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PLAN OF ACTION FOR THE MEDITERRANEAN

Co-ordinated programme for research,  
monitoring, and exchange of information  
and assessment of the state of pollution  
and of protection measures

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## I. INTRODUCTION

1. The purpose of this paper is to summarize the main initiatives as regards research and monitoring projects taken or contemplated by concerned agencies of the United Nations system and regional bodies of the Mediterranean, and to make suggestions for the consideration of participants, concerning research into and monitoring of marine pollution in the Mediterranean. Although it has been widely recognized that the pollution of the Mediterranean Sea is increasing and some riparian States have undertaken research into, and the monitoring of, the pollution usually within their own coastal waters, broader regional or subregional programmes have remained, until recently, at a comparatively early stage of development.
2. In 1969 the General Fisheries Council for the Mediterranean (GFCM) of the Food and Agriculture Organization of the United Nations formed an ad hoc Working Party on Marine Pollution in the Mediterranean and its Effects on Living Resources and Fisheries. This working party, with the collaboration of the International Commission for the Scientific Exploration of the Mediterranean (ICSEM), prepared a review, The State of Marine Pollution in the Mediterranean and Legislative Controls which was published in 1972 in the FAO Fisheries Review, No. 51, and is available to the meeting for information.
3. In 1973 the earlier Working Party was renamed the Working Party on Marine Pollution in Relation to the Protection of Living Resources, with revised and expanded terms of reference. In January 1974 this Working Party prepared a preliminary evaluation of information about sampling and analytical activities in the region as a basis for co-operation among concerned institutions. The Working Party started a review of existing or planned national and regional monitoring activities in the Mediterranean, and outlined a general scheme of work, specifying requirements for future research, for the evolution of a Mediterranean monitoring programme that would provide data needed for the protection of fisheries and aquaculture. Some preliminary information concerning river inputs of pollutants was assembled.
4. Under the joint auspices of the Intergovernmental Oceanographic Commission (IOC), GFCM and ICSEM, the United Nations Environment Programme (UNEP) supported an international workshop on marine pollution in the Mediterranean (Monaco, 9-14 September 1974). The workshop defined the pollution of coastal waters as the main problem in the Mediterranean and attributed it to the general lack of adequate systems for the treatment and disposal of domestic and industrial waste, to the input of pesticides and hydrocarbons (oil), and to the presence of pathogenic micro-organisms. The workshop reviewed the information on current regional programmes as well as on the research and monitoring facilities in the Mediterranean. They found the available information inadequate. Several priority studies and needs for co-ordinated activities were elaborated, and nine pollution monitoring and research pilot projects for the Mediterranean were outlined. The report of the workshop is available to the meeting for information.
5. As a follow-up of the IOC/GFCM/ICSEM workshop the GFCM working party met again (Monaco, 6-18 September 1974) to draw up a plan for the implementation of four of the nine pilot projects dealing with the protection of living resources and fisheries in the Mediterranean. WHO took steps to promote the implementation of one of the pilot projects dealing with the sanitary quality of the coastal waters, and IOC has prepared a draft outline for the pilot project dealing with the coastal transport of pollution. All these documents are available to the meeting for information.

6. Future work should take account of all work at present under way under the auspices of the international organizations. Several projects dealing with various aspects of coastal pollution and its control have been assisted by the United Nations Development Programme (UNDP). The World Health Organization (WHO) has acted as executing agency in many of these projects. For many years, WHO has also supported research into the effects on human health of pathogenic pollutants of a physical, chemical and biological nature. In addition, WHO has organized courses of instructions in the control of coastal water pollution and is planning to arrange similar courses on a regional basis wherever the need exists. The Organization for Economic Co-operation and Development (OECD) has played a role in the Mediterranean through the monitoring of toxic metals and pesticides in pilchard as well as through the promotion of exchange of information about the national pollution control activities of coastal States.

## II. REGIONAL PILOT PROJECTS FOR CO-ORDINATED RESEARCH INTO AND MONITORING OF MARINE POLLUTION

7. The report of the IOC/GFCM/ICSEM Workshop is available to the meeting for information. It proposed the pilot projects described below.

### A. Co-ordinated Mediterranean pilot projects for monitoring programmes

1. Baseline studies and monitoring of oil and petroleum hydrocarbon in marine waters.

8. The pollution of the Mediterranean by oil and petroleum hydrocarbons is a serious problem for beaches and other coastal, recreational areas, and as yet too little is known about the present levels of the pollution and about its effects on the Mediterranean ecosystem. So far as the levels of pollution are concerned, it appears appropriate to initiate a regional monitoring programme within the framework of the pilot project for the monitoring of marine pollution by petroleum of the Integrated Global Ocean Station System (IGOSS) of the IOC and the World Meteorological Organization (WMO). An operational plan for this project was developed by the IGOSS Planning Group and was finalized at a Symposium and workshop held at Gaithersburg, Maryland, USA, from 13 to 17 May 1974 by a joint ICC/WMO task team (II) on Marine Pollution Monitoring. The report of this task team is available to this meeting for information (document IOC-WMO/MPMSW-I). The IGOSS pilot project will involve initially the visual observation of oil slicks and other floating pollutants by ocean weather ships, research vessels, voluntary observing ships, fishing vessels and their supporting ships, and by observers on suitable offshore platforms and aircraft; tar ball sampling by ocean weather ships, research vessels and other vessels designated by Member States, and by staff at coastal stations, on islands and offshore platforms; survey of tar on beaches by staff of participating institutions of Member States; and sea water sampling by research vessels, ocean weather ships and other vessels suitably staffed and equipped.

9. The data reporting and data management system has been developed. Although the pilot project calls for the sampling of seawater for the determination of dissolved petroleum hydrocarbons, some problems of sampling and, in particular, of chemical analysis have yet to be resolved. The IGOSS task team II has requested the International Co-ordinating Group for the Global Investigation of Pollution in the Marine Environment (GIPME) to promote research into these problems, particularly that of measuring levels of pollution in biota.

10. The measurement of present levels of petroleum in all its forms in the Mediterranean assumes greater importance in view of the prospective reopening of the Suez Canal to the passage of oil tankers. The value of including the Mediterranean region within the project rests mainly on three facts: (i) the observational system has already been developed (IGOSS); (ii) by using a common system of observations the various subregions of the Mediterranean can be readily compared; and (iii) within a common system of observation, the Mediterranean can be truly compared with other areas (é.g. the North Atlantic) with quite different oceanographic regimes, in which the possibilities for dispersion and dilution are greater and the possibilities of evaporation generally lower.

11. The IGOSS pilot project is basically not designed to determine the effects of petroleum on the marine ecosystem, and the study of these effects should be part of the proposed pilot project on effects of pollutants, mentioned in section II B. 2, below.

2. Baseline studies and monitoring of metals, particularly mercury, in marine organisms.

12. Metals, and particularly heavy metals like mercury, are more or less toxic to man. They can reach man through the food chain, and the source of greatest concern is, therefore, the level of concentration of such metals in fish, shell-fish and other edible marine organism.

13. It is recognized that the Mediterranean is a tectonically rich region and that some metals manifest high natural levels and great variations in their concentration in sea-water and sediments. The bluefin tuna, as well as other tuna, is known to accumulate mercury and, although there is no strong evidence that the Mediterranean stock is separate from the Atlantic stock as a whole, Mediterranean tuna apparently have much higher levels than those from the Atlantic. The IOC/GFCM/ICSEM workshop therefore proposed the measurement of these levels as a priority task.

14. The GFCM Working Party developed this idea further by specifying the metals mercury, cadmium, selenium and manganese, without prejudice to the addition of others if participating institutions agree, and the object organisms; bluefin tuna, striped mullet and the Mediterranean mussel; the particular tissues to be analysed were also specified. The main criteria for this choice of organisms were that they are almost ubiquitous species in the region, are widely consumed by man, and represent different parts of the ecosystem (tuna - pelagic, mullet - nearshore benthic, and mussel - littoral).

15. Several riparian States of the region have undertaken local programmes and have developed facilities for measuring the levels of concentration of heavy metals in seawater, marine sediments and marine organisms.

3. Baseline studies and monitoring of DDT, PCB's and other chlorinated hydrocarbons in marine organisms.

16. Similar arguments to those advanced for the monitoring of metals apply to chlorinated hydrocarbons; they are persistent; they are usually accumulated by

organisms; they are usually harmful to man indirectly, through effects on the stocks of marine organisms he exploits. Even less is known about the present concentrations of these chemicals than about the concentrations of heavy metals. Since virtually all chlorohydrocarbons are generated by man, natural background levels of these substances are not a problem in baseline studies. Several different kinds of chlorohydrocarbons can often be detected in the analysis (by gas chromatography) of one sample containing them, though to do so requires an extremely high standard of technique if reliable results are to be achieved.

17. The GFCM Working Party proposed the following organisms: the Mediterranean mussel, striped mullet (both also to be investigated for the presence of heavy metals) and the Mediterranean shore crab, and specified the tissues and general sampling criteria.

18. With respect to all three monitoring projects mentioned so far the need is stressed for as wide a coverage of the Mediterranean as possible by means of a network of participating laboratories, for intercalibration exercises using the same reference samples, before monitoring commences for regional or subregional sampling strategies, for mutual assistance and training; to enable as many institutions as possible to participate, and for the inclusion of international and extra-regional laboratories in one or more phases of the pilot projects if necessary and desirable.

B. Co-ordinated Mediterranean research programmes

1. Effects of pollutants on marine organisms and their populations.

19. Laboratory and field experiments and observations on long-term effects of sub-lethal doses of potential pollutants and their transformation products are carried out in several Mediterranean institutions. The co-ordination of these efforts seems desirable, and the GFCM Working Party proposed two types of study: one within the concept expressed by the title of this section; and a broader one to determine the effects of pollutants on marine communities and ecosystems, which is discussed below (section B.2).

20. Since marine organisms have adapted to an environment that has only slowly changed on a geological time scale, they are likely to be particularly sensitive to two classes of pollutants: those pollutants not known to occur in nature, the synthetic chemicals, particularly the chlorohydrocarbons; and those known to occur in nature but in concentrations much lower than those now found as a result of human activity.

21. The GFCM Working Party proposed that acute toxicity tests should not be included, except for organisms that could not be kept in culture for extended periods. It proposed, on the other hand, long-term experiments to determine sub-lethal doses of potential pollutants on specific organisms; it recommended phytoplankton and zooplankton, which can be kept under long-term culture, and higher organisms used in aquaculture (grey mullet, striped mullet, sole and eel), without prejudice to the search for more sensitive organisms that could be cultured.

22. Apart from toxicity tests and the determination of dose/response relationships in selected marine organisms, the Working Party proposed that studies of pollutant antagonism and synergism (mitigation and reinforcement, respectively, of effects of two or more pollutants) should be undertaken.

23. Perhaps even more important than these effects at the level of the individual organism are those at the population level, which, even though mainly the summation of the effects on individuals, are of greater significance for man, particularly in respect of exploited species (e.g. fisheries). These effects are produced on the basic population parameters: growth (rate, maximum individual size, and length-weight relationship in particular); reproduction (fecundity, mating and spawning success); stock recruitment (egg, larval and juvenile survival); mortality; and behaviour (protective signalling, territoriality and mating behaviour), which pollutants may modify by the masking or interference of chemical signals.

24. On another level, the Working Party recommended studies of damage by pollutants to the genetic patrimony of a population of a particular species.

25. The pollutants proposed for inclusion in this study are: mercury, cadmium, selenium, manganese, DDT, PCB's, dieldrin and other chlorinated hydrocarbons, without prejudice to the inclusion of others if necessary and desirable. Radioactive elements are not included because discharges of these substances are already subject to considerable control, and studies on their effects on individual organisms are comparatively highly evolved. Nevertheless, there are no grounds for complacency, particularly with respect to the transuranic elements (artificial radionuclides of atomic weight greater than uranium's).

#### 25. Effects of pollutants on marine communities and ecosystems

26. A co-ordinated study of the effects of pollutants on marine communities and ecosystems is much broader than the one on marine organisms and their populations. The main difficulty is how to distinguish effects of pollutants from natural long-term changes in communities. The proposed studies, which quantify as far as possible both the abundance and species composition of a given community, should therefore, in principle, be long-term and undertaken in areas where high pollutant levels have been observed and where data from long-time series of observations on community structure are available. Alternatively, similar communities in polluted and unpolluted areas (e.g. marine parks) should be compared, and studies in confined areas or under controlled environmental conditions should be carried out. Since such studies are interdisciplinary and since marine communities and ecosystems are disrespectful of national boundaries, the need for co-ordinated regional work is apparent.

27. The IOC/GFCM/ICSEM workshop proposed the following communities for study: benthos (bottom-living organisms), neuston (sea-surface organisms), plankton (free floating microscopic animals and plants) and nekton (free-swimming organism), in that order of priority.

28. The GFCM Working Party proposed the phytoplankton and the benthos as two types of marine community that could be studied within the framework of a pilot project. This choice presents some difficulty: the phytoplankton community cannot be adequately studied without reference to the zooplankton and filter-feeding fish, such as the pilchard, which in fact form part of the epipelagic ecosystem to which these organisms all belong; the benthos is, on the other hand, a more self-contained collection of organisms.

29. The proposed phytoplankton study should be intensive rather than extensive, with a dense network of sampling stations; various relevant parameters of phytoplanktonic activity (e.g. primary production and primary productivity) and of the environment (e.g. dissolved oxygen and biological oxygen demand) should be measured. The proposed benthic study should take two areas as similar as possible in all respects except their pollutant load, and should quantify the benthic communities and measure the relevant environmental parameters. The Eastern Mediterranean Ecosystem Project proposed by an International Biological Programme/Productivity-Marine (IBM/PM) Symposium held in Malta in 1973 should be borne in mind in the development of such studies.

30. None of the pilot projects proposed so far should last for less than two years, and the last-mentioned should last longer, depending on the intensity of the effort and the amount and availability of existing data.

### 3. Coastal transport of pollution

31. The general pattern of sea surface transport in the Mediterranean is cyclonic (counterclockwise) in both the eastern and western basins. Pollutants discharged into coastal waters tend to be transported along the coasts, thus restricting advection from the coasts towards the open sea. At the same time, floating marine litter and tar balls in the open sea will tend to be centrifuged towards the coasts. Water leaves the Mediterranean at depth through the Straits of Gibraltar and enters at the surface there. Since most pollutants are most abundant in the upper layers of the sea, the loss by transport through the Straits is relatively small. The average residence time of entering seawater is estimated to be about 80 years, on the basis of the general hydrography of the Mediterranean and of mass transport measurements in the Straits, though the duration probably ranges from a few years to several hundred.

32. Although the general nature of the mass transport of seawater in the Mediterranean is reasonably well understood, our knowledge of local circulation patterns is still sparse. The former may serve in studies of the distribution of pollutants entering the sea via the atmosphere, but the latter is much more important in studies of the distribution of pollutants entering the sea via rivers.

33. The Intergovernmental Oceanographic Commission intends to propose a co-ordinated study, through the IOC/GFCM/ICSEM Co-operative Investigations in the Mediterranean, of coastal transport. Like all such studies mentioned in this document, this work will be based on previous or present studies now under way in individual institutions.

### 4. Coastal water quality control

34. The coastal water quality control project proposed by the IOC/GFCM/ICSEM Workshop on the basis of a submission by the World Health Organization has the objective of assisting participating countries in the development of comprehensive plans for the management of coastal waters so as to maintain agreed standards in the Mediterranean region. In addition to investigations and monitoring of the microbiological quality of coastal waters currently under way through WHO, such plans would provide the basis for the abatement of the pollution of the sea and the beaches, and for their protection from waste discharges from new industrial and urban centres. The pollution of the sea and the pathogenic infections in seafood will be correlated with the state of public health.



### C. Subregional multinational programmes

35. The RAMOGE project was established by France, Monaco and Italy for the coastal sea between Saint Raphael, Monaco and Genoa. A group of experts has drawn up a programme of sampling and analysis of the coastal marine environment, using standard methods; they have also made proposals for: the rationalization of effluent purification (industrial effluents and domestic effluents in successive stages); for a monitoring programme for environmental quality standards, with the prohibition of certain discharges; and for the development of common regulations and the exchange of information.

36. The joint Adriatic pollution research and monitoring programme was established as a contribution to the Italo-Yugoslav agreement on collaboration in safeguarding the waters of the Adriatic Sea and its estuaries; this agreement is in the process of being ratified by the Governments concerned. It arose out of deliberations of the Unesco Working Group on a European Network in Science. The programme is partly operational: it is executed by 12 laboratories, covers all the main forms of pollution in the whole of the Adriatic Sea, and includes a reference profile in the North Ionian Sea.

### III. LABORATORY NETWORKS AND OTHER INSTITUTIONAL ARRANGEMENTS

37. The successful execution of the pilot projects should be based primarily on the activities of the existing national laboratories. It is proposed that the various laboratories participating in the pilot projects should be organized into a co-operative network. The participation of a particular laboratory should be based on its present activities, available facilities, and existing experience. At the beginning, the environmental samples could be analysed in a few suitable subregional analytical centres, but immediate action should be taken, where required, to develop the capabilities of national laboratories to participate fully in the projects. The international laboratories may play an important role in co-operative programmes, particularly in intercalibration exercises, training in sophisticated analytical methods, and acting as subregional analytical centres.

38. All the pilot projects put forward for consideration require the identification of participating laboratories and similar technical institutions and their organization into co-operating networks to deal with specific regional pollution problems.

39. The IOC, with the support of UNEP, has initiated such an inquiry, the objectives of which are: to evaluate the institutional programmes in marine pollution research and monitoring in the Mediterranean region; to make an inventory of the capacity and interest of existing Mediterranean marine research and monitoring laboratories and institutions to undertake work and training necessary for the successful execution of pilot monitoring projects and co-ordinated research projects which could lead to the eventual development of a thoroughgoing marine pollution monitoring system (or systems) in the Mediterranean region; to prepare a proposal for networks of collaborating institutions and laboratories which could carry out those pilot projects outlined by

the IOC/GFCM/ICEM international workshop on marine pollution in the Mediterranean (Monaco, 9-14 September, 1974) and outlined above in section II.A. "Co-ordinated Mediterranean Pilot Projects for Monitoring Programmes" and section II.B. "Co-ordinated Mediterranean Research Programmes". A start has been made on this inventory by two consultants, but it has not been possible for them to visit all the relevant institutions in the region by the time of this meeting; nevertheless, a sufficiently large number of institutions has been visited to enable a preliminary appraisal to be made of their status in this region. As operational plans are developed for each pilot project, it is proposed to expand the evaluation to include visits by consultants expert in specific relevant fields.

40. It is recognized that some institutions may be willing to participate in the co-ordinated Mediterranean pollution monitoring and research programme, but may lack sufficiently trained staff or specialized equipment. This is a point to be taken into account in the inventory, so that some estimate of training and instrumentation needs will emerge in due course. It is proposed that arrangements be developed for on-job training of scientists and technicians where such training is needed. The purchase of specific instrumentation for pilot monitoring and co-ordinated research projects should be closely co-ordinated with the training programme in order to achieve the maximum benefit from the investment in training and in instrumentation for the projects.

41. The meeting is also asked to suggest the steps that should be taken to implement the pilot monitoring and co-ordinated research projects, including the mechanisms for an efficient co-ordination among the collaborating institutions. Recommendations for the development and the co-ordination of these research and monitoring networks have been made in the experts' report on the survey of the Mediterranean laboratories and institutions. This report is available to the meeting for information.

42. Although the question of the handling, processing, storage and exchange of data was considered at the Monaco Workshop, operational details have yet to be worked out for any specific pilot project. World Data Centre B (Moscow) has a sub-unit specifically concerned with the Mediterranean region; it is the Regional Oceanographic Data Centre for the IOC/GFCM/ICSEM's co-operative investigations in the Mediterranean.

43. The first six pilot projects mentioned above (section II.A. 1, 2, 3; II.B. 1, 2, 3) should be regarded as the most urgent for the purpose of understanding the true state of pollution of the Mediterranean as a whole, and the riparian States of the Mediterranean are asked to facilitate the participation of appropriate national laboratories in these projects. While, in principle, this participation should be of regional scope, it may, in practice, be national or subregional.

44. A distinction may be made between monitoring programmes in coastal areas and monitoring programmes in high seas. Monitoring in coastal areas may be done by the coastal States themselves, with technical assistance being given to them when it is required. Monitoring in the high seas may be done through co-operation amongst various States. In both cases, all laboratories and institutions should participate in intercalibration exercises to ensure that the same methods and reference procedures are being used, and that all the monitoring results can be readily compared and incorporated into a central regional network.

45. The Joint Adriatic Programme is an example of subregional participation; its scope is broad, its area small, but it can be grouped with the first six projects by virtue of its main aims. However, it should be emphasized that, even though the Adriatic Sea is bordered mainly by the two countries concerned, it is not for that reason excluded from the general regional interest and concern, since it is both one of the main sites for the formation of the Mediterranean deep water and one of the main sources of pollutants.

46. The first five pilot projects mentioned above (section II.A. 1, 2, 3; II.B. 1, 2) all represent contributions to the IOC's Global Investigation of Pollution in the Marine Environment (one of the main programmes of the International Decade of Ocean Exploration). GIPME is strongly supported by UNEP which is committed to the promotion and co-ordination of global environmental monitoring. UNEP, by such support, recognizes that monitoring without understanding is self-defeating.

47. The remaining two projects are mainly concerned with pollution control and the maintenance of agreed standards. The establishment of proper standards requires a full understanding of the pathways of pollutants, the processes affecting their distribution and the effects of pollutants on the biota, including man. Hence, although controls may be established at any time, they can only be rational in the light of adequate knowledge. It is unrealistic to suppose that man will discharge nothing into the sea; it is even more unrealistic not to seek a full understanding of the consequences of any discharge by man of foreign matter into the sea.

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