at sea under the London Convention, and thermal energy is not likely to be a candidate for disposal under the current terms of the Convention, the inclusion of the words 'or energy' in the definition of pollution under the Convention is probably not essential and largely academic. Nevertheless, GESAMP recommends that the London Convention include these words to maintain consistency with analogous definitions within other international agreements, especially UNCLOS.

Use of the Term "Severe Pollution"

10.4 The second section of paper GESAMP XXV/10, containing information related to the definition of "severe pollution" to the opinion of the Group represented a more complicated problem. GESAMP noted that the IMO Sub-Committee on Flag State Implementation (FSI) has considered the development of a database on shipping casualties that would, *inter alia*, classify casualties in accordance with the severity of ensuing environmental effects. In this context, the Sub-Committee had suggested that the

Annex VIII

INTEGRATED COASTAL MANAGEMENT

Summary of the report of the Task Team (Working Group 36)

1. At the Twenty-fourth Session of GESAMP in New York in 1994, a Task Force on Integrated Coastal Management was formed with the Terms of Reference cited below.
2. In response to TOR No. 2, case studies were selected on the basis of the following criteria:
 - (a) a resource management initiative that addresses at least two sectors such as fisheries and tourism within a defined coastal area;
 - (b) an initiative that has progressed beyond the planning phase and is within at least the initial stages of implementation;
 - (c) case studies that represent different developmental and environmental contexts in both developed and developing nations, and
 - (d) representing a range in the sophistication of scientific inputs to the programme.
3. A detailed outline was provided to the authors of case studies based upon the Ecuador coastal management programme, the Negumbo Lagoon and associated wetlands programme in Sri Lanka, the Pamlico-Albermarl Estuary programme (as an example of the estuarine management programme in the USA), and programmes for water and coastal management in the Netherlands.
4. The Task Force met at FAO in Rome, 28 November-2 December 1994. The case studies and several other papers were reviewed. However, an analysis of the roles of science was hampered by the absence of a pre-prepared conceptual framework. The bulk of the meeting was therefore devoted to preparing a conceptual framework for the process that is common to all ICM programmes and useful to an examination of the scientific inputs that should contribute to the management process. The Task Force decided to focus their analysis of the contributions of science to the issues of:
 - (a) habitat degradation and restoration, and
 - (b) water quality degradation.
5. The participants agreed that drafts on the framework had to be combined and expanded before a full analysis of case studies could be attempted. This was accomplished after the workshop and submitted for review as an initial draft at the Twenty-fifth Session of GESAMP in Rome. Initial text on habitat and water quality degradation was also submitted even though this text had not yet been reworked to reflect the conceptual framework. An outline for the proposed report and a workplan for completing a response to the Terms of Reference were also prepared for review.

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criterion of 'severe pollution' should be pollution that produces a 'major deleterious effect' on the environment.

10.5 Preliminary discussions within the IMO Marine Environment Protection Committee (MEPC) have identified certain biological parameters that would need to be covered by any definition of 'major deleterious effect'. However, the Committee has deferred a decision on the structure and scope of the term 'severe pollution' and has requested GESAMP to provide scientific advice on the matter.

10.6 Following discussion of this item, the Group concluded that any attempt to define degrees of marine pollution will involve a high level of subjectivity. Nevertheless, it was agreed that, in principle, it should be possible to identify, prioritize and/or rank the more significant factors (and combinations thereof) affecting the nature and scale of environmental impacts resulting from shipping casualties. The Group agreed with the statement that size and location of a spill would not provide sufficient basis for determining the severity of environmental impact for the purpose of defining "major deleterious effect". The Group felt that a mechanism of evaluation of pollution should be operational so that judgement could be made within a short period of time. In this connection, having briefly examined a list of criteria established by MEPC, the Group noted that some of the items could produce results only in terms of years, not hours or days. Also, the list of factors considered to date by MEPC was far from complete.

10.7 It was agreed that GESAMP would assist IMO in developing scientific criteria that could be used to define 'severe pollution' for purposes of the proposed FSI database. Because this was a specialized topic that required detailed consideration, it could not be adequately dealt with during the meeting. The work could be undertaken by a small task team (e.g. 2-4 experts), operating mainly by correspondence but with an opportunity to meet for 1-2 days. However, some aspects of the task needed clarification and it was recommended that one or two GESAMP members should meet with appropriate representatives of IMO/MEPC to prepare and agree on specific objectives and to discuss working arrangements. The task team would prepare a concise report for consideration by GESAMP.

Inclusion of Abstracts in GESAMP Publications

10.8 It was noted that the Working Group on Environmental Impacts of Coastal Aquaculture had formulated an abstract and keywords for its report, and it was decided that all technical GESAMP Reports and Studies should contain abstracts as well as keywords to facilitate their retrieval in bibliographic databases.

11 DATE AND PLACE OF NEXT SESSION

11.1 The Group noted that the Twenty-sixth Session of GESAMP would be hosted by Unesco-IOC in Paris, France, from 25 to 29 March 1996.

12 ELECTION OF CHAIRMAN AND VICE-CHAIRMAN

12.1 The Group unanimously re-elected Mr O. Osibanjo as Chairman and Ms H. Yap as Vice-Chairman for the next intersessional period and the Twenty-sixth session of GESAMP.

13 CONSIDERATION AND APPROVAL OF THE REPORT OF THE TWENTY-FIFTH SESSION

13.1 The report of the Twenty-fifth Session was considered and approved by the Group on the last day of the Session. It contains, in Annexes IV to IX, summaries of reports and papers prepared by Working Groups and Agencies. These summaries are included for information and were not considered by the Group with a view to approval.

13.2 The Twenty-fifth Session of GESAMP was closed by the Chairman of the Group at 12.15 hrs on 28 April 1995.

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Annex I

AGENDA

- 1 Adoption of the provisional agenda
- 2 Report of the Administrative Secretary
- 3 Evaluation of hazards of harmful substances carried by ships
- 4 Environmental impacts of coastal aquaculture
- 5 Opportunistic settlers and the problem of the ctenophore *Mnemiopsis leidyi* in the Black Sea
- 6 Sea-surface microlayer
- 7 Integrated coastal area management
- 8 Matters of concern with regard to the status of the marine environment
- 9 Future work programme
- 10 Other matters
- 11 Date and place of next session
- 12 Election of Chairman and Vice-Chairman
- 13 Consideration and approval of the report of the twenty-fifth session

Annex II

LIST OF DOCUMENTS

GESAMP XXV/1	Admin. Secretary	Agenda
GESAMP XXV/3	IMO	Evaluation of the hazards of harmful substances carried by ships
GESAMP XXV/4	FAO	Monitoring the ecological effects of coastal aquaculture waste
GESAMP XXV/5	UNEP	Opportunistic settlers and problems of the ctenophore <i>Mnemiopsis leidyi</i> in the Black Sea
GESAMP XXV/6	WMO	The sea-surface microlayer and its potential role in global change
GESAMP XXV/7	FAO	Report of the Task Force on Integrated Coastal Area Management
GESAMP XXV/9	IMO	Oil in the marine environment: new oil tanker designs
GESAMP XXV/9/Add.1	IMO	Oil in the marine environment: discharges from marine activities
GESAMP XXV/9/2	UNEP	Threats to marine biological diversity and their consequences
GESAMP XXV/10	IMO	Definitions of "marine pollution" and "severe pollution" requested for the implementation of regulations concerning the prevention of pollution from marine activities
GESAMP XXV/Inf 1	Secretariat	List of Participants
GESAMP XXV/Inf 2	Secretariat	List of Documents
GESAMP XXV/Inf 3	J. Gray	Matters of concern to GESAMP

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2.	Physical Processes in the Microlayer and the Air-Sea Exchange of Trace Gases
2.1	Surface Films
2.2	Physical Processes in the Microlayer
2.3	Wave Breaking and Bubbles
2.4	The Effect of Rain on Exchange Processes
2.5	Horizontal Transport and Deposition of Slicks in Coastal Zones
2.6	Review of Experimental Data on Gas Transfer
2.7	Review of Experimental Techniques
2.8	Parameterization of Air-Sea Exchange Processes
2.9	Conclusions and Recommendations
	References
3.	Biological Effects of Chemical and Radiative Change in the Sea Surface
3.1	Introduction
3.2	Samplers and Sampling Techniques
3.3	Characteristics of the Surface Microlayer
3.4	Biology in the Sea Surface
3.5	Chemistry in the Sea Surface
3.6	Effects of Ultraviolet Radiation
3.7	Effects of Chemical Contamination
3.8	Effects of Greenhouse Warming
3.9	Global Change and the Microlayer
3.10	Conclusions and Recommendations
	References
4.	Photochemistry in the Sea-Surface Microlayer
4.1	Introduction
4.2	Photochemistry in the Upper Ocean
4.3	Probable Photochemical Processes in the Microlayer
4.4	Global Change Issues
4.5	Conclusions and Recommendations
	References
Annex I	Participants in the Preparation of the Report

10. A prognosis regarding the overall significance of microlayer enrichment would require, first, an identification of organisms inherently dependent upon the microlayer as habitat for portions of their life-stages, and, second, the concentrations and forms (and therefore bioavailability) of the chemical agents involved. Chemical studies would require state-of-the-art contamination-free sampling and analytical capabilities that are presently only available to a few research groups. As already stated, biological effects would need to be placed in the context of analogous effects of the same chemicals throughout the water column and sediments. At present, the ecological significance of anthropogenically induced change within the microlayer, relative to changes in other components of the marine environment, is a matter of speculation.

11. Available evidence suggests that photochemical processes in the microlayer may not differ substantially from those in the near-surface bulk waters. Assuming the presence of a 50 μm thick microlayer that is enriched in light-absorbing biological pigments by a factor of two relative to the underlying water, it is concluded that the fluxes of reactive intermediates appear to be too small to affect significantly the transfer of reactive species across the air-sea interface. Further, the flux resulting from photochemical production of gases from within the microlayer is insignificant in relation to the total flux originating from the water column and sediments.

12. There remains a number of outstanding deficiencies in contemporary scientific understanding of the sea-surface microlayer. These include the importance of the 'cool skin effect' for the exchange of gases such as CO_2 and the role of bubbles as a medium for gas exchange. Specific concerns in this latter context are the exchange properties of dirty versus clean bubbles and the role of carbonic anhydrase in enhancing CO_2 uptake at the ocean surface.

Terms of Reference

To prepare a report on current understanding of the physics, chemistry and biology of the sea-surface microlayer with particular reference to its role in global environment changes as a marine habitat, including:

- a review of physical processes in the microlayer and their relation to changes in heat, momentum and mass exchange;
- a critical assessment of interaction of the biology and chemistry (including radiochemistry) in the microlayer including reference to the effects on living marine resources;
- a quantitative consideration of the effects of the sea-surface microlayer on air/sea exchange of gases;
- an assessment of the effects of solar radiation and photochemical reactions on the chemistry and biology of the microlayer, and
- an evaluation of existing and potential new techniques for investigating the surface layer of the ocean.

Annex III

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dampen small (capillary) waves and become visible as 'surface slicks'. Strong surface tension forces exist in these films creating a boundary region where turbulent mixing is attenuated.

6. There is increasing evidence for the importance of surface films in the transfer of mass, heat and momentum across the air-sea interface. The viscoelastic modulus (a measure of surface tension) appears to be the most relevant variable to characterize the ability of films to modulate such transfers. The present global distribution of surfactants capable of affecting exchange processes is largely unknown, as are factors controlling future distributions. In relatively uncontaminated areas it is reasonable to assume that marine biological productivity will be the dominant source and provide a good first order estimate of the extent of films.

7. Material accumulated in the sea-surface microlayer is ejected into the atmosphere in an enriched form as part of the sea-salt aerosol produced by bursting bubbles. This provides a mechanism for the selective transfer of materials to terrestrial environments. Documented examples of such aerosol transport from sea-surface microlayers include bacteria, viruses, 'red-tide' dinoflagellates and artificial radionuclides. In addition, production of these sea-salt aerosols provides an important mechanism for charge separation and electrification of the atmosphere.

8. As might be anticipated, lipophilic organic compounds of anthropogenic origin introduced by way of atmospheric transport or aqueous and particulate runoff should be enriched in the sea-surface microlayer. While this enrichment has been observed in some coastal environments, it has not been confirmed by reliable measurements made in the open ocean environment. Many studies of dissolved trace elements in the microlayer are now considered unreliable because of sample contamination. In particular, there are no reliable measurements for open ocean microlayers. Recent evidence from contaminated coastal areas suggests that trace metal enrichments are generally less than a factor of 10 rather than the several orders of magnitude reported in older literature. This is consistent with the strong likelihood that trace metals are passively enriched in the microlayer through association with surface-active organic matter.

9. The degree to which contaminants in the microlayer cause adverse biological effects depends on two factors - chemical exposures of organisms with time and the toxicities of the chemicals involved. The importance of biological effects in the microlayer in relation to effects in the entire water column and surficial sediments is related to the degree to which organisms are dependent on residence in the microlayer for part, or all, of their life-cycles. Virtually all information on the chemical and biological characteristics of the sea-surface microlayer pertains to coastal environments where the concentrations of contaminants in the water column and microlayer are expected to be enriched. It appears that particle-reactive and/or lipophilic substances, notably tributyltin and some other organic chemicals having relatively high toxicity, probably do cause adverse effects on microlayer organisms in some contaminated coastal waters, particularly semi-enclosed basins and harbours. The environmental significance of these effects (which remain to be demonstrated by *in situ* studies) is largely unknown and should be assessed in the context of concomitant ecological hazards associated with the same contaminants occurring in the underlying water column and sedimentary environments. Whether toxic effects on neuston occur in offshore oceanic microlayers remains unknown.

THE SEA-SURFACE MICROLAYER AND ITS ROLE IN GLOBAL CHANGE

Executive Summary, Rep. Stud. GESAMP, (59)
(Working Group 34)

1. Concern has been expressed in international fora that the relative importance of the sea-surface microlayer may have been underestimated, both as a site of adverse biological effects and as a medium for the transfer of energy and material between the sea and the atmosphere. This review was prepared to provide a contemporary perspective regarding scientific understanding of the nature, properties and role of the sea-surface microlayer with particular emphasis on its relative importance in the contexts of marine environmental protection and global change. The body of the report is in three parts (see Table of Contents):

- the physical nature of the microlayer and processes of air-sea exchange of trace gases;
- the chemical and biological nature of the microlayer and associated effects of chemical and radiative change;
- the photochemistry of the microlayer and its role in radiation energy transfer.

2. Each part of the report contains conclusions specific to each of these subject areas. This summary presents the conclusions of the overall review in the context of marine environmental protection.

3. The sea surface of the ocean comprises a series of sublayers. These include a thin surface nanolayer (approx. $< 1 \mu\text{m}$) enriched in surface-active compounds; the surface microlayer (approx. $< 1000 \mu\text{m}$) containing high densities of particles and microorganisms; and the surface millilayer (approx. $< 10 \text{ mm}$) inhabited by small animals and the eggs and larvae of fish and invertebrates. The sea-surface microlayer is operationally defined in this report as the uppermost $1\,000 \mu\text{m}$ (1 mm) of the ocean surface. It, together with an overlying atmospheric layer of thickness 50-500 μm , constitutes the boundary layer between the ocean and atmosphere.

4. Natural surface-active substances (surfactants) are often enriched in the sea surface compared to subsurface water. These include amino acids, proteins, fatty acids, lipids, phenols, and a variety of other organic compounds. The biota of the underlying water column are the primary source of such naturally-derived organic materials. Plankton produce dissolved compounds as part of their metabolic processes. Air bubbles, rising through the water column, scavenge such chemicals and bring them to the surface. In addition, as plankton die and disintegrate some particles and many of the breakdown products (e.g., oils, fats and proteins) are either buoyant or are actively transported to the surface.

5. The accumulation of natural organic chemicals modifies the physical and optical properties of the sea surface. Thin organic films, invisible to the naked eye, are ubiquitous in aquatic systems. These films become concentrated in areas of physical convergence (e.g., at fronts). Under light and moderate wind conditions, areas of accumulated film

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