UNCLASSIFIED

AD NUMBER

AD883797

NEW LIMITATION CHANGE

TO

Approved for public release, distribution unlimited

FROM

Distribution authorized to U.S. Gov't. agencies and their contractors; Foreign Government Information; 20 JUN 1970. Other requests shall be referred to Joint Group of Experts on the Scientific Aspects of Marine Pollution [GESAMP], Paris, France.

AUTHORITY

DDTS ltr, 15 Oct 1971

THIS PAGE IS UNCLASSIFIED

GESAMP-II / 11

20 June 1970

Original ENGLISH

AD 883797

AD No.
DDC FILE COPY

IMCO / FAO / UNESCO / WMO / WHO / IAEA

JOINT GROUP OF EXPERTS ON THE SCIENTIFIC ASPECTS OF MARINE POLLUTION

(GESAMP)

REPORT OF THE ~~SECOND~~ SESSION

held at

UNESCO Headquarters, Paris,

from 2 — 6 March 1970,

DDC
RECEIVED
MAY 20 1971
B

NOTES

1. This report is available in English, French, Russian and Spanish and is issued by the sponsoring Agencies in the following documentation series:

IMCO	-	Marine Pollution Circular (OPS/Circ...)
FAO	-	Fishery Reports
UNESCO	-	UNESCO Technical Papers on Marine Science
WMO	-	WMO Reports on Marine Science Affairs
WHO	-	WHO Water Pollution Series (WHO/W/POLL/..)

2. The report contains views expressed by experts acting in their individual capacities which do not necessarily correspond with the views of the sponsoring Agencies.

3. Permission may be granted by any one of the sponsoring Agencies for the report to be wholly or partly reproduced in publications, provided that the source of the extract and the condition mentioned in 2 above are indicated.

ACCESSION for
CFSTI WHITE SECTION
DDC BUFF SECTION
UNANNOUNCED
JUSTIFICATION
DISTRIBUTION/AVAILABILITY CODES
DIST. AVAIL. and/or SPECIAL
12

GESAMP II/11
22 April 1970

Original: ENGLISH

IMCO/FAO/UNESCO/WMO/WHO/IAEA JOINT GROUP OF EXPERTS ON THE SCIENTIFIC ASPECTS OF MARINE POLLUTION

REPORT OF THE SECOND SESSION

(Paris, 2-6 March 1970)

Opening of the Meeting

1. The Joint Group of Experts on the Scientific Aspects of Marine Pollution (GESAMP) held its second session at UNESCO Headquarters, Paris from 2-6 March 1970. At the opening of the session the Chairman (Mr. J. Wardley Smith) particularly welcomed the representatives of the World Health Organization (WHO) and the International Atomic Energy Agency (IAEA) which had recently joined IMCO, FAO, UNESCO and WMO in becoming sponsoring agencies of GESAMP.

2. The Representative of UNESCO, on behalf of his Director-General, extended a cordial welcome to participants and wished success to the session.

3. The Agenda of the second session, as adopted by the Group, is attached as Annex I and a list of documents considered as Annex II. A full list of participants, comprised of experts, representatives, observers and members of the Secretariat, is attached as Annex III.

4. The Chairman made reference to document GESAMP II/1/1 by which the Group was informed that, by Resolution 14(EC-XXI), the Secretary-General of WMO had been requested to ensure that "item (a) of the Group's terms of reference should include

consideration of 'pollution of the sea through the atmosphere'". The Administrative Secretary for GESAMP informed the meeting that the Directors-General of FAO and UNESCO and the Secretary-General of IMCO had agreed with this interpretation. WMO intends to follow up this agreement.

5. The Secretary of the IOC, representing the Commission at the session, as well as UNESCO, informed the Group that the sixth session of the Commission in September 1969, and the eleventh meeting of the IOC Bureau with the Consultative Council in January 1970 had shown great interest in the establishment of GESAMP and in its work. The Commission wished to have from time to time the advice of GESAMP on specific problems. The immediate problems, as the Commission saw them, were set out in a paper (GESAMP/34) which was before the Group. The Commission intended to be represented at meetings of the Group, and the relevant portions of its reports would be made available for use by the newly established IOC Group of Experts on Long-Term Scientific Policy and Planning, which would be developing further the outline and projects of the Long-Term and Expanded Programme of Oceanic Exploration and Research. This Long-Term Programme, it has been agreed, would include an important section on research related to marine pollution. It was considered important that this section be completely developed, and the proper balance struck between broad ecological research, and limited and urgent problems. The views of the Commission concerning GESAMP are summarized in Annex VII.

Inter-sessional activities, particularly on the state of preparation of reviews on technical matters requested from members

6. The Administrative Secretary informed the Group that a certain number of papers had been prepared by members of the Group in connexion with the implementation of recommendations approved at the first session or in relation to present Agenda items. They

had been received and circulated by the Secretariat as background documents, and are listed in Annex II.

7. Short verbal statements were made by representatives of other sponsoring organizations on activities undertaken during the inter-sessional period, of interest or related to the work of the Group. Some detailed reports were also made available and are listed in Annex II.

8. WHO had only recently joined GESAMP as a sponsoring agency on the request of the other agencies and had immediately taken steps for the participation of two experts on behalf of WHO to the second session of GESAMP. Through its full participation in the future work of the Group, WHO intends to take advantage of the advice of the Group as well as putting at their disposal the information and experience collected in 20 years of international activities on all the health aspects of environmental pollution.

9. The IAEA representative informed the meeting that the Director-General of IAEA was pleased that his organization was now formally associated with GESAMP and wished it well in its endeavours. This formal association came at a particularly appropriate time for IAEA in view of its close association with the impending Geneva Conference on the peaceful uses of nuclear energy at which topics associated with radioactivity in the marine environment would no doubt be discussed.

10. IAEA was glad to co-sponsor GESAMP, because it believes that it can both contribute to and benefit from the activities of this Group. The IAEA contribution can take the form of assistance in the provision to GESAMP of information on the use of nuclear techniques for the study of many problems of marine pollution. As models for studies of marine pollution generally, the various studies which

have been carried out on the dispersion and fate of radionuclides in the marine environment should prove useful. Particular emphasis has been placed by IAEA on the disposal of radioactive wastes into the seas and on the prevention of marine pollution by radioactive materials. IAEA expects that GESAMP will be able to assist it by elucidation of oceanographic processes of concern in understanding the behaviour of radionuclides in the marine environment, and by providing expert advice on specific topics in this particular sector of marine pollution.

11. The Agency's interest has been expressed in several ways. It co-operates actively with the other UN Agencies concerned with the fight against marine pollution; organizes scientific meetings on specific topics connected with radioactivity in the marine environment; and, through its International Laboratory of Marine Radioactivity in collaboration with national laboratories, prosecutes an experimental programme, involving the intercalibration of methods of sampling and analysis of chemical and biological materials and studies of the distribution and fate of radionuclides in the sea.

12. The IMCO representative reported that in pursuance of UN Resolution 2414 (XXIII), the IMCO Assembly, at its sixth session (15-30 October 1969), instructed the Maritime Safety Committee to proceed with all possible speed with work to promote the early development of such international agreements as may be necessary for the prevention and control of marine pollution, and decided to convene an international conference in 1973 with the object of concluding such an agreement. The Assembly also approved amendments to the Oil Pollution Convention of which the Group had been informed at the first session. Numerous amendments to the International Convention for the Safety of Life at Sea, 1960, aimed at improving safety at sea and preventing accidents such as the Torrey Canyon disaster, were also approved together with certain Recommendations to Governments aimed at improving the safety of drilling rigs and production platforms.

13. The Group was further informed that an International Legal Conference held in Brussels from 10-29 November 1969, under the auspices of IMCO, concluded two Conventions on the subject of marine pollution by oil. The first Convention (the International Convention on Civil Liability for Oil Pollution Damage) relates to the determination of liability for damage caused by oil pollution from ships and the provision of compensation for such damage; the other (the International Convention Relating to Intervention on the High Seas in Cases of Oil Pollution Casualties) deals with the rights of coastal states to take action to mitigate or prevent damage to their coastlines in cases of accidental pollution.

14. The WMO Representative, in referring to the documents submitted by his Organization, pointed out that these documents reflect that organization's growing concern regarding the increasing pollution of the atmosphere, and in turn, its possible contribution to the pollution of the sea. WMO is therefore of the opinion that an additional expert, well informed in the atmospheric processes and how they may act as a transport agent for marine pollutants, can profitably contribute to the work of GESAMP. Accordingly, arrangements have been made for Professor C. E. Junge of the Johannes Gutenberg University, Mainz, Federal Republic of Germany,* to become a member of the Group. This will ensure the availability of a report on this subject to the third session of the Group.

Report on Marine Pollution which may result from the exploration and exploitation of the sea-bed, ocean floor and its subsoil beyond the limits of national jurisdiction (UN General Assembly Resolution 2467 B(XXIII)

15. As agreed by the Sponsoring Agencies, the Group considered the draft outline of the report which the UN Secretary-General will submit to the UN Committee on the Peaceful Uses of the Sea-Bed and Ocean Floor Beyond the Limits of National Jurisdiction in

---

* With reference to paragraph 14, it became necessary, subsequent to the Session, to replace Professor Junge by Professor K. O. Munnich of the University of Heidelberg.

implementation of UN General Assembly Resolution 2467 B(XXIII). On the basis of contributions prepared by experts prior to the session, the Group prepared material for inclusion in the Report under those headings of the Draft Outline, falling within its terms of reference, which is attached as Annex IV. The Group suggested that the UN Secretary-General may wish to bring this Annex, together with an important technical paper on the effects of heavy metals (GESAMP/20), to the attention of the Committee. The Group would have preferred to have more time to assemble information relevant to this subject but, to enable the report to be completed in accordance with the programme envisaged by the United Nations Secretary-General, the contribution was dealt with as a matter of urgency at this session.

Implementation of operative paragraph 1(a) of UN General Assembly Resolution 2566 (XXIV) - Promoting effective measures for the Prevention and Control of marine pollution

16. The UN Representative drew attention to UN Resolution 2566 (XXIV), paragraph 1(a) of which called for a review of the harmful chemical substances, radioactive materials and other noxious agents and wastes which may dangerously affect man's health and his economic and cultural activities in the marine environment and coastal areas. The Sponsoring Agencies had agreed that the Group should carry out such a review which has special reference to preparations for the United Nations Conference on the Human Environment to be convened in 1972. The UN representative also pointed out that the UN Committee on the Effects of Atomic Radiation has been concerned for years with radio-active contamination of the oceans, particularly that due to radioactive debris from nuclear tests falling out on the sea surface. The latest assessment of the UN Committee is contained in Document A/7613, Annex A paragraphs 21-26. Problems of global radio-active contamination are likely to remain among the subjects that the Committee will wish to keep under review.

17. The Group noted the replies to questionnaires on marine pollution which had been made available by IMCO (GESAMP/22) and recalled the work carried out at its first session (GESAMP I/11 paragraphs 19-38 inclusive), when it had elaborated on certain categories of pollutants based on a table prepared by the IOC Working Group on Marine Pollution (SC/CS/150 Annex X). In this connexion it also noted the work currently being carried out with a view to identifying noxious or hazardous cargoes from the Index to the International Maritime Dangerous Goods Code (GESAMP I/11 paragraphs 17-18).

18. In considering the terms of Resolution 2566 (XXIV) it was apparent that the review of harmful substances, although submitted to the Sponsoring Agencies in the first instance, might well prove significant to governments in further deliberations on the desirability and feasibility of an international treaty or treaties for preventing or controlling pollution. For this reason, the Group endeavoured not only to identify and describe the principal categories of pollutants, but also to link these categories to the principal sources or means by which the pollutants enter the sea, indicating their relative importance in each case.

19. A preliminary draft of such a review is attached at Annex V to this Report. The Group suggested that the Sponsoring Agencies of GESAMP should bring this preliminary draft to the attention of the UN Secretary-General and inform him that the Group will be continuing to develop its advice on this subject in the forthcoming inter-sessional period, taking also into account material which it had prepared at its first session (and annexed to the report of that session) and the large volume of existing published documents relevant to this task.

Follow-up of, and elaboration of research projects within the scope of the Long-Term and Expanded Programme of Oceanic Exploration and Research (LEPOR): Scientific basis for a monitoring system.

20. Following an introduction by the Secretary of the IOC, the Group examined the pollution section of the Comprehensive Outline of the Scope of the Long-Term and Expanded Programme of Oceanic Exploration and

Research (LEPOR) drawn up by the IOC with the assistance of its advisory bodies, and endorsed by the twenty-fourth General Assembly of the United Nations. The Group was pleased to note that research on this subject was considered to be of sufficient importance and urgency to justify it being dealt with under a special section of LEPOR, although it noted that many research projects, especially in the fields of biology and of physical and chemical oceanography, and meteorology outlined in other sections, were pertinent to the understanding of pollution problems. The attention of the Group was drawn to the specific questions posed to it by the eleventh Meeting of the IOC Bureau with the Consultative Council (Annex VII) and took these into account in subsequent discussion. The Group also examined the report "Global Ocean Research" prepared by a Joint Working Party of ACMRR, SCOR and WMO (AGOR) and observed that this report contained much useful detail and analysis which had not been carried forward into section III of the Comprehensive Outline of the Scope of LEPOR; in this connexion, particular reference was made to the discussion in "Global Ocean Research" of mass balance models.

21. It appeared to the Group that a key concept in both documents was the preparation of regular "reports on the health of the ocean". This required a comprehensive system for bringing together and retrieving information as necessary (see discussion under Agenda item 11), prompt registration of accidental spillages and deliberate discharges of pollutants into the sea, and development of the proposed monitoring programme. These matters were subsequently discussed separately. Members of the Group made a variety of comments on the content of the report "Global Ocean Research" - Marine Pollution section, with suggestions for improvement of the statements given therein. The Group hoped that these would be useful to the IOC Group of Experts on Long-Term Scientific Policy and Planning, which was to have the main task of elaborating the Comprehensive Outline of LEPOR in the light of comments by IOC Member Governments, by international organizations and by other

specialized groups of scientists such as GESAMP. The comments and suggestions made included the following:

(a) Most of the monitoring programmes would be undertaken by national institutions and related initially to near-shore waters; this would require co-ordinating and supplementing internationally taking into account the development of IGOSS, the World Weather Watch and the background air pollution monitoring system of WMO. Assistance would be needed internationally especially in areas near developing countries. These areas are mainly tropical ones in which processes in the sea relating to the transport and effects of pollutants may be of a different nature or proceed at a different pace from those in the better known temperate zones. Some of these tropical areas have particularly vulnerable environments (e.g. coral reefs) and also the human populations are particularly dependent on the products from a healthy sea for their sustenance.

(b) Some members gave high priority to measurement of toxicities of various substances for a broad range of test organisms, and the variation of these with environmental factors; determining those effects of long-term exposures to sub-lethal concentrations; and seasonal and year-to-year changes in pollutant occurrence and concentration. Development models of dispersion, especially for coastal and estuarine water, was also considered urgent.

(c) Some members were inclined to give high priority to chemical analyses in monitoring systems; others pointed out that too often the chemistry was known, but not the biological significance.

(d) Some members insisted that it was too often incorrectly assumed that the normal pattern of life in the sea - species

composition, biochemical constituents, ecological relationships, etc. - were already known. This was not so, particularly in the tropics, and determination of norms, before industrial development took place was urgent.

(e) Insufficient attention was given to problems of toxicity of organisms being induced by pollutants. More attention should be given also to the general degradation of the environment that might be induced by continuing injections of very heterogeneous mixtures of pollutants and this required much more research on interactions which could be of a highly complex nature.

(f) It was pointed out that the Seminar being convened at the FAO Technical Conference on Marine Pollution (December 1970) (see under Agenda item 10) offered an important opportunity for further consideration of problems of monitoring methods, and that the results should also be useful to the IOC Group of Experts.

(g) It was pointed out that the problems of monitoring the sea and of registering deliberate and accidental additions of substances to the sea and reporting environmental changes related to pollution were universal. There is need to monitor all ocean areas, and for all significant acts of ocean pollution to be recorded and reported, irrespective of the state involved (e.g. whether or not a member of the United Nations, of IOC or of other UN bodies) and of the origin of the pollutant (e.g. military or civil industrial activity).

22. After the general discussion, the members of the Group continued examination of the specific problems of monitoring, pollution through the atmosphere, registration of discharges, and dispersion and transport of surface pollution by natural physical processes. A preliminary report on these problems of the expanded programme is given in Annex VI.

Registration of discharges and spillages

23. The need under this heading is one for more international action rather than for further scientific advice. The list of noxious substances and categories of pollutants that the Group had prepared gave the scientific basis for developing a registration system. Such a system was not an alternative to a monitoring system, but a necessary complement to it. It is necessary to be made known what is put into the sea, either deliberately, accidentally or incidentally to other activities. Registration of coastal injections is essentially a question of national power and action, although international exchange of information is needed. Pollution arising from ships and other equipment operating in the marine environment poses a rather different problem.

24. The Group was informed that the IMCO Assembly at its sixth session (15-30 October 1969), desiring to improve the detection of offences (under the Oil Pollution Convention), which cause the discharge of significant or harmful quantities of oil into the sea, requested the Maritime Safety Committee to review the existing arrangements for the reporting of incidents involving pollution by oil. The Assembly had in mind the compilation of a record of such incidents, centralized in one organization, for the furtherance of work in this field and for the information of governments. The Group hoped that this work would soon be fruitful, and that as soon as practicable such reporting should also cover spillages of other noxious substances, with a view to facilitating international measures for the prevention and control of such pollution.

Pollution of the sea through the atmosphere

25. Two documents (GESAMP II/2/4; GESAMP II/2/1) prepared by the WMO Secretariat were presented to the Group for consideration under this item. GESAMP II/2/4 outlines the role of the atmosphere in the hydrological cycles which contributes to marine pollution as a result

or run-off from the land areas contaminated by industrial dust or pesticides used in agriculture. The second document revealed WMO's concern regarding the widespread and growing pollution problem in the atmosphere and presented details on the establishment of a network of stations to measure background atmospheric pollution. This document further points to the fact that pollutants entering the atmosphere may be transported over great distances and ultimately, through fall-out or precipitation, contribute to marine pollution.

26. The Group discussed the extent to which the atmosphere plays a role as a transport agent for pollutants. It was agreed that, in the case of pesticides, the transfer from the atmosphere to the sea was important (restrictive or preventive measures recommended) and, with regard to inorganic wastes (heavy metals and other toxic inorganic compounds) and radioactive materials, the transfer was significant (restrictive or preventive measures should be considered). The Group further proposed, among other things, that arrangements be made to secure expertise on major categories of pollutants and have them related to pathways to the marine environment, one of such pathways being the atmosphere.

27. The Group welcomed the WMO project aimed at the establishment of a network of stations to measure background atmospheric pollution and recommended that these measurements be expanded to the atmosphere over the ocean areas. The Group also made the following observations:

(a) With regard to the analysis of atmospheric samples, as many substances as possible should be measured and emphasis should be placed on the measurement of pesticides, radioactive materials and lead.

(b) Where possible, over ocean areas, measurements of pollutants at a given geographical location should be made simultaneously in both the atmosphere and the oceans.

(c) Advanced methods are available for simple analysis of certain chemicals and the use of these methods in the monitoring of atmospheric pollution should be investigated.

(d) Artificial satellites may offer a source of supplementary information e.g. research on surface pollutants as identified by aerial colour photography, and new advanced techniques for measuring sulphur dioxide in the atmosphere.

Dispersion and Transport of Surface Pollution by Natural Physical Processes

28. The Group took note of Document GESAMP/24, prepared by Mr. O. Haug entitled "Transport of Pollution in the Sea", which specifically dealt with the technical aspects of the problem relating to surface pollutants, many of which cannot be solved by utilizing present available knowledge and information. However, the paper further contained a simplified practical scheme, which is well within the present "state-of-the-art", and can be used for forecasting the movement of oil for a limited period (1-3 days) of time. The Group felt that the availability of such forecasts is extremely useful, especially in connexion with certain operational decisions that must be made regarding the use of chemicals or other means for absorbing, precipitating or removing oil from the sea.. The Group therefore suggested that the report be given further dissemination for practical use in developing countries, as well as for general information in all states regarding the need for further research.

29. Other statements were presented regarding work that is now going forward in forecasting the movement and dispersion of both surface and sub-surface pollutants especially in the USSR, UK, France, Canada and the USA. Continuation of this work was encouraged with the plea that it be extended downward since virtually nothing is known about the deep ocean currents and diffusion. Dr. Simonov offered to present a paper at the next meeting on this subject; this would be circulated in time for study

before the next meeting. The Group further requested that the Sponsoring Agencies provide them with a listing of the projects now being actually prosecuted in this field.

Use and Effects of Chemical Means for Absorbing, Precipitating and Removing Oil from the Sea.

30. The Group considered papers, submitted by Experts in response to a request made at its first session (GESAMP I/11 paragraph 41), containing available information on the use and effects of chemical means for absorbing, precipitating and removing oil from the sea (GESAMP/21, GESAMP/25, GESAMP/26, GESAMP/27, GESAMP/28). Information which had been submitted by Governments in response to an IMCO questionnaire on national arrangements for dealing with spillages of oil (GESAMP/29) was also noted together with a summary list of products mentioned in the replies (GESAMP/29/Add.1).

31. Through the Secretary-General of IMCO, the Sub-Committee on Marine Pollution had sought the Group's advice on:

(a) the most suitable and effective methods of using emulsifiers, other chemical products and agents for absorbing or precipitating the oil; and

(b) a practical indication of their suitability and effectiveness for the purpose for which they are intended.

Noting that this request had been made with a view to providing governments with information which might be useful in the establishment of emergency ports or depots for dealing with oil spillages, the Group agreed that the papers already submitted by the experts should be passed to the IMCO Sub-Committee and that the experts should contribute any other information relevant to this subject as soon as possible, so that it could be made available to the IMCO Sub-Committee without delay.

The Group agreed that the information which IMCO was collecting could well be incorporated eventually, in a composite manual for the guidance of administrations concerned in implementing contingency plans for dealing with oil spillages.

32. As a basic form of treatment of spillages, the Group favoured methods of removal of oil from the sea in preference to sinkage or dispersal. Some recent tests in France, however, had indicated good results with an agent which produced an emulsion, increased the density, was non-toxic and which enhanced bacterial action. A full list of products under test in France had been submitted directly to IMCO.

33. The Group noted that, while considerable testing of products had been carried out in temperate zones, particularly in the northern hemisphere, little knowledge is yet available on the effects of emulsifiers and chemical agents on the marine flora and fauna peculiar to the arctic and tropical zones where the risk of large spillages of oil is now increasing. It is not possible at present therefore to make specific recommendations on the use and effects of available products on a global basis. Furthermore, there is a need to establish suitable test procedures for assessing the toxicity, both lethal and sub-lethal, in the arctic and tropical regions, giving particular consideration to the selection of suitable test species. This would require considerable expansion of present toxicological information, particularly with regard to the more sensitive forms of marine life.

FAO Technical Conference on Marine Pollution and its Effects on Living Resources and Fishing

34. The Group received a progress report on the state of preparation and arrangements for the FAO Technical Conference (December 1970), which is being organized in agreement with the scientific programme established by GESAMP at its first session. During the inter-sessional period, the members of the Group have been assisting the FAO Secretariat in charge of the

Conference, in identifying the convenors, rapporteurs and reviewers for its various sections. The Group agreed to continue their advice through direct consultations between members and the Secretariat of the Conference, in cases where the acceptance of submitted experience papers is doubtful.

35. The FAO Conference is expected to review the state of knowledge, to identify research gaps and to provide guidance for future research in the field of marine pollution, in relation to living resources. Therefore, it was agreed that the Conference report should be submitted to the Group for study and consideration at its forthcoming session, with a view to using this information as a background for the planning of the Marine Pollution Section of LEPOR. Advice of GESAMP will be welcomed as appropriate on action required to implement the recommendations of the Conference, as far as they are within the terms of reference of the Group.

36. The representative of UNESCO informed the Group that this Agency intended to be represented at the FAO Conference and that it is proposing to arrange with FAO a round-table discussion, possibly on the evening of the opening day of the Conference. The discussion is intended to focus on the philosophy and ecological basis of management of the environment, in order to place the Conference in a broad humanistic context bearing in mind Unesco's involvement, through its man and biosphere programme, with general scientific aspects of environmental quality. This idea received strong support from the Group, members of which offered to assist in the selection of possible speakers to be invited.

37. The Group was informed by the FAO representative that a contribution to the preparatory work required in connexion with the proposed world-wide system for monitoring of marine pollution will be given through the Seminar on Methods of Detection, Measurement and Monitoring of Marine Pollutants in conjunction with the FAO Technical Conference. Organized jointly by FAO, UNESCO, SCOR and possibly also by WMO and IAEA, the Seminar will be of a very special nature and its programme, under

preparation by Professor Goldberg, will take into account pertinent conclusions and suggestions made by GESAMP. It was agreed that the members of the Group should assist the organizers in identifying experts to be invited to participate on methods for the study of various categories of pollutants, and on sampling.

Information System concerning marine pollution and its effects including storage, retrieval and exchange

38. Other than information on discharges and spillages, which was dealt with under another agenda item, this subject related essentially to two distinct, if related, questions, as the Group had identified at its first session (GESAMP I/11, paragraph 57).

39. The IOC Group on Oceanographic Data Exchange, to whose attention the Group had suggested this matter be drawn, had not yet met to discuss the question; it would do so later in 1970. The attention of the new SCOR/ACMRR Working Group on Biological Data Inventories should also be drawn to the need to ensure the proper storage and retrieval of the relevant biological information, and to relate it to concurrent physical and chemical data.

40. The Group discussed the extent to which these data needed to be transmitted in "real-time" for the purposes of pollution research and control, and thus the extent to which the groups involved in the development of IGOSS should be concerned. However, the only information which clearly needed immediate dissemination was that relating to events such as spillages, and this would be treated other than by the World Data Centre System.

41. The representative of FAO reported on the development of scientific information services for pollution research within the general field of marine science. The Group noted reasonable progress and asked that the Secretariat report on this matter in some detail to its third session.

42. Since its first session, a mimeographed "newsletter" started by Professor Clark and oriented to the IBP had gained wide distribution and had now appeared as a published Marine Pollution Bulletin on general sale (copies of Volume I(N.S.) No. 1 were made available to the Group). Although this had not yet been quite achieved, it was intended that the Bulletin would have global and balanced coverage of news.

43. The UN Agencies sponsoring GESAMP may be able to help improve the usefulness of the Bulletin. Members of the Group welcomed and applauded Professor Clark's initiative and hoped that the change in format would not inhibit submission of information. It was also important that sources of information be indicated and appropriate disclaimers made of editorial responsibility for opinion expressed. Attention of the Group was drawn to the fact that the Center for Short-lived Phenomena of the Smithsonian Institution reports oil spills and other acute pollution and "ecological events".

Future Work Programme

44. In considering the uncompleted items in its work programme, the Group recognized that the most important tasks which would need to be pursued during the coming inter-sessional periods were as follows:

(a) The LEPOR programme relative to marine pollution research projects. Although it was not essential that this programme should be completed in the current year, its development should show significant and continuous progress.

(b) The review of harmful chemical substances called for in paragraph 1(a) of UN Resolution 2566 (XXIV) for which experts should prepare papers for circulation as soon as possible with a view to completing the task at the next session. The study of marine pollutants and their sources should nevertheless be regarded as a continuing task in the future.

45. The representative of the World Health Organization stated that, while it had not been possible to prepare specific items for action by the Group at this session, there were several fields upon which that Organization would seek advice in the future. These included microbiology of the marine environment and toxicological studies with particular reference to the effects of pollutants on man.

Election of Chairman

46. Dr. M. Waldichuk was elected Chairman for the inter-sessional period and for the third session. In making this decision, the Group recorded its gratitude to the retiring Chairman, Mr. Wardley Smith, for the efficient and helpful way in which he had conducted its deliberations during the first two sessions and throughout its initial period of operation.

Date and Place of the Third Session

47. The Group, noting the FAO offer to act as host for the third session, proposed that it should be held in January 1971.

ANNEX I

AGENDA

1. Opening of the meeting.

2. Adoption of the agenda.

3. Progress report on inter-sessional activities, particularly on the state of preparation of reviews on technical matters requested from members (GESAMP I/11, paragraph 63)

4. State of preparation of the Report on Marine Pollution which may result from the exploration and exploitation of the sea-bed, ocean floor and its subsoil, beyond the limits of national jurisdiction (follow-up of United Nations General Assembly Resolution 2467B (XXIII).

5. Consideration of action needed to implement operative paragraph 1(a) of UN General Assembly Resolution 2566 (XXIV).

6. Follow-up of, and elaboration of research projects required to implement the Marine Pollution Section of the Report on Global Ocean Research prepared by a joint Working Party of ACMRR, SCOR, WMO/AGOR, as well as Section III (Marine Pollution) of the Comprehensive Outline of the Scope of the Long-term and Expanded Programme of Oceanic Exploration and Research (LEPOR), endorsed by the IOC, 6th Session.

7. Scientific basis for a monitoring system of marine pollution including pollution of the sea through the atmosphere and registration of discharges.

8. Use and effects of chemical means for absorbing, precipitating and removing oil from the sea.

9. Dispersion and transport of surface Pollution by natural physical processes.

10. The FAO Technical Conference on Marine Pollution and its Effects on Living Resources and Fishing (Rome, December 1970).

11. Information system concerning marine pollution and its effects including storage, retrieval and exchange.

12. Future work programme.

13. Date and place of next session.

14. Other matters.

15. Election of Chairman for next inter-sessional period and for the 3rd session, and election of Steering Group.

16. Consideration and approval of the Report.

ANNEX II

LIST OF DOCUMENTS

Document No.	Title
GESAMP II/1/Rev.2	Agenda
II/1/1	Memorandum on the Joint Group of Experts on the Scientific Aspects of Marine Pollution. By WMO Secretariat
II/2	State of Preparation of Reviews on Technical Matters requested from Members.
II/2/1	Joint IMCO/FAO/UNESCO/WMO/WHO/IAEA Group of Experts on the Scientific Aspects of Marine Pollution - 2nd session - Agenda item 10. The Atmosphere as a Transport Agent for Marine Pollution. By WMO Secretariat
II/2/2	Information System concerning Marine Pollution and its Effects, including Storage, Retrieval and Exchange. By WMO Secretariat
II/2/3	Preparation of Draft Sections of the Report on Marine Pollution which may arise from the Exploration and Exploitation of the Sea-Bed and Ocean Floor Beyond the Limits of National Jurisdiction (UN General Assembly Resolution 2467 B (XXIII)). By WMO Secretariat
II/2/4	Pollution of the Sea through the Atmosphere. By WMO Secretariat.

Document No.	Title
GESAMP II/3	State of Preparation of the Report on Marine Pollution which may result from the Exploration and Exploitation of the Sea-Bed, Ocean Floor and the Subsoil thereof Beyond the Limits of National Jurisdiction (UN General Assembly Resolution 2467 B (XXIII)). By the Administrative Secretary
II/4	Consideration of Action needed to Implement Operative Paragraph 1(a) of UN General Assembly Resolution 2566 (XXIV). By the Administrative Secretary
II/5	Use and Effects of Chemical Means for Absorbing, Precipitating and Removing Oil from the Sea. By IMCO Secretariat
II/5/1	Scientific Basis for a Monitoring System of Marine Pollution including Registration of Discharge. By the Administrative Secretary
2/70 INF.6	List of Abstracts of Contributions received for the FAO Technical Conference on Marine Pollution and its Effects on Living Resources and Fishing. By FAO Secretariat
2/70 INF.7	Summary of FAO Activities in the field of Marine Pollution. By FAO Secretariat
2/70 INF.8	Some forthcoming Meetings (1970) which may be of interest to Specialists in Marine Pollution. By FAO Secretariat

Document No.	Title
GESAMP II/9	List of Documents
II/10	List of Participants
II/11	Report of the Second Session

BACKGROUND DOCUMENTS

Document No.	Title
GESAMP/16	Legal Aspects of Problems connected with the Implementation of International Control of Pollution in the Marine Environment. By Dr Jan LOPUSKI, LL.D
16/1	Legal Aspects of Problems connected with the Development of International Control of Pollution deriving from the Exploration or the Exploitation of the Sea-Bed and the Ocean Floor. By Dr Jan LOPUSKI, LL.D
17	Toxicity-Testing with particular reference to Oil Removing Materials and Heavy Metals. By Dr J. E. PORTMANN
18	Effects of Thermal Pollution. By Bruce W. HALSTEAD, M.D.
19	Marine Pollution due to Sedimentation. By Bruce W. HALSTEAD, M.D.
20	Marine Pollution by Mining Operations with particular reference to Possible Metal-Ore Mining. By Dr J. E. PORTMANN
21	Oil Pollution of Marine Environment. By Mr J. WARDLEY SMITH
22	Research Priorities concerning Major Categories of Pollutants particularly with a view to Facilitating International Action for Pollution Control. By IMCO Secretariat.

Document No.	Title
GESAMP/23	Hazards on Mining Radioactive Materials. By Dr J. JOSEPH
24	Transport of Pollution in the Sea. By Dr O. HAUG
25	Removal of Oil Film from the Water Surface. By Dr M. WALDICHUK
26	The Toxicity of Several Oil-Spill Removers to some Species of Fish and Shellfish. By Dr J.E. PORTMANN and Mr P.M. CONNOR
27	The Effects of Oil Pollution on the Marine Organisms. By Dr H. TSURUGA
28	Bibliography and Studies on the Chemical Treatment of Oil Released at Sea. By Dr H. TSURUGA
29	Marine Pollution. Action taken by Governments to implement national arrangements for dealing with significant spillages of oil. By IMCO Secretariat
29/Add.1	Marine Pollution. List of products for dealing with spillages of oil at sea. By IMCO Secretariat

Document No.	Title
GESAMP/30	Marine Pollution. Observations by Expedition 'RA' By IMCO Secretariat
2/70 WP.31	An attempt to use the Fish Screened by Resistivity to Mercuric Chloride for Toxicity Testing. By Dr H. TSURUGA
3/70 WP.32	Progress Report on the Establishment of an Information Storage and Retrieval System. By FAO Secretariat
33	Comprehensive Outline of the Scope of the Long-Term and Expanded Programme of Oceanic Exploration and Research (LEPOR). By IOC Secretariat
34	Note to the Second Session of GESAMP By the Secretary of IOC

REFERENCE DOCUMENTS

Report of the First Session of GESAMP (London 17-21 March 1969). GESAMP I/11

UN General Assembly Resolution. A/RES/2467 (XXIII) Examination of the question of the reservation exclusively for peaceful purposes of the sea-bed and ocean floor, and the subsoil thereof, underlying the high seas beyond the limits of present national jurisdiction and the use of their resources in the interests of mankind.

UN General Assembly Resolution. A/RES/2566 (XXIV) Promoting effective measures for the prevention and control of marine pollution.

Global Ocean Research. Report of a Joint Working Party of the ACMRR, SCOR and WMO (AGOR). (Ponza and Rome 29 April - 7 May 1969).

Table of Major Categories of Pollution. Extract from Annex X of Summary Report of IOC Fifth Session (19 - 27 October 1967) SC/CS/150, Annex X - Page 3.

ANNEX III

LIST OF PARTICIPANTS

Members of the Group

Dr. D. DYRSSEN	Professor, University of Gothenburg, Department of Analytical Chemistry, Fack S-402 20, Gothenburg 5, Sweden
Dr. E. FØYN	Professor, Institute for Marine Biology, University of Oslo, Frederiksgt. 3, Oslo, Norway
Mr. B. HALSTEAD	Director, International Biotoxicological Centre, World Life Research Institute, Colton, California, USA
Mr. O. HAUG	Meteorologist, Det Norske Meteorologiske Institutt, Blindern, Oslo 3, Norway
Dr. P. KORRINGA	Director, Netherlands Institute for Fishery Investigation, P.O. Box 68, Haringkade 1, Ijmuiden, Netherlands
Dr. J. LOPUSKI	Assistant Professor, Morski Instytut Rybacki Al. Zjednoczenia 1, Gdynia, Poland
Dr. J. E. PORTMANN	Chemist, Ministry of Agriculture, Fisheries and Food, Burnham-on-Crouch, Essex, England
Dr. A.I. SIMONOV	Professor, Oceanographic Institute, 6 Kropotkinsky Pereulok, Moscow G-34, USSR
Mr. G. TENDRON	Sous-Directeur, Museum National d'Histoire Naturelle, 57 rue Cuvier, Paris 5^{e}, France
Dr. H. TSURUGA	Chemist, Tokai Regional Fisheries Research Laboratory, Ministry of Agriculture and Forestry, 5 Kachidoki, Chuo-ko, Tokyo, Japan
Dr. M. WALDICHUK	Oceanographic Consultant, Fisheries Research Board of Canada, Room A-317 Sir Charles Tupper Building Riverside Drive, Ottawa 8, Canada

Mr. J. WARDLEY SMITH (Chairman)	Warren Spring Laboratory Gunnelswood Road, Stevenage, Herts, England
Dr. L. W. WEINBERGER	Zurn Industries Inc., 2600 Virginia Ave. N.W., Washington, D.C. 20037, USA

Secretariat from sponsoring UN Organizations

Mr. S.L.D. YOUNG Technical Secretary IMCO	Head, Cargoes & Related Matters Section, IMCO, London
Mr. L. LEPLAT Administrative Secretary IMCO	Cargoes & Related Matters Section, IMCO, London
Dr. M. RUIVO	Director, Fishery Resources Division Department of Fisheries, FAO, Rome
Dr. L. ANDREN Technical Secretary FAO	Fishery Biologist (Marine Pollution) Marine Biology & Environmental Branch, FAO, Rome
Dr. S.J. HOLT	Director, Office of Oceanography, UNESCO, Paris and Secretary IOC
Dr. M. STEYAERT Technical Secretary UNESCO	Programme Specialist Office of Oceanography, UNESCO, Paris
Mr. C.R. DALE Technical Secretary WMO	Chief, Synoptic & Maritime Section, WMO, Geneva
Dr. R. PAVANELLO Technical Secretary WHO	Chief, Environmental Pollution Division of Environmental Health, WHO, Geneva
Dr. J. JOSEPH	Director, International Laboratory of Marine Radioactivity, IAEA, Monaco
Mr. E.D. HESPE Technical Secretary IAEA	A/g Head, Division of Health, Safety & Waste Management, IAEA, Vienna

Representatives from other UN Organizations

United Nations (UN) Mr. A. DOLLINGER	Special Representative in Europe for Co-ordination, Palais des Nations, Geneva, Switzerland

Observers from International Organizations

International Council for the Exploration of the Sea (ICES)

Mr. B.I. DYBERN	Fishery Biologist, Institute of Marine Research, Lysekil, Sweden
Dr. H.A. COLE	Director of Fishery Research, Ministry of Agriculture, Fisheries & Food, Fisheries Laboratory, Lowestoft, UK

Scientific Committee on Oceanographic Research (SCOR)

Mr. A.J. LEE	Fisheries Laboratory, Lowestoft, UK

Advisory Committee on Marine Resources Research (ACMRR)

Prof. M. FONTAINE	Director, Musée d'Histoire Naturelle, Paris

International Union for Conservation of Nature (IUCN))
International Association of Biological Oceanography (IABO))
International Biological Programme (IBP))

Prof. R.B. CLARK	Professor, Department of Zoology, University of Newcastle-upon-Tyne, UK

International Chamber of Shipping (ICS)

Miss VARCIN) Miss MOUSSU) Capitaine MARINET)	C/o International Association on Water Pollution Research (IAWPR)
Mr. JAMME	Ingénieur Général des Ponts et Chaussées, 44 bis quai d'Austerlitz, Paris 13

ANNEX IV

Report on Marine Pollution which may result from the Exploration and Exploitation of the Sea-bed and Ocean Floor and its Sub-soil beyond the limits of national jurisdiction. (UN Resolution 2467 B (XXIII)).

1. DEFINITION OF THE PROBLEM

1.1 Introduction

1.1.1 It is at present impossible to give any reasoned value for the possible extent and levels of the pollution arising from increased exploration. The problem would be less critical, however, than similar activities within coastal and shelf waters, where the main exploitable living resources and amenities are located. Moreover, the situation of potential centres of exploitation in very deep water, usually at a considerable distance from the coast, in itself provides additional protection by dilution and dispersion for the rich resources of coastal and shelf waters.

1.1.2 Pollution from a source in the deep ocean when coming up to the surface may be spread widely by wind and currents and despite the inevitable dispersion and dilution, may be detectable far from its source. Moreover, accumulation of pollutants may occur by passage through the food web and so may affect members of the ecosystem at higher trophic levels. Pollution can arise in one of two ways: (a) as a result of the actual process of exploration or exploitation or (b) as a result of the introduction into the environment of an ore which was safely buried in the ocean floor. Pollution in the first case might be by: (i) heat, (ii) increase or decrease in salinity, or (iii) the discharge of materials such as drilling mud, etc. Pollution in the second case is caused by the discharge from the working area of materials which have been mined, such as (1) oil or gas,

(2) ores which are in whole and part soluble in the sea, (3) debris both coarse and fine and (4) materials with a positive buoyancy.

1.1.3 The natural products most likely to be extracted from the sea bed of the continental slope or ocean floor within the foreseeable future are thought to be oil, gas, phosphorite and manganese nodules (UN Report on the sea bed). Of these, only oil seems capable of giving rise to substantial pollution but the character of this will differ in no way from oil drilling close inshore in more productive waters. The effects of offshore activities are likely to be less severe by reason of distance and dispersion.

1.1.4 If, because of exhaustion of more readily available supplies, mining of metallic ores is eventually extended to depths greater than 200 metres, the risks of pollution would be greatest in operations concerned with the extraction of the heavy metals such as copper, lead, mercury, nickel and zinc.

2. CAUSES, TYPES, EFFECTS AND LEVEL OF MARINE POLLUTION

2.1 Geological and geophysical sampling

2.1.1 The pollution created by prospecting and sampling is small compared to actual exploitation. This is true in the sea as it is on land. Bottom sampling by shipborne remote-operating devices or more directly by submersibles causes only minor disturbances at selected points. Core drilling is generally carried out by surface craft. The pollution caused by the craft is perhaps more significant than that caused by the actual drilling process. Non-destructive geological surveying is inconsequential pollution-wise. Magnetometers and gravity meters may be shipborne or airborne

and make measurements with sensitive geophysical intruments directly without physical probing or introduction of artificial sound sources. These are the least disturbing types of exploratory devices. Seismic surveying, on the other hand, generally requires explosive charges to provide a penetrating sound signal. All petroleum exploration is preceded by seismic surveys. The explosive charges can destroy aquatic organisms, particularly fishes which are especially susceptible to shock waves. Seismic explorations have been closely controlled by fisheries agencies in recent years, with the result that explosive charges are becoming less damaging. Most explosives used in seismic work are comparatively small, although they can still kill fish in their immediate vicinity. Some effort has been made by exploration companies to employ an explosive material with as slow a build-up of the shockwave as possible to prevent fish destruction but still fulfilling the requirements for seismic measurements.

2.2 Gas and Oil Exploitation

2.2.1 The most likely cause of pollution is the increased exploitation of gas and oil in deep sea areas. Past experience indicates that from time to time blow-outs occur. The USA report that since 1954 some 8,000 wells have been sunk off-shore and 25 blow-outs have occurred, though only two of these have resulted in severe oil pollution.

2.2.2 Nevertheless, there is some indication that the insidious effects of chronic pollution may produce irreversible effects so that even slight escapes of oil into the sea must be prevented. Slight leaks and major blow-outs can occur at any stage of the operation though they are more likely towards the end of the drilling operations. Drilling in waters where ice floes, particularly icebergs, are found may produce

further pollution hazards as the ice extends very far down into the sea and the random motion of the floes could damage well-heads or pipe lines.

2.3 Solid Mineral Dredging

2.3.1 The most likely solid mineral dredging commercially, beyond the continental shelf will probably occur first for manganese nodules and phosphorites. While phosphorites appear to be most common on the continental shelves, manganese nodules are generally found in deeper waters (> 200 m.) where environments suitable for their formation exist. Eventually other mineral concentrations may be discovered suitable for commercial exploitation. Dredging operations for tin ore in comparatively shallow water are already in progress off Thailand and Indonesia. Dredging typically disturbs the bottom and creates turbidity. Benthic populations can be expected to suffer most. Not only would the benthos on the site of the dredging be destroyed, but communities at some distance surrounding the dredging operation would undergo siltation. This would be especially so downcurrent from the mining site.

2.3.2 Because material stirred up by dredging is heavier than water, it is not anticipated that it would rise much above the dredging site, in the absence of strong vertical currents. However, convection currents created by the dredging operation or normal upwelling could cause the lighter suspended fraction to rise. Turbidity could conceivably be increased in the euphotic zone with the consequences of reduced basic productivity. Any sediment introduced into tropical reef areas could be particularly disastrous because many reef organisms, such as sponges and coelenterates, are especially sensitive to increased sedimentation. Recent studies show that certain micro-organisms and many such invertebrates are producers of a vast variety

of biodynamic substances which may ultimately prove to be among our most valuable marine biological resources. Exposure of sediments to oxygenation will alter the redox potential and could lead to leaching by certain elements. Phosphorus is one of the elements which might be leached from the sediments and carried to the surface with little ill-effect or even potentially beneficial effect. However, heavy metal ions, such as zinc, copper and mercury, could lead to toxicity to organisms. More important, these elements can be concentrated by aquatic organisms to levels dangerous for human consumption.

2.3.3 In general, dredging operations can be considered as sources of pollution to bottom organisms, including fish, but also they produce disturbing effects on bottom communities. While the communities may be sparse at depths beyond the zones of national jurisdiction, the organisms which comprise these communities are expected to be many times more sensitive to disturbing effects than near-shore continental shelf organisms. This stems from the evolutionary process of marine biota where near-shore organisms are subjected to frequent natural changes in environmental conditions compared to small, infrequent changes in the deep-sea environment. While the commerical impact of destruction of deep bottom communities may be relatively small, the ecological consequences could be serious, as rare species could be destroyed and the cycle of the deep-sea ecosystem disrupted.

3. RESEARCH REQUIREMENTS

3.1 Research requirements related to the exploitation of the sea bed beyond the limits of national jurisdiction do not differ basically from those arising from similar activities in coastal waters. The problems posed will generally be less severe than those

generated by near-shore activities for the reasons stated in the Introduction. Thus, the detailed consideration of research needs in the marine pollution field to be undertaken in relation to the further development of the Long-Term and Expanded Programme of Oceanic Exploration and Research will also suffice to define the general research requirements arising from exploitation of the sea bed beyond the limits of national jurisdiction.

3.2 However, deep sea exploitation has certain characteristics which may call for special investigations, e.g. it will be desirable to initiate further studies of dispersion by currents and wind so as to forecast the probable spread of oil pollution from drillings at the shelf edge or beyond, and the dispersion of a pollutant from a point source on the sea bed in deep water.

3.3 The exploitation of mineral resources on the continental slope will also call for a greater knowledge of turbidity currents and sediment slumping. It is possible that these could damage mining installations on the slope and hence cause widespread pollution. Information about the frequency and severity of such currents will be required before exploitation begins in any particular area of the slope.

3.4 In recent years, the sea bottom of the shelf edge from a depth of 200 metres outwards to the continental slope has been extensively trawled for deep water fish in many parts of the world. Ecological studies at these depths have been rather sparse, and in areas likely to be heavily exploited for mineral resources, it may be advisable to arrange for systematic surveys of bottom communities, to provide a baseline for the assessment of pollution damage.

3.5 At this stage it is virtually impossible to list research projects which are especially needed for the exploitation of the ocean floor beyond national jurisdiction. The problems of the

shallower areas which demand research apply equally well to the deeper areas. The only exception is the area of the lower continental shelf or slope. Slumping and sedimentation occur in this area of extreme turbulence about which little is known.

4. THE LEGAL ASPECT

4.1 Considering the biological effects of pollution, the seas constitute an indivisible totality. On the other hand, from the juridical point of view, the seas are divided into zones. In consequence of this division, certain portions of the sea are under the jurisdiction of coastal states and the extent of control which may be exercised by coastal states over these portions of the sea varies, being dependent on the character of the given zone (interior waters, territorial sea, contiguous zone, waters over the continental shelf).

4.2 This aspect should be kept in mind. The pollutants move freely in the water with the force of winds or currents. Whatever is the juridical character of the zone in which pollution occurs, the pollutants may spread out to other zones and affect the whole marine environment in a large area. From the point of view of international control of marine pollution, the division of the seas into zones under different legal regimes is not very adequate. In order to be effective, the control of marine pollution should embrace the entirety of marine environment.

5. SUGGESTIONS FOR ACTION

5.1 Many of the proposals for exploitation are still preliminary, but it is essential that information about such proposals be made available at an early stage so that their implication in marine pollution can be studied with a view to taking preventative measures before the operation starts, rather than having to improvise remedial action after the pollution has occurred. The UN might well be the custodian of the index of such plans and proposals.

ANNEX V

REVIEW OF HARMFUL CHEMICAL SUBSTANCES

(as called for by UN Resolution 2566(XXIV) - Promoting effective measures for the prevention and control of marine pollution).

1. INTRODUCTION

1.1 UN General Assembly Resolution 2566(XXIV) calls for a review of harmful chemical substances, radioactive materials and other noxious agents and waste which may dangerously affect man's health and his economic and cultural activities in the marine environment and coastal areas. The terms of the Resolution further indicate that this review has special reference to the preparations for the UN Conference on Human Environment to be held in 1972 and would thus eventually be taken into consideration in the context of deliberations related to the desirability and feasibility of an international treaty or treaties on the subject.

1.2 With a view to illustrating the comparative importance of substances causing pollution a table has been compiled (Table I) showing major categories of pollutants and their relative effect in terms of:

(a) harm to living resources
(b) hazards to human health
(c) hindrance to maritime activities
(d) reduction of amenities

The categories of pollutants are essentially those drawn up by the IOC Working Group on Marine Pollution, modified in the light of the decisions of the First Session of GESAMP (GESAMP I/11 para. 13 - 38 incl.). It must be emphasized that this Table can only be regarded as a general guide, since particular substances in any one category may be found to have more pronounced effects than others. Consideration

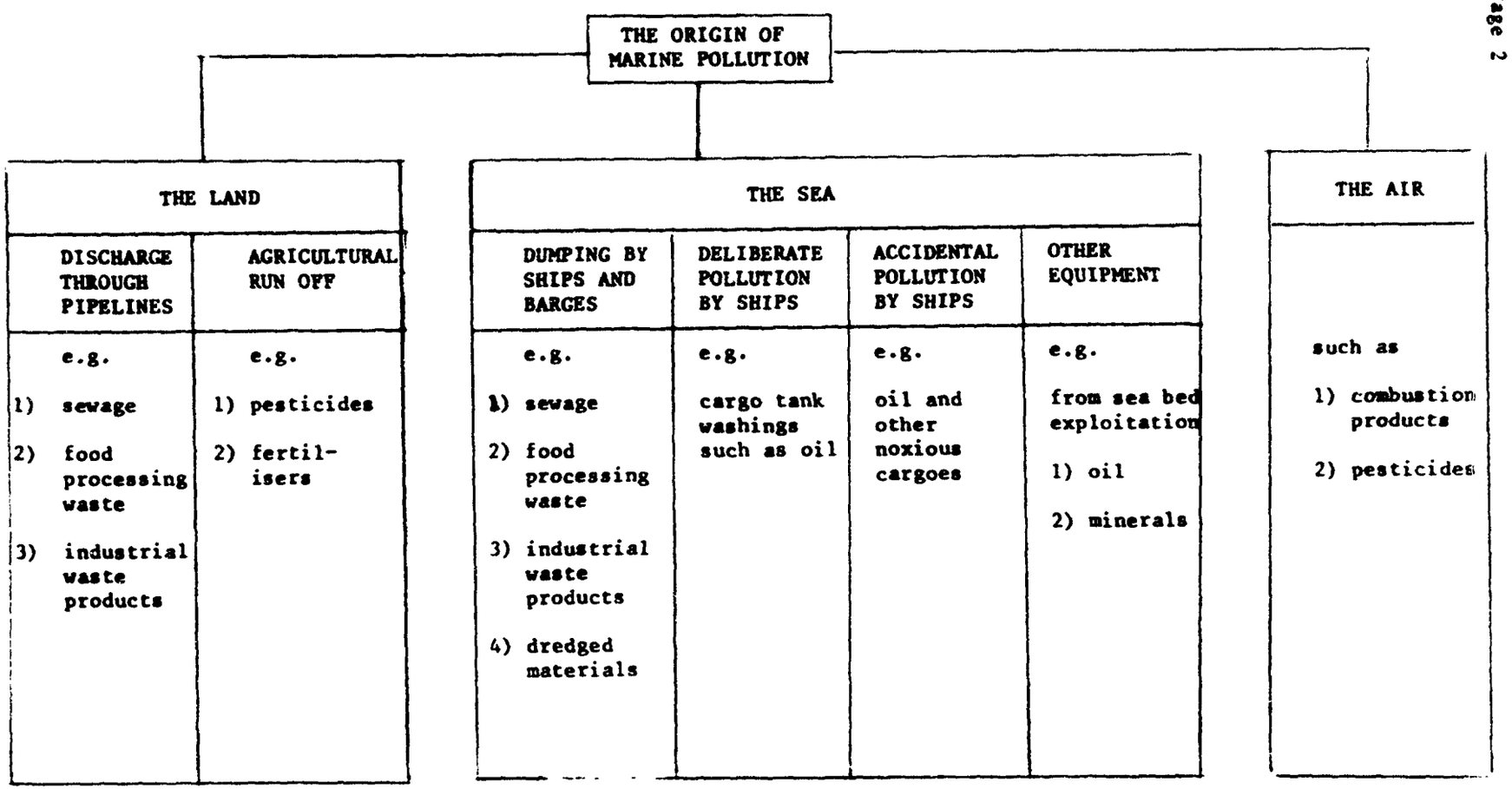
THE ORIGIN OF MARINE POLLUTION
THE LAND
DISCHARGE THROUGH PIPELINES
e.g.
1) sewage
2) food processing waste
3) industrial waste products
AGRICULTURAL RUN OFF
e.g.
1) pesticides
2) fertil-isers
THE SEA
DUMPING BY SHIPS AND BARGES
e.g.
1) sewage
2) food processing waste
3) industrial waste products
4) dredged materials
DELIBERATE POLLUTION BY SHIPS
e.g.
cargo tank washings such as oil
ACCIDENTAL POLLUTION BY SHIPS
e.g.
oil and other noxious cargoes
OTHER EQUIPMENT
e.g.
from sea bed exploitation
1) oil
2) minerals
THE AIR
such as
1) combustion products
2) pesticides

DIAGRAM I

was also given to the need for providing an additional column relating to the impairment of quality of the sea water as mentioned in the basic definition of marine pollution (GESAMP I/11 paragraph 12). This was recognized as being generally a very localized problem closely related to the purpose for which the water is to be used and possibly arising from the presence of many types of pollutants, and it was therefore decided not to include it.

1.3 The Group felt that there was a need to give some thought to the sources from which pollutants originate, as it is generally at their sources that measures of prevention or control have to be applied. To facilitate further consideration of the desirability and feasibility of international treaties, a broad illustration of the main sources of marine pollution together with examples of potential pollutants arising from them is set out in diagrammatic form in Diagram I. This is further elaborated in Table 2.

1.4 Attention is also drawn to the fact that the cargoes carried by ships include a wide variety of noxious substances, falling within the categories listed in Table 1, which may be discharged into the sea either by accident (such as in collision or stranding of a vessel) or deliberately, such as in the tank cleaning and ballasting operations of a tanker or bulk carrying vessel. A particular pollutant may therefore be subject to control under separate regimes, one associated with transport by sea (e.g. IMCO) and the other with its use or production ashore.

1.5 The Group is not aware of any situation in which the release of radioactive materials to the sea by the nuclear energy industry has produced adverse affects, i.e. pollution. This situation has resulted from the very firm control imposed by national governments over this industry since its beginning. The work done

on the study of the dispersion effects and fate of radioactive materials in the marine environment has been and continues to be, large. It has had the result that, although there is yet a great deal to be learned before international instruments of control could be established, the status of radioactive materials as potential pollutants of the marine environment is more clearly defined than that of many other materials recognized as serious pollutants.

1.6 The routes by which marine pollutants enter the sea were then examined. The Group decided that the main headings should be as follows:

(a) Disposal of manufactured and industrial products or of the waste resulting from them by direct outfall or via rivers.

(b) Disposal of domestic wastes by direct outfall or via rivers.

(c) Run-off from the land of materials used in Forestry, Agriculture or Public Health activities.

(d) Deliberate dumping of material from ships.

(e) Operational discharge of polluting materials by ships in the course of their normal tasks.

(f) Accidental release of material from ships or submarine pipe lines.

(g) Discharge or dumping of unspecified materials during military activity.

(h) Transfer of pollutants to the ocean from the atmosphere.

These descriptions were included in Table 2 and the importance of each of them as a route for the different categories of pollutants to enter the sea has been shown by the use of a number of symbols. To aid in the study of Table 2 each category of pollutant is the subject of a brief note.

1.7 The list of noxious substances includes known or suspect agents capable of producing toxic effects upon marine organisms and, possibly, to man. Attention is called to the fact that there is an increasing number of toxic substances that may appear in effluents discharged into the marine environment. These substances are present in both industrial and military wastes as a result of complex manufacturing processes. These materials are sometimes of a classified or proprietary nature and, consequently, information on the chemical identity and toxicity of these materials may not be available. In addition, some chemical substances may be altered by marine organisms or they may produce a synergistic effect, resulting in acute or low-level chronic toxicity. Little is known about the mechanism by which some of these processes take place. There is evidence that in some instances trace elements may trigger toxicity cycles in marine organisms. This is an area of chemi-ecological biogenesis about which little is known. In view of the fact that some of these toxic chemical substances may become protein bound and produce carcinogenic or other deleterious effects, the build-up of these substances in the marine environment is becoming of increasing concern, particularly as it relates to an expanded utilization of marine protein food resources and the production of marine protein concentrates. The present list of toxic materials is only tentative and will undoubtedly be expanded from time to time.

1.8 Although some measures of prevention and control, both national and international, are known to be in force for certain pollutants, the Group recommends that serious consideration be given especially to those categories shown in the Tables as 'important' or 'significant' with a view to improving the effectiveness of existing legislation and, where necessary, taking further action to limit or control their discharge into the sea.

2. CONCLUSION AND RECOMMENDATIONS

2.1 The Tables prepared represent no more than a listing of the principal groups of marine pollutants, with an indication of the nature and seriousness of their effects and the pathways by which they reach the marine environment. Nevertheless, the Joint Group believes that they may have value in showing where the main problems lie and the nature of the action needed to reduce or prevent damage to the marine environment and its living resources.

2.2 As the next step, the Joint Group proposes that experts be appointed either from within the Group, or from elsewhere if they have appropriate knowledge and experience, to deal in more detail with the main constituents of each major category of pollutant. It is proposed to provide, insofar as this is possible in the existing state of knowledge, information for each main constituent under the following subheads:

(a) Principal sources and pathways to the marine environment;

(b) Mode of occurrence and distribution in the sea;

(c) Toxicity and mode of action;

(d) Persistence and/or bioaccumulation;

(e) Known effects on living resources, human health, maritime activities and amenities.

It is proposed that this work should be undertaken during the inter-sessional period so that a further, more comprehensive report, may be prepared when the Joint Group meets again in 1971.

3. NOTES ON MAJOR CATEGORIES OF MARINE POLLUTION (TABLES 1 and 2).

3.1 Domestic Sewage, including Food Processing Wastes

In the raw form, domestic sewage has five major polluting characteristics:

(a) high bacteria and possible virus concentration, endangering use of shellfish and bathing areas;

(b) dissolved organic constituents which give it a high biochemical oxygen demand;

(c) organic solids, eventually depositing on the bottom to undergo decay and oxygen removal;

(d) high nutrient concentrations (mainly phosphorus and nitrogen compounds) leading to enrichment of receiving waters; and

(e) floatables, which may be organic or inorganic materials on the surface or in suspension.

All factors affect recreation, utilization of sea food and amenities. The best basis for control of pollution by sewage appears to be maintenance of shellfish quality. Filter-feeding molluscan shellfish concentrate bacteria and viruses along with other particulate materials. The transmission of viral diseases, such as infectious hepatitis, by consumption of raw oysters is well documented. Various degrees of treatment eliminate or reduce some of the foregoing polluting characteristics: primary - normally eliminates the settleable solids and floatables and may or may not destroy the microflora; secondary - clears the effluent of the finer colloidal suspensions, reduces the biochemical oxygen demand and provides chlorination to eliminate microbes; tertiary - removes the plant nutrients by biological or chemical action or by a combination of the two.

Other household wastes enter the municipal sewer, including detergents, which will be dealt with in another section. Household pharmaceuticals, pesticides, and incidental chemicals are further minor pollutants in domestic sewage. However, the other major problems of municipal sewage are not related to wastes from dwellings but to industrial wastes discharged into the municipal sewer.

3.2 Pesticides

The term 'pesticides' covers a range of materials with widely differing chemical composition. In general and by the very nature of their usage, they are highly toxic but certain classes, particularly organo-chlorine compounds, pose special problems as a result of their persistence and bioaccumulation. The bioaccumulation feature places the predatory animals at special risk since, because the organo-chlorine compounds are highly lipophellic and hydrophobic, the predator retains much of the pesticide it receives in its food. Pesticides are likely to be found in the marine environment in solution in the water and surface films and adsorbed on particulate matter. The state of knowledge regarding the organo-chlorine pesticides is comprehensive on matters such as distribution and concentration, but information on effects which are likely to be produced on physiology, behaviour and breeding success is largely speculative. Information on the other groups is poor but, with the exception of the mercurials, few have so far been detected in the marine environment, probably as a result of their relative lack of persistence.

The route of entry of pesticides via the atmosphere is important although only a proportion of the atmosphere's polluting load arises as a direct result of land usage (e.g. due to spray drift). The remainder enters the atmosphere by evaporation, codistillation with moisture and as a result of land erosion.

Polychlorinated biphenyls (PCB's) are chlorinated organic compounds which have a wide usage. They resemble the organochlorine pesticides in that they are highly persistent and may accumulate in biological materials. Concentrations of these compounds in certain predatory marine animals (e.g. seals and sea birds) may be high, but very little is at present known about the effects of PCB's on marine life, even at high concentrations. The main routes of entry into the marine environment have not been fully established so far.

3.3 Inorganic Wastes

Inorganic wastes are likely to reach the sea either in solution or, in certain instances, in suspended particulate form, either as discrete particles or adsorbed on detrital material. Some are biodegradeable, e.g. cyanide and others (at least in moderate quantities) e.g. phosphate, may in certain circumstances be beneficial. Others are persistent and toxic, e.g. certain metals. Evidence of accumulation by marine organisms exists for many inorganic materials, but only in a few instances e.g. with mercury, zinc and copper, is there much evidence of accumulation up the food chain. The degree of toxicity varies, depending upon the waste, but also according to the form in which the material is discharged. This may best be illustrated by the damage to marine life and potential hazard to human health caused by the recent discharge of particulate elemental phosphorus in Canada. In certain instances, biological action may render a material more toxic after discharge. For example mercury, whether discharged in ionic or complexed form, appears to be converted to methyl mercury which has a very high toxicity. An aspect of the problem which applies particularly to mercury gives rise to special concern. In certain areas, e.g. Japan, Sweden, Canada, the levels of mercury found in fish already have exceeded that considered safe for human consumption and human fatalities have occurred. The affected marine animals, however, do not exhibit any obvious symptoms.

Transfer of inorganic pollutants to the sea via the atmosphere may be important in certain instances e.g. lead and possibly mercury. (The lead arising from its use in automobile fuel and mercury from industrial usage).

Knowledge of the sublethal effects of most inorganic wastes is far from complete and much work remains to be done.

3.4 Radioactive Materials

Although as a result of fallout from nuclear explosions or weapon testing, radioactive materials may reach the marine environment in uncontrolled amounts, the development of the civil uses of nuclear energy is strictly controlled, usually by special legislation so as to minimize the hazard to public health or damage to marine resources. The disposal of solid radioactive waste to the deep oceans is similarly controlled.

The fate of radioactive materials dumped on the deep sea floor should be further studied.

3.5 Oil and Oil Dispersants

In general terms, the substances in this group are lighter than water and are distributed by the action of wind and surface currents. Pollution is primarily associated with their physical presence. They can cause spoiling of the flavour of marine products and may present danger to man through the consumption of organisms in which carcinogens have accumulated.

In temperate and tropical ocean waters biodegradation is fairly rapid. On the whole toxicity is low but some materials used to disperse spilled oil are themselves toxic. The main pollution is the gross reduction of amenities - contamination of beaches, clogging of fishing equipment and tainting of fish, and killing sea birds. Knowledge of the effects of and fate of oil in the sea and of remedial methods is rapidly increasing.

3.6 Petrochemicals - Organic Chemicals

The petrochemicals industry is a very large branch of the chemical industry and may serve as an example of the pollution problems that are connected with chemical processing and shipping of hazardous products. The industry is highly diversified and petrochemical waste may contain

both inorganic products (heavy metals, acids and chlorine) and organic products. Some of the latter have caused spoilage of the flavour of marine products; others are carcinogens which may be accumulated in marine products.

Another hazard is the shipping of petrochemicals either as final products (e.g. organic solvents) or products for further chemical processing (e.g. ethyleneoxide).

Industries are now making important progress in their waste treatment; however, some problems related to the accumulation of waste and the final disposal of the products still remain.

3.7 Organic industrial wastes - including Pulp and Paper Mill waste

In general, these wastes can be harmful to receiving waters for four reasons:

(a) toxicity
(b) biochemical oxygen demand (BOD)
(c) suspended solids
(d) colour

A variety of compounds in organic wastes are toxic to marine organisms. In pulpmill wastes, for example, these are usually sulphur-containing compounds, arising from the wood digestion process, and chlorinated phenolic compounds created by bleaching the pulp and paper.

High BOD is a characteristic of untreated sulphite pulp effluents, as well as of any other bio-degradable organic wastes. Many fish kills have occurred because of oxygen depletion in waters receiving high-BOD wastes. Stabilization ponds with aeration, and activated sludge systems are common forms of treatment.

The solid organic wastes from industry accumulate in sludge beds to produce local nuisances. These undergo decomposition and remove

dissolved oxygen from water. They often form noxious gases. In addition, large areas of the bottom of receiving bodies of water may be covered with a thin layer of settled organic material having undesirable effects on benthic communities. Improved in-plant facilities, more efficient screening and better retention in clarifiers and/or ponds are helping to reduce solids losses.

The effects of industrial organic wastes are often of a subtle long-term nature. They may interfere with various trophic levels in the food chain which ultimately lead to degradation of the coastal environment. These problems may be of particular significance to tropical insular areas. The effects on the higher forms of marine flora and fauna are often sub-lethal rather than acute. For example, oyster quality is known to have declined in many pulp mill areas, although there is little documentation on actual mortality. The food supply of these sedentary organisms can be markedly altered owing to decline of phytoplankton caused by turbidity and colour which can lead to undernourished, lean shellfish.

3.8 Military Wastes

The dumping of military wastes is a significant factor in the pollution of national and international waters. These wastes may consist of organic materials, biological and chemical warfare agents, heavy metals, petrochemicals, explosives, defoliating agents, pesticides, solid objects, dredging spoils and other miscellaneous inorganic materials peculiar to the military establishment. Because of the classified aspect of military operations, the exact chemical and toxicological nature of these materials is frequently unknown. Moreover, details concerning the dumping of these materials are not generally available. Nevertheless, it should be pointed out that the dumping of many of these materials may be contrary to sound conservation practice.

3.9 Heat

The increasing production of power in conventional and nuclear power plants contibutes to the thermal pollution of surface waters. A high temperature of surface waters is accompanied by a decrease in aeration and a resultant loss of dissolved oxygen with marked effects on the flora and fauna. Thermal pollution may also interfere with subsequent uses of water for municipal and industrial purposes. In certain circumstances it has made estuaries unsuitable for various commercial species of fish and shellfish, and on the other hand, leads to the introduction of undesirable forms such as timber-boring organisms. There is need for more critical quantitative studies in order to evaluate the effects of thermal pollution in the marine biotope.

3.10 Detergents

Pollution qualities of detergents have been related to:

(1) non-biodegradability, resulting in foaming of receiving waters; and

(2) phosphate content, leading to enrichment of receiving waters.

Virtually all detergents on the world markets today are bio-degradable, as a result of conversion by manufacturers from the "hard" alkyl benzene sulfonate (ABS) to the "soft" linear alkyl sulfonate (LAS) form.

However, sodium tripolyphosphate remains as a major constituent (20 - 60%) in most detergents. Because it performs vital functions related to cleaning efficiency, manufacturers are reluctant to eliminate or even reduce the amount of phosphate in detergents. American manufacturers say that there is no suitable substitut for phosphate at present. In Sweden NTA (sodium salt of nitrilotriacetate) has been used as a substitute for phosphate in detergents for some time. However, its environmental effects are not fully known. Instead of phosphate being added to the aquatic environment, a small amount of nitrogen is added by NTA.

Recommendations recently made to the International Joint Commission, regarding pollution of the lower Great Lakes, have specified that phosphates should be eliminated from detergents to reduce the eutrophication problem. Up to 50 of phosphate in sewage is attributed to detergents. Pressure is being exerted on detergent manufacturers in Canada to phase phosphate out of detergents.

3.11 Solid Objects

Pollution of the sea by solid objects takes the form of floating and sunken articles such as drums, wire, bottles, timbers, unwanted vehicles and plastic articles, including ropes and fishing nets made of synthetic fibres. Many of these are virtually indestructible. Their main effect is that they are a nuisance in that they interfere with navigation and fishing operations and when washed up on shores reduce amenities. For example, pieces of synthetic ropes and fishing nets are commonly found floating in areas of intense fishing activity, such as the North Sea, and they can immobilize vessels by getting wound round propeller shafts. Again, plastic bottles and containers thrown overboard and washed ashore are a common feature of beaches in many parts of the world. There is also increasing evidence of damage to sea-birds due to their getting entangled in pieces of floating fishing net. Sunken objects may also interfere with fishing operations and some areas have been reported as being unfishable after offshore oil drilling operations on account of the rubbish left behind. In some cases, the dumping of objects has been on such a scale as to affect the habitat of bottom-living animals.

3.12 Dredging Spoil and Inert Wastes

The modification of coastal areas due to dredging and mining operations can create an excessively high sedimentation factor which can reduce the

supply of light for plants, smother fish eggs, larvae, invertebrates, and micro-organisms, thereby interfering with the normal bottom component of biological energy cycling. These effects may be particularly disastrous in tropical reef areas where many reef organisms such as sponges and coelenterates are especially sensitive to increased sedimentation. Recent studies have shown that many of these micro-organisms and invertebrates are producers of biodynamic substances which may prove to be valuable marine resources. There is a need for accurate quantitive data regarding the effects of increased sedimentation in the marine biotope.

In addition to sand and silt dredged from navigable channels and harbours, and dumped at sea, there are industrial activities which result in a large volume of inert waste which may either reach the sea by pipeline as a slurry, be dumped from barges, or merely tipped on the shore. Examples are china clay, gypsum, "red mud" from bauxite reduction, fly-ash from power stations and colliery waste. These materials are usually inert and non-toxic but may affect marine life by settling on the sea bed, and so modifying the ecosystem, or by creating turbid conditions and reducing light penetration. Fish spawning grounds may be destroyed and the settlement of molluscs prevented. The bottom may be rendered unsuitable for crustacea such as lobsters, crabs and prawns, but new communities of bottom animals may be produced which may provide additional food for fish. Where dredging includes a substantial quantity of organic material an additional BOD may be created locally and nutrients may be added.

TABLE 1

MAJOR CATEGORIES OF MARINE POLLUTION

	Category	Harm to living resources	Hazards to human health	Hindrance to maritime activities	Reduction of amenities
1.	Domestic sewage including food processing wastes	+ +	+ +	(+)	+ +
2.	Pesticides	+ +	+	-	-
3.	Inorganic wastes including heavy metals	+ +	+ +	-	(+)
4.	Radioactive materials	.	+	(+)	-
5.	Oil and oil dispersants	+	.	+	+ +
6.	Petrochemicals and organic chemicals	+	.	(+)	(+)
7.	Organic wastes including pulp and paper wastes	+ +	?	(+)	+
8.	Military wastes	+	.	+	?
9.	Heat	+	-	+	-
10.	Detergents	(+)	-	-	(+)
11.	Solid objects	+	-	+	+ +
12.	Dredging spoil and inert wastes	+	-	+	+

Key to symbols:

+ +	important
+	significant
(+)	slight
	uncertain
-	negligible

TABLE 2

PRINCIPAL SOURCES OF MARINE POLLUTION

	Category of pollutant	Manufacture & use of industrial products - disposal via direct outfalls & rivers	Domestic wastes. Disposal via direct outfalls & rivers	Agriculture Forestry Public Health via run-off from canal	Deliberate dumping from ships	Operational discharge from ships in course of duties	Accidental release from ships and submarine pipelines	Exploitation of sea bed mineral resources	Military activities	Transfer from the atmosphere
1.	Domestic sewage inc. food processing wastes	+	+ +	-	+	(+)	-	-	-	-
2	Pesticides	+	+	+ +	?	-	0	-	?	+ +
3	Inorganic wastes inc. heavy metals & other toxic inorganic compounds	+ +	+	(+)	+	-	0	(+)	?	+
4.	Radioactive materials	+ +	?	-	?	-	0	-	?	+
5.	Oil & oil Dispersants	+	(+)	-	+	+	+ +	+	?	-
6.	Petro-chemicals & organic chemicals	+ +	(+)	-	+	(+)	0	-	?	-
7	Organic wastes inc. pulp & paper wastes	+ +	+ +	+	+		-	-	-	-
8	Military wastes	?	-	-	?	?	?	-	?	-
9.	Heat	+ +	-	-	-		-	-	-	-
10.	Detergents	(+)	+ +	-		-	-	-	-	
11.	Solid objects	-	-	-	+ +	+ +	?(+)	(+)	-	
12.	Dredging spoil & inert wastes	+	-	-	+	-	-	+ +	-	-

key to symbols

+ +	important	(+)	slight	-	negligible
+	significant	?	uncertain	0	potentially harmful

INDICATION FOR CONTROL

In relation to the prevention and control of marine pollution, the symbols would generally imply the following:

- • • - restrictive or preventive measures recommended
- • - restrictive or preventive measures should be considered
- 0 - measures to assess potential harm advisable
- . - further investigations required pending which caution is recommended
- (•) - no special action indicated
- - - no special action indicated

Best Available Copy

ANNEX VI

PRELIMINARY REPORT ON PROBLEMS OF MARINE POLLUTION WITHIN THE SCOPE OF THE LONG TERM AND EXPANDED PROGRAMME OF OCEANIC RESEARCH (LEPOR): SCIENTIFIC BASIS FOR A MONITORING SYSTEM

1. Research categories

The research projects fall into five complementary categories concerned with:

(a) Technology and methodology;

(b) Mode of entry, pathways, and fates of pollutants in the sea;

(c) Routine monitoring of pollutant levels;

(d) Surveying trends and changes in the marine environment;

(e) Establishment of laboratories, etc.

2. Priorities

It will be necessary to establish priorities of projects within each category and, since each project is comprehensive, priorities between the various tasks that contribute to each project.

The establishment of priorities requires careful thought and at the detailed level, the advice of specialists in the various fields. This process should continue during the months following the present GESAMP meeting.

In indicating priorities it will be necessary to harmonize general scientific and global needs with national or regional interests which will vary depending upon the local situation and the most critical problems in each area.

3. International co-ordination

Information exchange and co-ordination of effort between countries engaged on parts of this programme is an urgent need in almost all projects.

Much development work is already in progress in different countries and a number of national monitoring programmes have been initiated or are planned. Co-ordination of effort would reduce wasteful duplication and facilitate standardization of methods.

4. Projects

4.1 Technology and methodology

(a) Development of relevant methods of analysis of materials in seawater and in marine organisms, including multi-element and multi-substance analysis, and automation of analysis. These developments should relate particularly to pollutants already known to be hazardous, but there should also be the facility for the rapid development of new assay techniques as new pollutants are identified.

(b) Development of new and more sophisticated methods of bioassay for testing for, and quantifying pollutants and marine intoxicants. Present techniques are in a rudimentary state compared with physical and chemical assay techniques. It will be necessary to:

(i) broaden the spectrum of organisms that can be used as indicators, particularly as greater areas of the world come under surveillance and investigation;

(ii) increase the range of responses (i.e. in addition to assessing lethal doses) used as indices of pollution;

(iii) develop new techniques, such as establishing buoys and other devices carrying test organisms (e.g. bivalves) in selected places.

(c) Both physical, chemical, etc., and biological assay methods should ideally be standardized, but where this is impracticable, it is essential that methods of sampling, analysis and instrumentation should be intercalibrated so that it is possible to compare the findings of different laboratories. There is a need for investigating means of intercalibrating assay methods.

4.2 Mode of Entry, Pathways and Fates of Pollutants

Only the most urgent problems are listed.

(a) Study of entry of pollutants into the sea:

(i) measurements of the amount of pollutants in rainwater and atmospheric dust entering the sea and related investigations of the atmosphere as a transport agent of potential marine pollutants.

(ii) comparative investigations of transport and dispersion of pollutants at river mouths and pipeline outfalls.

(b) Dispersion and distribution of pollutants in the sea:

(i) development of methods of studying diffusion processes near the seabed at oceanic depths and below the thermocline in shallow seas;

(ii) investigation of vertical diffusion as a function of current velocity and density gradient;

(iii) development of mathematical and physical models of the motion of the ocean in relation to the transport and dispersion of pollutants in coastal waters and estuaries.

(c) Investigation of absorption and adsorption of pollutants by sediments in suspension.

(d) Physical accumulation of pollutants. Both non-miscible and, in some cases, miscible products accumulate in certain areas under the influence of hydrological, meteorological and oceanographic factors. In some areas flocculation occurs. The following studies are necessary:

(i) delimitation of areas where physical accumulation and flocculation occur;

(ii) because of the importance of benthic production and general quality of the seabed to fisheries, particular attention should be given to the accumulation of pollutants in sediments, either directly or indirectly by bacterial or other degradation of organic material;

(iii) accumulation of gases (e.g. H_2S) and its consequences requires special examination;

(iv) synergistic phenomena in physical accumulation may lead to complex products. These phenomena and their consequences need examination.

(e) Biological accumulation and transport:

(i) investigation of the accumulation of pollutants in macro- and micro-organisms resulting from direct intake from the physical environment (water, sediments, etc.) or by intake of organic matter;

(ii) investigation of the biological transport of pollutants within the food webs of the sea. (Note that in many areas of the world this will involve elucidating the food webs themselves - see 4.4(e) below). It is important not to confine attention to the pathway of the initial pollutant but to

consider also other products into which it may be changed under the influence of the environment or of living organisms, and biotoxins, the production of which may be stimulated by the presence of the pollutant;

(iii) development of improved methods of establishing accumulation processes and their physiological background.

4.3 Routine Monitoring of Pollutants

Reference is made to the Report of the Joint Working Party of ACMRR/SCOR/WMO "Global Ocean Research" pages 20 - 25, on a proposed monitoring programme, with which the Group generally agrees.

4.3.1 A programme of monitoring is required to:

(a) provide information on long-term trends in certain signficant characteristics of the marine environment;

(b) give warning when certain pollutants exceed maximum permissible concentrations in either water or the marine biota;

(c) provide a measure of distribution of polluting substances in the world oceans.

4.3.2 Pollutants falling in one or more of the following categories should be monitored:

(a) pollutants found in a marine organism at a level known to be hazardous to itself, its predators, or man;

(b) pollutants that are themselves highly toxic;

(c) persistent or bioaccumulated pollutants;

(d) pollutants discharged in quantities representing a significant fraction of that found in the natural environment.

4.3.3 Elements or substances to be monitored and the plan of sampling in space and time must be selected so that the greatest benefits can be derived from the effort expended. Maximum use should be made of multi-element and multi-substance techniques rather than monitoring single substances. In this way, unknown discharges or previously unknown pollutants which may have harmful effects on marine organisms could be identified. Such a monitoring system would also be helpful in establishing pathways of matter other than pollutants in the ocean system. It is envisaged that a global monitoring plan into a coastal and deep-sea programme would be instituted as follows:

(a) Coastal monitoring programme (i.e. on continental shelf). Substances to be monitored may be considered from three standpoints although they overlap to some degree:

(i) maintenance of health of fish and shellfish stocks, e.g. DDT, etc., polychlorinated biphenyls;

(ii) prevention of risk to public health, e.g. mercury pathogenic microbes, toxic marine organisms;

(iii) preservation and balance of the ecosystem, e.g. detergents, agricultural run-off.

Note that it is simplest to monitor major categories of pollutants near their sources which are generally urban industrialized sites. Thus organisms, waters, sediments and atmospheric fallout should be monitored in coastal waters and in estuaries.

(b) Deep-sea monitoring

In order to establish the amount of widely distributed pollutants and also deliberate and accidental discharges from ships, monitoring should take place in remote areas of the open sea. Such monitoring should include surface

water, plankton and atmospheric fallout. Direct air sampling of impurities and collection of rain water samples should be included in any monitoring programme. Biotypes on the shores of remote islands, and coral reefs should also be monitored. Isolated oceanic islands, weatherships, buoys and ships of opportunity are feasible monitoring platforms. The potential value of satellites for monitoring should not be overlooked. Substances to be monitored include:

(i) lead, mercury;
(ii) radioisotopes;
(iii) hydrocarbons;
(iv) sulphur dioxide and sulphuric acid, carbon dioxide, DDT.

Emphasis should be placed on monitoring the mixed layer at oceanic stations. However, since the dumping of hazardous materials in deep water is now practiced, it is also necessary to monitor deep bottom waters and the relevant fauna. Because some members of the biosphere act as integrators, through uptake of substances over wide areas, a selection of organisms should be made to provide the most representative and useful information.

4.4 Survey of Trends and Changes in the Marine Environment

(a) For the development of more sophisticated and realistic biological assay methods (see 4.1(b) above), it will be necessary to gain much greater understanding of delayed or sub-lethal effects of pollutants on marine organisms. This will involve consideration of:

(i) individual pollutants;

(ii) various pollution loads of individually harmless effluents in different environmental situations (e.g. in conjunction

with low salinity, high temperature, or other natural forms of environmental stress).

(iii) synergistic effects of different pollutants, in relation to growth, reproduction, behaviour and other biological processes at different development stages and at vulnerable periods in the life history (e.g. at spawning) of a spectrum of organisms.

(b) Determination of standards of environmental quality (i.e. of water and substrata) for different purposes:

(i) fisheries
(ii) aquaculture
(iii) bathing beaches
(iv) industrial use, etc.

(c) Some effluents (e.g. heated water) may be put to advantage providing their discharge is properly managed. This requires the development of models in particular instances.

(d) Detailed observation of the marine environment in a number of selected areas to detect trends or unexplained changes in abundance of organisms, species composition of the biota, etc., and the examination of such cases to see which are the direct or indirect consequences of marine pollution. The following are some recently detected changes which urgently require study in depth:

(i) the incidence of poisonous fish and the biogenesis of intoxicants in certain tropical waters;

(ii) the incidence of "red tides" in the North Sea and adjacent waters;

(iii) changes in the benthic meio- and macro-fauna of nursery grounds for fish in some areas of the North Sea.

(e) Scientifically little explored areas, particularly in tropical and sub-tropical waters present an additional problem. In most such places there is an almost total lack of basic taxonomic and ecological information, including knowledge of seasonal fluctuation and population dynamics. Under these circumstances, it is virtually impossible even to begin marine pollution investigations. Some basic studies are likely to be developed in connexion with other programmes (e.g. fisheries exploitation), but they are so essential to marine pollution research in these areas that they must be regarded as a specifically marine pollution project also. Otherwise, aspects of taxonomy and ecology particularly related to pollution studies may be omitted from other programmes, or the work may not be given a sufficiently high priority to meet the needs of a marine pollution programme.

4.5 Provision of Laboratories

(a) The high cost, sophistication and specialized nature of some equipment required in the monitoring programme are such as to justify the centralization of analytical services into relatively few laboratories. Arrangements need to be made for this, and in some cases, new laboratories should be established.

(b) Detailed and continuing programmes listed under 4.4(d) and 4.4(e) will need to be carried out in a number of strategically selected sites for investigations in different climatic and ecological situations. Northern temperate seas are well served, but it will be necessary to establish new laboratories or support and direct the work of existing laboratories in some tropical and sub-tropical areas.

(c) There is urgent need for some provision for training scientists and technicians in marine pollution research.

ANNEX VII'

UNITED NATIONS EDUCATIONAL,
SCIENTIFIC AND CULTURAL ORGANIZATION

INTERGOVERNMENTAL OCEANOGRAPHIC COMMISSION

NOTE TO THE SECOND SESSION OF THE
JOINT GROUP OF EXPERTS ON THE SCIENTIFIC
ASPECTS OF MARINE POLLUTION (GESAMP)

by the Secretary of IOC

The Eleventh Meeting of the IOC Bureau with the Consultative Council, held in Paris 26-31 January 1970, considered questions related to the scientific aspects of marine pollution. The Bureau and Consultative Council noted that an item of the revised Provisional Agenda for the Second Session of GESAMP concerned the follow-up and elaboration of research projects required to implement the sections dealing with marine pollution in:

(a) the report, Global Ocean Research, prepared by the joint Working Group on Scientific Aspects of International Ocean Research nominated by SCOR, ACMRR and WMO/ACOR (the Ponza Report);

(b) the Comprehensive Outline of the Scope of the Long-Term and Expanded Programme of Oceanic Exploration and Research which was endorsed by the Sixth Session of IOC.

The Bureau and Consultative Council also considered the following general questions to be very important:

(a) the dispersion and transport of surface pollution by natural physical processes;

(b) pollution of the sea by transfer from the atmosphere;

(c) the development of an information centre concerned with marine pollution.

The Bureau and Consultative Council recommended that GESAMP undertake the following tasks:

1. to develop programmes to monitor the input to the oceans of such substances as heavy metals (lead and mercury), pesticides and industrial chemicals like PCBs coming from the atmosphere, rivers and outfalls respectively, in order to establish the relative importance of these various pathways;

2. to consider the advisability of:

   (a) establishing international and regional laboratories to monitor alterations of the marine environment by man;

   (b) encouraging additional studies of the transfer of pollutants from one trophic level to another - so leading to their concentration at the various levels;

   (c) initiating studies of the degradation of various harmful substances into harmless ones in the natural environment with a view to finding factors and conditions which would accelerate such processes;

   (d) initiating studies of the synergistic aspects of marine pollution;

   (e) inviting when necessary interested international scientific organizations to consider the formation of working groups on methodological research and the inter-comparison of analytical methods.

The pertinent parts of the report and recommendations of the Second Session of GESAMP will be made available to the IOC Group of Experts on

Long-Term Scientific Policy and Planning, prior to the first meeting of that Group which is expected to take place in the first months of 1971. The IOC Group of Experts will be considering scientific problems involved in the development of the Long-Term and Expanded Programme of Oceanic Exploration and Research, with the co-ordination of which the IOC has been entrusted by the United Nations General Assembly. In this task the IOC is co-operating closely with, and being supported by, organizations of the United Nations System concerned.