Intergovernmental Oceanographic Commission
technical series

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A Comprehensive Plan for the Global Investigation of Pollution in the Marine Environment and Baseline Study Guidelines

Unesco 1976

ISBN 92-3-101430-7
French edition 92-3-201430-0
Spanish edition 92-3-301430-4
Russian edition 92-3-401430-8

Published in 1976 by the United Nations Educational,
Scientific and Cultural Organization
7, Place de Fontenoy, 75700 Paris

Printed in Unesco's workshops

Printed in France

PREFACE

This document is an amalgamation of document IOC/INF-263 rev., entitled "A Comprehensive Plan for a Global Investigation of Pollution in the Marine Environment (GIPME)", and document IOC/INF-276, entitled "Report of the IOC/ICES Working Group on Baseline Study Guidelines", as amended by the IOC Executive Council at its seventh session (Bergen, 21-26 June 1976).

In the present text some editorial changes have been made to bring the information contained in these two component documents up to date, and to make them compatible with the overall format.

This version takes into account comments received by the Secretary from Member States and interested international organizations up until 1 July 1976, without prejudice to further revisions based on further comments from Member States and from experience gained in the conduct of baseline studies.

It is hoped that Member States and international organizations concerned with marine pollution on a global or regional scale, particularly as regards marine pollution research, will find this publication useful in orienting their work so that it will contribute effectively to the construction, in due course, of a complete picture of the pollution of the marine environment.

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A Comprehensive Plan for the Global Investigation of Pollution in the Marine Environment and Baseline Study Guidelines

THE SCIENTIFIC FRAMEWORK[1]

1. Introduction

The GIPME Comprehensive Plan provides an international framework within which national and regional programmes on various aspects of marine pollution may be co-ordinated to contribute to an understanding of global pollution problems.

The ultimate objective of a comprehensive investigation of marine pollution is to provide a sound scientific basis for the assessment and regulation of the pollution problem, including sensibly planned and implemented monitoring programmes. Whilst monitoring, in a regulatory context, is not a part of GIPME, its proper planning and execution are dependent on the successful outcome of GIPME. Monitoring needs will, in some respects, be different between regions and will change with time, but in order to give an early start and sensible orientation to such activities, a first priority in GIPME should be the conduct of baseline studies. These will largely be conducted on a national or regional basis, but it is essential that they be conducted within a carefully thought out framework in order to facilitate collation and interpretation of data as future "health of the ocean" statements. As the picture of global distribution of marine pollutants builds up from baseline studies, requirements for larger scale surveys on a more closely integrated international basis may emerge. A major element of the plan, therefore, provides for the first type (national or regional) of baseline study and takes due account of the need to cater for mass-balance calculations, for the provision of exposure standards and other needs for rational regulatory action.

In order to satisfy these latter requirements, equal priority is given to a number of research activities dealing with inputs, pathways, sinks, effects and dose/response relationships; although these activities will have to proceed on a longer time scale than individual baseline studies, they nevertheless should start now.

Baseline studies will provide valuable data on inputs, distributions and pathways, and to some degree will help the mass-balance studies. However, much important work will need to go forward on mass balance and particularly on transfer processes between major reservoirs, such as the sea and the atmosphere, and similar requirements have yet to be met for river inputs and exchange of pollutants between water and bed sediments.

Nor can a proper understanding of the pollution problem be envisaged without the provision of adequate basic exposure standards for man and other organisms and an evaluation of effects on climate, etc.

In formulating the programme due account has been taken of relevant United Nations resolutions and the activities and requirements of various United Nations bodies, and particular use has been made of the modified Castellabate Report (document IOC/GIPME-II/7) and the Programme for the Global Investigation of Pollution in the Marine Environment presented by the Union of Soviet Socialist Republics (document IOC/INF-198).

(1) A glossary of the key terms and a list of the acronyms used in this document are given at the end. The technical terms defined in the glossary are underlined at their first appearance in the text.

1.1 Organizational principles

The baseline studies envisaged in the Comprehensive Plan can be at three levels:

1.1.1 National studies of pollution in estuaries and coastal waters, including circulation studies.

1.1.2 Regional studies of pollution carried out by groups of States sometimes under the auspices of a regional body such as ICES or GFCM.

1.1.3 Studies of pollution in open-ocean areas, carried out by Member States, by regional bodies or under other intergovernmental arrangements.

The measurement and evaluation of pollution levels carried out by participating States must be conducted on the basis of agreed methods. The co-ordination of regional and open-ocean studies with those conducted by Member States on an individual basis will need to be arranged by IOC in agreement with the appropriate States and regional bodies.

2. Elements of the Plan

2.1 Tasks and aims

The Plan selects the elements considered to be most relevant to immediate needs.

2.1.1 Planning and executing systematic baseline observations of the concentrations of selected pollutants in the marine environment, including marine organisms, sea water and bottom deposits.

2.1.2 Identifying the major pollutant sources, determining rates of input via various pathways, identifying the sinks and determining rates of removal; this will lead to mass-balance estimates.

2.1.3 Development of basic standards for exposure to pollutants, of either man or elements of the marine environment, thus providing an essential part of the basis for control of marine pollution.

The above tasks, when successfully completed, will permit:

(i) a systematic picture of the level of pollution, and of the spatial distribution of major pollutants, as a necessary preliminary to an assessment of the health of the ocean;

(ii) a quantitative understanding of the transfer to and within the marine environment of major pollutants;

(iii) the provision of a sound scientific basis for measures controlling the introduction of pollutants to the ocean;

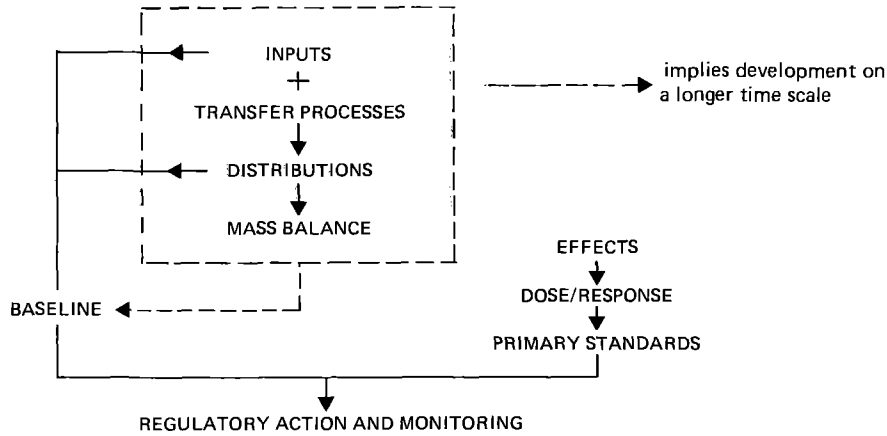
(iv) the development of the predictive capacity to assess the potential effects on the marine environment caused by changes in the pattern of pollutant introduction.

2.2 Types of pollutants

At the present time attention should be paid to the study of heavy metals and other toxic elements (e.g. lead, mercury, cadmium), the halogenated hydrocarbons, both aromatic (DDT, PCBs and others) and aliphatic (hydrocarbon wastes from PVC manufacture and others), petroleum, microbiological pollution (sewage disposal), nutrients (nitrogen and phosphorus) and artificial radioactivity (plutonium and some of the fission and activation products). Since the importance of a pollutant varies from area to area, any form of ranking is unwarranted.

2.3 Phase A of the Comprehensive Plan

The diagram below indicates the principal areas requiring action now and relates them to the final regulatory objective:



The various elements of the phase A plan are discussed in more detail in sections 3-6.

2.4 Phase B of the Comprehensive Plan

In many research programmes, after the basic data are collected and a model is developed, there is a need to test the model. Accordingly, phase B of GIPME will involve the examination of conditions after a period of ten years, say, following imposition of controls on inputs, if these are found necessary after initial mass-balance calculations.

Phase B will require the feedback of results from not only baseline studies and research, but also from any monitoring programmes that may be instituted. Therefore, it would be difficult to develop a realistic plan for phase B at this time.

2.5 Data exchange

An important element of the Comprehensive Plan is the management of information and data produced during the investigation. Close collaboration between the IOC Working Committee on IODE and GIPME is essential in dealing with data problems. Systematization and processing of data on marine pollution are now being carried out, to a limited extent, by the World Data Centres A and B (Oceanography), by some National Oceanographic Data Centres, and by some Regional and Specialized Data Centres. Information management is probably less well developed and the plan will need in due course to take account of intergovernmental efforts at present under way; e.g. the IRS of UNEP and ASFIS of FAO.

3. Baseline studies

Investigations of the present distribution of certain selected pollutants in the marine environment are known as baseline studies, and constitute the basis for future pollution monitoring. Baseline studies are considered the most important immediate actions to be taken.

During these studies the analytical methods are developed and tested, and experience is gained in making observations. The manifold problems of sampling at sea, avoiding contamination, and necessary pretreatment and storage of samples taken, must be resolved. The procedures developed may later be used in a monitoring system. Finally, an initial appreciation of the nature and magnitude of marine pollution in the region concerned is acquired.

A fundamental element of baseline studies is intercalibration, which may lead to a selection of commonly agreed methods. For an intercalibration exercise it is usually necessary to develop first a set of carefully selected and prepared reference samples. The data produced in the

intercalibration experiment have to be evaluated finally according to standard quality assurance methodology.

Baseline studies should first be carried out in those regions of the ocean that seem to exemplify a particular aspect of marine pollution. Baseline study guidelines are given in the third major section of this document; they are not included at this point because they deal with the general operational aspects of baseline studies rather than the conceptual aspects.

It is essential that the results and experience of these preliminary baseline studies be evaluated by the Working Committee for GIPME and that similar studies be developed in other relatively unpolluted regions, including sub-polar and tropical seas, so that a more comprehensive picture of the present state of marine pollution can be obtained.

The experience gained by ICES in its North Sea baseline study could serve as a basis for similar studies elsewhere, although it is recognized that each region would have special conditions, needs and circumstances.

It is important that the main direction in which the baseline study is to go has to be developed firmly at the beginning. The most straightforward approach would undoubtedly be directed towards public health; however, effects of pollutants on living resources, ecosystems, amenities, shipping, fishery and other legitimate uses of the sea may be more imperative in other geographical areas. Baseline studies would also be a very useful exercise in some very remote regions, to document the undisturbed "natural" state before specific large-scale human activities are started.

Any baseline study, since it is aimed at yielding an "instant" picture of the pollution situation, should be carried out rapidly in as short a time as possible: preferably not more than one year.

The distribution of pollutants determined by baseline studies can be used with their input estimates to derive approximate mass-balance statements for specific pollutants in the marine environment. When more accurate input and removal estimates are made available through the developments of research on the "processes" involved, the accuracy of the mass-balance relationships will be improved accordingly. The improved mass-balance relationships of pollutants in specific regional areas, as well as on a world-wide scale, will greatly help the future diagnosis of the "health of the oceans".

4. Mass balance

4.1 Introduction

The formulation of mass balances for selected pollutants in the marine environment constitutes a basic component of the scientific strategy of the comprehensive plan for GIPME. The concept of mass balance or mass budget is essentially a simple accounting procedure which requires estimates of the input, storage and output rates for a reservoir such as the ocean. The value of such a procedure is in identifying the major pathways of pollutants through the system, and thus in pointing out areas in which our information is inadequate.

Mass balances may be usefully determined for specific pollutants on either a regional or a global basis. Although such a calculation is necessarily approximate initially, it may become progressively more precise as results from baseline studies and research become available. It is essential to note, however, that the exercise does not provide an understanding of the details of basic processes that control the inputs and outputs of the systems or the distribution of pollutants within the reservoir.

Examples of studies contributing to the formulation of mass balances include the open-ocean studies (polygon studies), proposed by the USSR, and the regional study of the pollution of the North Sea by ICES.

4.2 Inputs

The relative importance of the various pathways of pollutants entering the ocean will depend upon the location and geographic scale of the ocean region under consideration as well as on the individual pollutant. Assessing these various inputs will present a wide range of problems including the

procurement of information, the understanding of the basic processes involved, and the difficulties of measurement. The following are possible pathways from other reservoirs to the oceans.

(i) influx from rivers in dissolved or suspended state;

(ii) influx from the atmosphere in the liquid, solid or gas phase;

(iii) influx from coastal outfalls including pipeline discharge, seepage and run-off;

(iv) influx from intentional discharge, such as ship operation, and dumping or accidental discharge, such as collision or shipwreck;

(v) influx from the sea bottom by mining, drilling, seepage, leaching or natural disturbance.

In addition, pollutants may be transferred from one region of the ocean to another by physical or biological transport, or they may be introduced by chemical or biological transformation from other substances.

4.3 Outflows

Although there is not as much emphasis on pollutant removal from the ocean in the early stages of GIPME, it is, nevertheless, important from a mass-balance point of view, and for identifying sinks. There is less known about this subject than about inputs, but some of the major outflow pathways are:

(i) deposition as sediments following coagulation or accretion of dead organisms;

(ii) loss to the atmosphere;

(iii) deposition of oil and marine litter on shores.

As with input from one region to another, outflow will also occur, as will loss by chemical and biological transformation.

4.4 Distribution

The other important early objective of baseline studies is to investigate pollutant levels and distributions; this is related to the storage term in the mass-balance equation. It must be noted that interpretation of data on pollutant distribution within the various elements of a reservoir, or on pollutant levels, or changes in pollutant levels, is not possible without a thorough understanding of the processes responsible. In this regard the study of water movements, both coastal and open ocean, are important.

5. Transfer processes

5.1 Introduction

The next element in the framework of a strategy for investigating marine pollution is a study of the physical, chemical and biological processes in which the pollutants take part. It is convenient to consider the "pathway" or "route" of a substance through that part of its biogeochemical cycle which is the marine environment. A substance originates from a source in the atmosphere or on land, for example, and passes through the oceanic reservoir, which consists of the ocean and its inhabitants, until it is eventually removed to a sink, such as the ocean-bottom sediment, or perhaps the atmosphere. The time scale for this progression may vary from near-instantaneous to millions of years. During this time, a pollutant takes part in a number of processes, which may be usefully defined in this context as a physical, chemical or biological link between adjacent stages of the pollutant's pathway through the marine environment.

It is the study of these various processes that will provide an indication of the relationship between observed pollutant inputs and distributions - the two essential elements of baseline surveys. Processes are thus a significant part of the mass-balance scheme. Additionally, the observed effects upon which dose-response relationships and ultimately standards are based, can only be interpreted in terms of the processes responsible for those effects.

One of the ultimate aims of this investigation is to develop a predictive capacity for future change in the marine environment. Only when constituent processes are thoroughly understood will it be possible to attempt the construction of a model for this purpose.

5.2 Types of processes

The marine environment is a complex system - it comprises portions of the atmosphere, the land mass, and rivers, in addition to the ocean itself. Within the oceans are distinct regions and a multitude of organisms. Each of these elements may have associated with it a large number of individual processes requiring investigation. It is convenient then to divide the system into manageable sections which contain a number of related elements, whose processes may be discussed and examined together. These are listed below with their components:

(i) other reservoirs - atmosphere, river, land, sediment;

(ii) reservoir interfaces - atmosphere/ocean, river/ocean, land/ocean, sediment/ocean;

(iii) internal interfaces - coastal waters/open ocean, surface mixed layer/deep ocean;

(iv) ocean - coastal waters, deep ocean, surface mixed layer;

(v) biological element - water/organism, organism/organism, sediment/organism.

For each of the elements in the five groups it is possible to identify types of processes and often list individual processes deserving attention. This is considered below.

However, it is first informative to comment briefly on these groups. The first involves processes that affect the nature of the pollutants before they are transferred to the ocean itself. Although the results are very important to this programme, such investigations should not be included in the framework of GIPME. Rather, information should be actively sought from appropriate, responsible bodies, such as the RIOS and proposed TTP Working Groups. The second group involves those processes that govern the rates and points of entry (and exit) of pollutants to (and from) the ocean. Knowledge of these is urgently required for mass-balance calculations. The third group, internal interfaces, includes processes that control mass transport between different oceanographic zones of the ocean, and the fourth group includes processes that occur within each of the main oceanographic zones of the ocean. The last group, biological in nature, includes processes that govern the interaction of pollutants with organisms and also the distribution within the marine bio-system.

Table 1 shows types of processes and specific examples for the various categories. There is no attempt to provide an exhaustive listing.

Table 1 - Processes in various areas of the marine environment

CATEGORY	ELEMENT	TYPES OF PROCESS AND EXAMPLES
Other reservoir	atmosphere	transport, transformation (photo-oxidation)
	river systems	" " (sedimentation)
	land	" " (bio-reduction)
	sediment	" " (compaction)
Reservoir interfaces	atmosphere-ocean	air-sea exchange, interface film transformation (gas-phase exchange)
	rivers-ocean	mixing, chemical transformation (flocculation)
	land-ocean	physical, chemical, biological exchange (dissolution)
	sediment-ocean	" " " (bioturbation)
Internal interfaces	coastal waters - open ocean	reactions between liquid, solid phases, biological uptake, transport by currents, mixing (advection)
	surface mixed layer - deep ocean	vertical exchange: diffusion, mixing, biological transport (turbulent mixing)

CATEGORY	ELEMENT	TYPES OF PROCESS AND EXAMPLES
Ocean	coastal waters	mixing, tides, currents (biological migration)
	deep ocean	transport, chemical transformation (sedimentation)
	surface mixed layer	mixing, tides, biological transport and transformation (turbulent mixing)
Biological systems	water - organism	direct exposure processes (absorption, flushing)
	organism - organism	indirect exposure (trophic magnification)
	sediment - organism	process (ingestion)

5.3 Priorities for the study of processes

With the recognition that each investigation and each scientist will assign specific priorities to research on these processes according to their objectives, interests and facilities, it is, nevertheless, helpful to indicate the areas in which new knowledge would most rapidly aid the progress of GIPME. At this stage, study of those processes that contribute to a knowledge of pollutant inputs and distribution should be emphasized. Within these areas, priorities will be subject to the specific pollutants and specific target species examined.

For example, when investigating the input and present distribution of DDT in a baseline study, it is essential to give top priority to those processes governing input from the atmosphere, distribution in the surface mixed layer of the ocean, and uptake and distribution in the target species, which may be fish eaten by humans. Until these first steps are understood, it will be necessary to give lower priority, for example, to other sink processes removing DDT from the ocean.

Flexibility is important in assigning such priorities, because there will be considerable feedback from each project or survey completed which will point to new areas requiring immediate attention.

6. Provision of basic standards for exposure to pollutants

Sensible control over the introduction of pollutants to the marine environment is dependent upon the elaboration of suitable basic exposure standards either for man or for marine organisms. In order to define these basic standards, it is necessary to establish suitable dose/response relationships (criteria) for various categories of pollutant and organism and to take account of cost-risk/cost-benefit considerations. These requirements have been achieved in relation to human radiation exposure, and the resulting widely accepted standards and methodology have greatly facilitated the establishment of the present effective control over radioactive waste disposal.

For most pollutants the acceptable degree of exposure of man or other organisms is either unknown or poorly quantified. No quantitative statement can be made on acceptable levels of exposure, without some estimate of the rate of incidence of harmful effect resulting from a given degree of exposure. There are great difficulties in obtaining this information for man, or for organisms, in the natural environment. Resort has to be made therefore either, in the case of man, to epidemiological studies, or to exposure of organisms under experimental conditions at high rates of exposure. There is an urgent need to develop methods for the assessment, or estimation, of the effects of chronic exposure of individual organisms, populations and ecosystems, for without such information it will be difficult to define the appropriate standards on which to base rational decisions on acceptable rates of introduction of pollutants, or to interpret properly environmental monitoring data.

In the absence of sufficient data at the low rates of exposure normally found in the environment, it may be necessary to make linear extrapolations from effects at high exposure rates to zero effects at zero exposure, as has been done with radioactivity. This may provide a suitable initial basis for setting conservative standards on which adequate environmental quality control measures can be based. Since these standards will often have to be established from laboratory studies, or even theoretical considerations, in advance of direct evidence of their validity - indeed in many

cases it may never be possible to establish acceptable levels on the basis of observed effects under natural conditions - the development of a co-ordinated approach to their establishment is urgently required. The conduct and design of toxicity tests and the use of data from them in developing dose/response criteria needs to be examined. The application of basic standards to environmental situations and the use of such concepts as cost/risk and cost/benefit analyses require attention.

Essential components of a research programme to evaluate the effects of pollutants must include:

(i) The determination of acceptable risks (somatic or genetic) to man from the ingestion of seafoods containing the pollutants or from direct exposure.

The dietary patterns of exposed populations clearly must be ascertained. Exposure levels and a methodology for establishing maximum permissible concentrations in seafood have been established for some radioactive substances and for mercury by some countries. International exposure and derived ingestion standards should be established for these, and for petroleum, halogenated hydrocarbons and other pollutant heavy metals where appropriate. These standards and methodologies, supplemented with information obtained from a monitoring programme, will allow the establishment of safe levels for seafood consumption. The GESAMP review of harmful substances will provide a useful basis for the establishment of first priorities.

(ii) Multidisciplinary studies of the long-term effects of pollutants on the stability of marine ecosystems.

The most important effect of pollutants on marine ecosystems which can influence large areas of the ocean may be caused by long-term exposure of marine organisms to low levels of pollutants. In principle, these effects can be studied by assessment of long-term changes of community structure in the open ocean or by the manipulation of controlled ecosystems. In practice, there are serious difficulties in community structure assessment:

(a) Accurate estimates of biomass are contingent upon the ability to quantify the effects of uneven population distribution. At present, it is difficult to quantify and separate temporal and spatial variability from normal random unevenness in distributions of pelagic populations.

(b) "Critical" (most sensitive) species of a heterogeneous food web are not always identifiable.

(c) If subtle population alterations are detected, it is presently not possible to determine whether the cause is due to climate changes, to normal population fluctuations, or to pollution, or to any particular combination of these factors.

The alternative to open-ocean community structure assessment is to conduct programmes designed to study the effects of pollutants on marine ecosystems in environments that can be properly managed, experimentally manipulated, and that are sufficiently like the real world to be a valid simulation of it. This system(s) must have as its prime requisite the capability of maintaining stable natural mixed-species populations of at least two (preferably more) trophic levels of the food chain. Several options to accomplish this are:

(a) artificial impoundments (ponds etc.);

(b) flow-through systems (troughs);

(c) massive impoundments (e. g. damming of lochs);

(d) experimental tanks (land-based);

(e) artificial entrapment of large volumes of water containing natural populations.

Such programmes require a multidisciplinary effort and the co-operation of a number of laboratories to carry out the field programmes and to provide back-up information necessary to design experimental procedures in the large systems.

To ascertain and predict the long-term effects of chemical perturbations on marine populations, it is essential to understand the relationships between trophic levels. To achieve predictive capability, models must be constructed that can account for effects that operate differentially on different species within and between given trophic levels. Initial model input data on pollutant effects on such parameters as growth, reproduction and mortality can be obtained by laboratory experimentation. Subsequent model testing can be conducted in large impoundments with controlled levels of pollutants. The pollutant levels chosen for study should be:

(a) similar to those presently observed in marine waters;

(b) an order of magnitude higher; and

(c) where predictable, those that might be reached in future years.

In addition to determining the concentration of the pollutant itself in water, biota and in sedimenting materials, frequent measurements of pH, redox potential, nutrients, particulate and dissolved organic carbon, illumination, bacterial activity, photosynthesis, phyto-zooplankton species composition and numerical abundance, and zooplankton grazing, behaviour, reproduction and species succession, are required for modal development.

Unpredicted catastrophic events frequently provide an opportunity to study the effects of a pollutant on natural systems through exaggerated alteration of community structure. When logistically feasible such events should be thoroughly studied by the immediate dispatch of qualified scientists to the scene of the episode. The effects of such catastrophes such as those on the members of the biota, should be examined in as much detail as possible. These studies should continue for as long as effects are discernible.

The following types of investigations are of high priority and can best be conducted at individual laboratories:

(a) development of techniques for determining concentrations of human viruses and their persistence in sea water and seafood;

(b) studies to ascertain subtle but important changes in living systems, which result from continued low-level exposure to pollutants (e.g. chromosome aberration, alteration of behaviour and physiology);

(c) synergistic or antagonistic effects of pollutants.

Three groups have some bearing on the question of effects on ecosystems: ACMRR/IABO Working Party on Ecological Indices of Stress to Fisheries and, to a lesser extent, the ACMRR Working Party on Biological Accumulators and the ACMRR/IABO Working Party on Biological Effects of Marine Pollutants.

7. Co-ordinating mechanisms

The successful execution of phase A of the Comprehensive Plan for GIPME requires the establishment of effective management and co-ordinating mechanisms. The future structure of GIPME should reflect these needs and should therefore contain arrangements for programme evaluation and review of the major subject areas.

The comprehensive plan identifies several major areas of activity that could conveniently be allotted to appropriate task teams each with responsibility for organizing, overseeing and co-ordinating its own work. However, it must be recognized that, due to the interdisciplinary nature of the problems involved, there are numerous bodies and working groups dealing with several of the aspects of the comprehensive plan and international scientific effort in marine pollution in general.

Areas of concern

The Comprehensive Plan indicates the following major areas of concern:

Baseline studies	Although these cover a wide variety of marine regions and will be conducted by a variety of regional, national and even institutional organizations, it is highly desirable, for the purposes of GIPME and for fundamental scientific reasons, that such studies conform as far as possible to an agreed basic plan in respect of intercalibration, analytical and sampling methods, and media; in short, a logistical uniformity consistent with the special characteristics, circumstances and needs of each region; the baseline study guidelines given later were prepared by an IOC/ICES Working Group with this aim in mind.
Inputs	These are broadly classified as atmospheric, fluvial and terrestrial; there is a need to review and evaluate the work being carried on at the international level, either regionally or globally; in due course each major group of inputs may require a task team.
Mass-balance	Once appropriate information has been assembled on inputs, outflows and distributions, and as a more thorough understanding is gained of the relevant processes, global balance statements for specific pollutants may be possible; the preparation of such statements may be assigned to a task team.
Processes	There will also be a need to evaluate and review on-going work in this area; processes are broadly subdivided in the plan into those between the principal media and those within each main medium, and may accordingly require more than one task team.
Effects, Dose/Response Relationships, and Standards	These areas are less well-developed and, although of a similar priority to the above-mentioned activities, will require continuing effort over a longer period; in due course, however, one or more task teams may be required.

Activities of other bodies

These areas of activity are also the subject of working groups and other bodies, both governmental and scientific, now active at the international level. Those whose areas of concern are of immediate relevance to GIPME, and thus with which the Working Committee would expect to work most closely, are summarized in Table 2 which is, however, not exhaustive. More details on the main ones are given below:

General	SCOR is concerned with the study of the oceans generally and can form ad hoc working groups, if requested to do so, to study specific topics. ACMRR, as noted above, can form working parties to study specific biological topics; some specific subsidiary bodies of these two committees are mentioned below. ICSU's Scientific Committee on Problems of the Environment is concerned with the environment as a whole and works with SCOR on oceanic aspects thereof.
Baseline studies	ICES has recently published a report on the pollution of the North Sea, including a baseline study thereof. In collaboration with SCOR, ICES is now organizing a similar study of the Baltic Sea and will, in the next few years, organize and conduct a baseline study of the north east Atlantic Ocean in the NEAFC area.

The IOC, FAO and UNEP are jointly organizing regional scientific workshops which may lay the basis for regional baseline studies; the areas and co-operating regional bodies are: Mediterranean - GFCM/ICSEM; Caribbean - CICAR/WECAFC; East Asia - CSK/IPFC.

UNEP, working through the IOC and GFCM, is organizing baseline studies of oil in water, and heavy metals and halogenated hydrocarbons in marine organisms.

The IOC/WMO IGOSS Pilot Project on Marine Pollution (Petroleum) Monitoring became operational on 1 January 1975. It is an operational feasibility study rather than a normal baseline study, but will produce baseline data.

Inputs, Processes and Distributions

The GESAMP ad hoc Working Group on Interchange of Pollutants between the Atmosphere and the Oceans, and the proposed SCOR/ACOMR/IAMAP Working Group on the Tropospheric Transport of Pollutants (TTP)[1] would be the most concerned about air-sea boundary processes.

ICSU's Global Atmospheric Research Programme (GARP) does not have a specific concern with pollutants but it does deal with atmospheric processes that are relevant to the distribution of pollutants.

The GESAMP Working Group on the Scientific Basis for the Disposal of Waste into the Sea has dealt with mass transport processes among others.

The SCOR/ACMRR/UNESCO/ECOR/IAHS Working Group on River Inputs to Ocean Systems (RIOS) is concerned with the physical, chemical and biological processes in rivers and estuaries; it is not directly concerned with global quantities of materials, including pollutants, entering the sea through rivers. The International Hydrological Decade (IHD) programme, on the other hand, is concerned with quantities of water and sediments and, in the future, possibly with certain pollutants, though this remains to be seen. The UNESCO/UNEP World Registry of Rivers Discharging to the Oceans may eventually provide information on pollutant inputs.

The IOC ad hoc Group of Experts on Pollution of the Ocean Originating on Land (POOL) has proposed means of obtaining, on a global basis, data on production and use patterns of (at this time) two test-case pollutants (total DDT and PCBs). The GIPME Task Team on Marine Pollution Input Data will undertake the work proposed. POOL has therefore been disbanded.

The ACMRR/IABO Working Party on Ecological Indices of Stress to Fisheries is concerned with the selection and/or formation of well-balanced sets of indices; the ACMRR Working Party on Biological Accumulators is concerned with studies on the use of bio-accumulator species as sensitive tools for measuring concentrations of pollutants. They also are aimed at developing guidelines for relevant pilot studies.

(1) The formation of this group remains pending the outcome of a workshop on the subject of TTP organized by the U. S. National Committee for SCOR in Miami, Florida, U. S. A., 8-12 December 1975. ACOMR was disbanded by WMO in June 1976 and its functions assumed by a WMO Executive Committee Panel on Environmental Pollution.

Effects, Dose/Response Relationships and Standards	The International Commission on Radiological Protection (ICRP) sets and continuously reviews standards governing the control of radioactivity in the environment. The ACMRR/IABO Working Party on Biological Effects of Marine Pollutants will review and evaluate critically the methods for bio-assays and toxicity tests. A GESAMP Working Group on Coastal Water Quality Criteria has reviewed the scientific basis for establishing certain standards; a Working Group on the Impact of Oil on the Marine Environment has reported on the effects of oil on living resources; and a Working Group on the Scientific Basis for the Determination of Concentrations and Effects of Marine Pollutants has proposed an open-ocean monitoring system; this proposal is being developed further by UNEP, WMO and IOC with a view to carrying out a pilot project in the Atlantic Ocean.

7.1 Overall co-ordination

The Working Committee for GIPME will obviously co-ordinate the activities of any Task Teams it creates. It should also co-ordinate those activities contributing to the GIPME programme but executed by other bodies and organizations as part of their work programmes.

The Working Committee will undoubtedly require to maintain close liaison with other international bodies such as ICES, UNEP and ICSU, among others, which carry out programmes of direct relevance to GIPME. In maintaining this liaison, for purposes of co-ordination, the Working Committee may, as appropriate, work through the IOC Secretariat. The liaison with UNEP relating to the GEMS component of Earthwatch (IOC is represented on the Inter-agency Working Group on Earthwatch - GEMS) and, in a more generalized way, with ICSPRO agencies, are cases in point. At a later stage, GIPME recommendations to IOC Member States would best pass through the IOC Secretariat.

7.2 Laboratory networks

Research is under way at a number of laboratories, particularly in the developed countries, on problems related to marine pollution, including the development and application of methods for determining chemical pollutants in sea water, marine organisms and sediments, and the determination of effects of pollutants on organisms. These laboratories are the elements of the scientific effort in GIPME.

Already in some regions laboratories are closely associated in their activities. For example, in the North Sea and Baltic Sea, marine laboratories are effectively linked through ICES. In the Mediterranean within the UNEP Joint Co-ordinated Project on Pollution, laboratory networks have been established for seven marine pollution pilot projects. There are also rudimentary networks, sometimes of a temporary nature, for specific problems and projects. The organization of networks of co-operating laboratories concerned with marine problems, on regional and subject bases, for the exchange of information, improvement and intercalibration of methods, provision of analytical services and co-ordination of scientific effort, training and education, is urgently required and should be promoted by the Working Committee as a fundamental part of GIPME. Regional networks should be developed within the context of regional co-operative investigations, especially baseline studies, and regional organizations where these exist. In the case of subject networks, high priority should be given to (i) laboratories concerned with development and application of methods for determining chemical pollutants in sea water, marine organisms and sediments, and (ii) laboratories concerned with determining the effects of pollutants on marine organisms.

In the developing world, there are few laboratories where studies of marine pollution are being undertaken. This makes it particularly difficult to carry out baseline and other pollution studies in tropical regions where the present condition of the marine environment is little known and the biological effects and processes of transformation are poorly understood. To investigate effectively pollution in the tropical oceans, it is necessary to assist countries and laboratories in such regions to develop the capability of participating in the investigation of marine environmental problems.

Table 2 - GIPME Programme in a Proposed Comprehensive Plan

PHASE	PRIMARY ACTIVITIES	ANCILLARY ACTIVITIES	MECHANISMS FOR DEVELOPING INTERNATIONAL CO-OPERATION*	OBJECTIVES	TIME FRAME
A	BASELINE STUDY	1. Intercalibration and recommendation of appropriate analytical methods.	ICES Regional Baseline Study of the North Sea and ICES/SCOR Study of the Baltic Sea; IGOSS; IDOE baseline studies in the Atlantic. IAEA's ILMR Intercalibration Exercises.	Health of the Ocean	(1974)-1978
		2. Workshops and/or symposia on baseline studies.	IOC/FAO/UNEP Regional Scientific Marine Pollution Workshops on the Mediterranean, Caribbean, East Asia (1974-1976).	Mass Balance	
		3. Biological accumulators	ACMRR Working Party on Biological Accumulators.		
		4. Pathogenic bacteria and viruses	IAMS, WHO.		
	MASS BALANCE CALCULATIONS	1. Inputs (a) Atmosphere	GIPME Task Team on Marine Pollution Input Data. SCOR Joint Working Group on Tropospheric Transport of Pollutants (TTP). WMO Executive Committee Panels on Environmental Pollution and Meteorological Aspects of Ocean Affairs. GESAMP Working Group on Interchange of Pollutants between the Atmosphere and the Oceans.	Identification of sources, routes and sinks.	1975 and continuing
		(b) Rivers	SCOR Joint Working Group on River Inputs to Ocean Systems (RIOS) (qualitative aspects). IHD Programme on River Monitoring, and related UNESCO/UNEP World Registry of Rivers Discharging to the Oceans.		
		(c) Shore-based discharges			
		(d) Ships and other vessels	IMCO's Marine Environment Protection Committee.		

* The list given is not exhaustive, and others will be made use of as and when necessary.

Table 2 (cont.)

PHASE	PRIMARY ACTIVITIES	ANCILLARY ACTIVITIES	MECHANISMS FOR DEVELOPING INTERNATIONAL CO-OPERATION	OBJECTIVES	TIME FRAME
		2. Processes (a) Physical-advection and diffusion	GESAMP		
		(b) Chemical			
		(c) Geological	IDOE Geochemical Sections Study (GEOSECS).		
		(d) Biological	ACMRR/IABO Working Parties on Biological Accumulators, and on Biological Effects of Pollutants		
		3. Distributions (a) Results from Base-line Studies	ACMRR/IABO Working Party on Ecological Indices of Stress to Fisheries, IGOSS.		
		(b) Monitoring Programmes			
A	STANDARDS	Effects Dose/Response Relationships Primary Standards	ICRP; WHO, ACMRR/IABO Working Party on Biological Effects of Pollutants; GESAMP.	To support regulatory activities	continuing
B	EVALUATION AND READJUSTMENT OF PROGRAMME	Activities will depend on feedback of results from baseline studies and monitoring programmes	Working Committee for GIPME.		

The following steps for the implementation of the Comprehensive Plan are recommended:

1. Regional marine pollution workshops

The first step in implementing the GIPME Comprehensive Plan is the conduct of regional marine pollution workshops. The purpose of these workshops should be to design and co-ordinate the implementation of regional baseline studies and the necessary research programmes using the present document.

An International Workshop on Marine Pollution in the Mediterranean has been organized by the IOC in co-operation with the General Fisheries Council for the Mediterranean (of FAO) and the International Commission for the Scientific Exploration of the Mediterranean, with the support of UNEP; and an International Workshop on Marine Pollution in East Asian Waters has been organized by the IOC with the co-operation of the Indo-Pacific Fisheries Council (of FAO) and UNEP. A third, an International Workshop on Marine Pollution in the Caribbean and Adjacent Regions, with the co-operation of the Western Central Atlantic Fisheries Commission (of FAO) and UNEP, will be held in late 1976.

Consideration needs to be given to other areas where regional marine pollution workshops would be appropriate. In this context among criteria which might be employed in selection are:

(i) Known or anticipated degree of pollution.

(ii) Areas which have already been identified for special attention within a regional or international pollution control framework.

(iii) Adequate geographical coverage on a global basis and, in particular, the inclusion of several relatively unpolluted (clean) background sampling areas.

The IOC, in conjunction with the other appropriate bodies, is preparing a time-table for conducting regional marine pollution workshops up to 1980 with the aim of providing a first baseline coverage of the global marine pollution situation by 1983 at the end of phase A of GIPME, as reflected above in the section on the scientific framework of the Comprehensive Plan. It is anticipated that areas that might at that time have been covered would include:

1. North Atlantic
2. Baltic
3. Mediterranean Region, including the Black Sea
4. East Asian Seas (CSK and IPFC areas)
5. Caribbean
6. Gulf areas of the north west Indian Ocean region and the Red Sea
7. Selected Southern Ocean background stations
8. Various national baselines, e.g. U.S.A. - Pacific, Atlantic and Gulf Coasts

Regional marine pollution workshops should be organized and conducted by the IOC with the collaboration of appropriate regional organizations whenever possible. Care should be taken to avoid overlapping the boundaries of regional organizations (e.g. fishery commissions). In areas without appropriate regional bodies, the IOC should assume the responsibility for such workshops.

It should be borne in mind that nationally organized workshops have been held or are being planned. The IOC should arrange for the publication of the reports of such national workshops and for their distribution to regional organizations conducting regional workshops or other regional studies.

2. Marine pollution monitoring programmes

The Working Committee for GIPME will contribute to the further development and implementation of marine pollution monitoring programmes within IGOSS, in accordance with Resolution IOC.VIII-20 of the eighth session of the IOC Assembly, and within other appropriate frameworks at the international, regional or national levels, by assessing the requirements and providing the scientific basis for such monitoring, and by providing advice on sampling and analytical techniques and methodology. A GIPME Task Team on Marine Pollution Monitoring has been established chiefly for this purpose.

3. Baseline studies

Baseline studies are the essential first step to providing data on inputs, distributions and pathways of pollutants. Several regional baseline studies are already, or are nearly, under way, including for example those of the North Atlantic and the North Sea under the auspices of the International Council for the Exploration of the Sea, the Baltic Sea under the auspices of ICES and the ICSU Scientific Committee on Oceanic Research, the Mediterranean under the auspices of GFCM, WHO and IOC with the assistance of UNEP.

These baseline studies should, where appropriate, be conducted taking full account of the relevant international marine pollution conventions.

In addition to the convening of regional marine pollution workshops, the following steps related to the conduct of baseline studies should be taken:

(i) The IOC should request from Member States and relevant regional bodies, a periodic statement of their knowledge, concerns, and programmes related to the study of pollutants in marine waters.

(ii) IOC should determine the possibility of regular provision by IOC Member States and international bodies, of information on the production and use of major marine pollutants, identified by GIPME as having particular importance for the marine environment.

4. Research on marine pollutants

The Comprehensive Plan for GIPME calls for continuing research into physical, chemical and biological processes which govern the inputs, behaviour and the effects of pollutants in the marine environment. The study of such processes will provide a knowledge of the relationships between observed pollutant inputs and distributions, as determined by regional baseline surveys, and assist in the understanding of their effects.

The function of the Working Committee for GIPME in this regard is to assess, promote and co-ordinate required research activities. The following actions will be taken:

(i) The progress of research into processes which contribute to a knowledge of pollutant inputs and distribution will be followed closely and applied to mass-balance determinations as data are received from baseline studies and GIPME task teams.

(ii) The IOC Secretariat will prepare and distribute to Member States a questionnaire to obtain a list of major research programmes under way which are relevant to GIPME goals, and which may be designated as GIPME projects. Such a compilation will then be submitted to the Working Committee for GIPME for assessment and further setting of priorities.

(iii) The Working Committee for GIPME will review annually the results of marine pollution investigations, including baseline studies, research programmes and monitoring activities, with the purpose of assessing the progress achieved, identifying gaps in knowledge, and setting a new list of priorities for research.

(iv) The Working Committee for GIPME will recommend future research activities to the following:

(a) regional marine pollution workshops;

(b) international co-ordination groups for co-operative investigations;

(c) other working committees of the IOC;

(d) appropriate United Nations Specialized Agencies;

(e) appropriate intergovernmental organizations;

(f) appropriate non-governmental organizations.

(v) The IOC Secretariat will encourage WHO and FAO to establish, on the basis of their joint programmes on food contamination, a research programme on exposure standards for humans involving pollutant transfers through the marine environment.

(vi) These groups will be asked to keep the Working Committee for GIPME informed of their progress.

5. Other implementation recommendations

In addition to the activities related specifically to the implementation of the Comprehensive Plan for GIPME, the following actions will also be taken:

(i) Every effort will be made to ensure the continued participation in GIPME of non-IOC bodies which are providing relevant information to GIPME through their on-going activities.

(ii) The Working Committee for GIPME will work in close contact with the IOC Working Committee for IODE and particularly its ad hoc Group on Marine Pollution Data in order to develop existing internationally co-ordinated systems (i.e. forms and formats) for exchange of marine pollution data, and to assist in the further development of existing inventories of marine pollution data in order to facilitate the implementation of various GIPME programmes and projects.

(iii) The implementation of the GIPME programme may reveal the need for the training of technicians and scientists in appropriate disciplines. The Working Committee, with the collaboration of relevant working groups and other bodies, will determine as precisely as possible what those needs are. It will work closely with the IOC Working Committee on Training, Education and Mutual Assistance (TEMA).

With regard to data storage, retrieval and exchange, the Working Committee for GIPME may identify needs special to the GIPME programme. Accordingly it will work closely with the IOC Working Committee on International Ocean Data Exchange (IODE).

1. Introduction

In the section on the scientific framework for the Global Investigation of Pollution in the Marine Environment special importance was given to the execution of baseline studies of marine pollution, and they were given priority in the time-table of activities foreseen by the Plan.

The International Co-ordination Group for GIPME[1] therefore decided to ask the IOC and ICES Secretariats to form a Working Group to draw up general guidelines for the execution of regional baseline studies of marine pollution, with a view to facilitating at least a qualitative comparison of results from various regions, and perhaps a quantitative comparison if appropriate inter-regional intercalibration exercises could be organized.

The following sequence of operations provides a basis for regional baseline studies:

(i) Evaluation of the present state of knowledge in a given area and identification of major gaps.

(ii) Selection of possible pollutants of importance, taking the regional situation into account.

(iii) Selection of types of samples to be analysed for each pollutant.

(iv) Identification of possible inputs of pollutants to be measured.

(v) Selection of typical scales for averaging observational data in time and space.

(vi) Determining of geographical spacings of sampling stations, taking into account regional and world-wide distribution of pollutants, averaging in time and space, the physical oceanography of the geographical region in question, the geology and the sediment distribution of the coastal area, and the distance from pollution sources.

(vii) Adoption of appropriate sampling methods and sample storage procedures for each pollutant.

(viii) Adoption of suitable analytical methods for each pollutant.

(ix) Allocation of analytical tasks among the participating laboratories.

(x) Intercalibration exercises, regional as well as world wide.

(xi) Execution of experimental work in a relatively short period of time (1 year).

(xii) Compilation and mapping of pollutant distribution in the areas concerned, with a view to the eventual synthesis of a global distribution pattern of major possible pollutants, and the identification of information gaps.

(1) Now replaced by the Working Committee for GIPME.

These indications are enlarged upon in the following sections, by way of some general indications of steps to be taken which are applicable to baseline studies of all pollutants. The proceedings of a workshop entitled "Marine Pollution Monitoring: Strategies for a National Program" and sponsored by the U. S. National Oceanic and Atmospheric Administration in Catalina, 1972, have been extensively referred to.

2. Evaluation of present knowledge

First, a list should be drawn up of all scientific and technical institutions directly concerned with marine pollution in a given region.

The organizers of the regional baseline study should then ask these institutions to provide all available information. This is usually done by means of a detailed questionnaire suitably adapted to the circumstances of the region. This information should also cover the sampling and analytical capacities of the institutions.

The answers to the questionnaire should be compiled by the organizers and the overall capacity of the laboratories in the area evaluated and synthesized to serve as a basis for further development of the baseline study plans (see, for example, ICES/SCOR Working Group on the Study of Pollution of the Baltic, Report C. M. 1973/E: 7, Annex 3). In some regions a wide variety of analytical procedures can be expected, in which case it is advisable to nominate one or two experts to visit each laboratory that responded to the questionnaire, discuss the methods with the analysts, compile them in a report, and make the report available to everyone (without generating a manual). This compilation will be a very valuable basis for the detailed planning of the programme; a lot of this planning may be conveniently done during meetings of analysts. An example is given by the "Report on applied methods for the analysis of selected potential pollutants in Baltic laboratories", prepared by K. Kremling and W. Slaczka for the ICES/SCOR Working Group on the Study of Pollution of the Baltic. At least one meeting of the analysts from the participating laboratories is needed to formulate specific recommendations (e. g. ICES/SCOR Working Group on the Study of Pollution of the Baltic, report C. M. 1974/E: 14, Annex 5).

In some cases Member States may wish to summarize the information in a national statement for use in a regional baseline study planning meeting. Experience shows that it may be helpful if a consultant is retained to visit the Member States to assist them in the preparation of the overall report, particularly where no central national authority on marine pollution matters exists.

In regions where there is an abundant technical and scientific literature on marine pollution, it may be necessary or desirable to retain a consultant to review such literature as part of the evaluation of present knowledge.

3. Possible major pollutants

The types of pollutants considered by the ICG for GIPME to require the most urgent attention are the heavy metals and other toxic trace elements (e. g. lead, mercury, cadmium), the chlorinated aromatic hydrocarbons (DDT, PCBs and others), the halogenated hydrocarbons in general (chlorinated aliphatic hydrocarbon wastes from PVC manufacture and others), petroleum and persistent petroleum products, microbiological pollution (sewage disposal), excess nutrients (nitrogen and phosphorus compounds), and artificial radioactivity (plutonium and some of the fission and activation nuclides). Since the importance of a pollutant varies from area to area, any form of ranking is unwarranted. The determination of the main pollutants for study in a particular area will depend chiefly on the outcome of the evaluation of present knowledge, but the decision to include a given pollutant among those to be studied will also depend on:

(i) the existence of reliable and generally accepted sampling and analytical methods;

(ii) the availability in the region of appropriate instruments and technicians for applying such methods.

It should also be borne in mind that in some regions physical pollutants may be more important than chemical or biochemical ones. For example, silting due to terrestrial run-off from denuded coastal areas and to inshore sub-marine mining is a significant marine pollution problem in the East Asian region, and poses a serious threat to coral reef and other benthic communities.

4. Identification of inputs

It is probable that the main sources of the pollutants will be identified during the evaluation of existing knowledge. Nevertheless, it is desirable to specify as far as possible the locations and magnitudes of the sources. Information about these can be obtained by means of a questionnaire. As an example, see that given in ICES Co-operative Research Report No. 39 entitled "Report of a Working Group for the International Study of the Pollution of the North Sea and its Effects on Living Resources and their Exploitation".

The identification of input sites is of considerable value in planning the sampling array, even if quantitative data are sparse. Thus, all domestic and industrial pipelines discharging wastes directly into the sea, all dumping sites, whether on the shore-line or offshore, and all river estuaries should be mapped.

For each input site some estimate should be made of:

(i) the gross annual quantity of the pollutant produced by the industries and conurbations connected with the site;

(ii) the nature and rate of the discharge.

5. Selection of sample types and sampling arrays

A given marine pollutant may be present in the sea-water, in the organisms, in the sediments and in the atmosphere near the sea surface. In principle all four media should be sampled. However, it should be pointed out that considerable difficulties exist in the implementation of this principle in any baseline survey. These difficulties are due to the fact that in a number of fields the sampling and analytical techniques are inadequate and need further development and that, even in those fields where the techniques are adequate, the laboratory facilities and the logistic support are often insufficient.

ICES has carried out, or is at present carrying out, baseline surveys in the North Sea, Baltic Sea and the north east and north west Atlantic. A careful study of the problems in each area has led the Council to the view that priority should be given to a baseline survey for pesticide residues, PCBs and certain metals in fish and shellfish. The necessary analytical and sampling techniques for such a survey are relatively well developed. Intercalibration exercises show that good agreement can be obtained between competent laboratories.

Attempts at organizing internationally co-ordinated investigations of certain "dissolved" metals in sea-water have so far revealed considerable problems in getting comparable results between laboratories with considerable analytical competence despite numerous intercalibration exercises.

As far as surveys of sediments are concerned, it should be noted that while certain scientists have undertaken localized surveys there has so far been no undertaking of a large-scale regional survey on an international basis.

In all four media, every effort should be made to take special series of observations to determine as well as possible the variability of the measurements of the pollutants. Such special studies would probably have to be concomitant with the baseline study rather than a part of it, and the considerable difficulty likely to arise in assigning the causes of the variation can be underestimated.

In view of the desire to limit the programme for technical or analytical reasons, or shortage of personnel, etc., it may be advisable to agree upon a limited number of obligatory substances and organisms, and to declare certain additional ones as desirable. In selecting the obligatory ones, the desire for comparison between different regions should be borne in mind, implying that some common organisms should be included.

Various elements (pollutants) can be present in different compounds or complexes; it should be specified which compounds are to be analysed. The changing chemistry of the natural environment should also be considered as regards silled fjords and semi-enclosed seas like the Baltic where anoxic conditions can prevail with aperiodic turnovers.

5.1 Water

The sampling programme should take account of:

(i) the method of introduction into the ocean (atmospheric fall-out, coastal runoff, or man's activities on the high seas);

(ii) the character of the introduction (continuously, as in industrial discharges; seasonally, as in the spring runoff or in the rainy season; or occasionally, as with oil spills); and

(iii) the mechanism of transport, both horizontal and vertical, within the marine environment (current systems, turbulent mixing, especially vertically, biological activity, sinking of particulate matter or dispersion as a surface film).

In designing the water sampling programme it should be borne in mind that:

(i) Horizontal advection and turbulent mixing are the principal agents of transport and dispersion within the marine environment. Therefore, in the case of a surface layer source of material that becomes dispersed in the water, concentrations are higher at the surface and in the mixed layer than below the pycnocline. Exceptions are particulate material that sinks rapidly to the bottom, and vertical transfer by organisms. The pycnocline is the main barrier to the spread of pollutants to greater depths and it divides the relatively mixed surface-layer water from the deep water. The (relatively) strong stratification in the pycnocline layer suppresses the vertical transfer of matter there by two to three orders of magnitude compared with the mixed surface layer. More samples should therefore be taken above the pycnocline than below.

The mechanical mixing induced by the wind can erode the pycnocline, thereby forcing it to greater depths. At the same time the density interface is sharpened. The erosion is a very slow process and depends upon the strength and persistence of the winds. It is very common to find several density interfaces at different depths in the transition zone from the wind-mixed layer to the deep water. Clearly the general wind system of a region and the seasonal variation of climatic factors should be taken into account in planning the sampling array in depth and time.

Special care is required in regions and at times where a summer thermocline overlies a deeper permanent pycnocline, since certain pollutants may be trapped between the two layers of strong stratification.

Some attention should in this connexion be given to special conditions in fjords and landlocked seas where incoming contaminated water can spread at intermediate levels. It is obviously necessary to observe the salinity and temperature profiles in connexion with the sampling. In some cases it may be better to adjust the sample spacing according to the salinity and temperature distribution rather than to sample at standard depths.

(ii) In planning the horizontal array, it should be borne in mind that, as a general rule, pollutant concentration in sea-water will decrease with increasing distance from the pollutant source, which is usually on the coast. Also, values nearest the source will tend to be much more variable in space and time than those far from the source. Inshore or near-shore stations should, therefore, be more closely spaced than those offshore or far from the source. It should be noted that river water is generally less dense than sea-water and when it enters the sea it tends to remain at the surface, and that consequently the dissolved pollutants also tend to remain in that layer.

(iii) In a generalized situation, a transect perpendicular to the coastline is to be preferred. In measuring the spread of the discharge from a specific source such as a river or pipeline, an array of sampling stations along the axis of the flow (usually alongshore) of the discharge is to be preferred. In some regions it may be necessary to make some preliminary observations of such flow before planning the array of sampling sites.

(iv) Hitherto, oil spills have been the only large-scale events that have been reflected in major short-term local changes in concentration outside the estuaries.

(v) Available sampling techniques require the facilities of a research ship with laboratory space and hydrographic winch, and the surface sampling must be done while the ship is hove to on station. However, in many cases it is preferable to take surface water samples from the bow of the ship while the ship is moving forward very slowly, in order to obtain samples unchanged by material originating from the ship itself.

Widely scattered annual observations in the surface layers in the open-ocean part of the region, with at least one deep series in each open-ocean area, are recommended, together with more closely spaced seasonal observations on the continental shelves, especially: (a) off estuaries with important pollution sources, and (b) along the axis of prevailing coastal flow. Sample collection should be accompanied by measurements of temperature and salinity at all sites and depths. In coastal areas current measurements are recommended.

Estuaries are important in themselves as parts of the marine environment, and may be important pathways for the introduction of certain heavy metals, halogenated hydrocarbons, and petroleum products to the sea. The selection for study of a relatively small number of major estuarine areas that have great socio-economic value and pollution potential, and that encompass a variety of estuarine types, is recommended. Standard stations in these estuarine systems for sampling of pollutants in dissolved and/or suspended particulate form should be established as follows:

(i) Since the primary natural pathways for the introduction of pollutants into the estuarine environment are rivers, the rivers flowing into the main estuaries should be sampled weekly in their lower reaches, but well above the upstream limit of measurable sea salt.

(ii) One or more mid-estuary stations, depending upon the complexity of the particular system, should be established well away from the influence of local inputs. They should be occupied at approximately monthly intervals. Samples should be taken from near the surface, mid-depth, and approximately two metres from the bottom. Care must be taken to occupy these stations at a consistent phase of the tide, preferably slack water, in order to minimize difficulties of interpretation. Measurements of temperature, salinity, currents, and pH should be made concurrently with the foregoing.

(iii) To assess the relative importance of the inputs of pollutants to the sea from the selected estuaries, water samples should be collected on a monthly basis in their major outlets to the sea. Samples should be collected near the surface, at mid-depth, and at 2 metres above the bottom. Sampling should be done at the end of ebb tide. Concurrent measurements of temperature, salinity, currents, and pH should be made.

At stations both in the open ocean and in the coastal areas, all samples should be taken once in each main climatic season. Special consideration should be given to the nature of the discharge of a given pollutant to the area (i.e. whether it is steady or irregular): where such a discharge occurs at a particular time or times of the year, sampling should be adjusted accordingly.

Table 3(a) summarizes the main guidelines for sampling sea-water.

5.2 Organisms

The purposes in analysing marine organisms are:

(i) many of the organisms are of immediate importance to man as food, and hence the concentrations of pollutants in their bodies may present hazards to human health;

(ii) marine organisms concentrate many pollutants and are therefore useful as indicators of the spatial and temporal distribution of pollutants; and

(iii) the biosphere is probably an important reservoir and transport medium for pollutants, and it is therefore of great importance in the attempt to determine mass balances of pollutants in the world system.

In choosing the organisms to be sampled, the following primary criteria should be satisfied, as far as present knowledge permits:

(i) the organism bioaccumulates a given pollutant and thus has a significantly higher concentration in its tissues than the ambient water;

(ii) the organism is either eaten by man, or is directly in the food chain leading to man so that most of its pollutant content passes into, and is retained in, another species which is eaten by man;

(iii) the organism is abundant and widespread enough to make sampling easy and to form a significant element in the diet of the target human population.

These criteria are biased in favour of human health considerations, which are, however, likely to be foremost in regional baseline studies, but broader, ecological considerations should not be ignored.

Apart from the immediate problem of the hazard to human health from the consumption of contaminated fish and shellfish, there is a need to establish the extent to which pollutants and their existing levels in the marine environment are doing harm to natural resources and to marine ecosystems in general. Accordingly, an extension of pollution baseline studies to an assessment of the effects of pollutants on natural resources should be strongly considered.

There are then some secondary criteria by which a decision to sample a particular species may be taken:

(i) the species represents one of several habitats or ecosystems, such as the littoral zone, the inshore benthic zone, the coastal pelagic zone, the offshore benthic zone or the offshore pelagic zone;

(ii) the species is considered by ecologists to be a key species in the particular ecosystem it comes from, particularly in the sense that it is a main contributor to the biomass of the ecological zone or ecosystem it represents;

(iii) the species forms part of an ecological suite of species, chosen for sampling, representing the various trophic levels within an ecosystem; e.g. phytoplankton (primary producers), filter feeders (primary herbivores), primary carnivores and secondary carnivores.

In the coastal area, species may be chosen because of possible differences in pathways due to different physiologies and biochemistries. Filter feeders, for example, are much more closely associated with the water, and their mucus absorbs material directly from the water much more readily than the feeding mechanisms of particulate feeders.

Special consideration should be given to any euryhaline species (common in estuaries), particularly shellfish, since the uptake of certain heavy metals is apparently salinity-dependent.

The highest levels of pollutants can be expected in coastal waters, which are, however, the nursery grounds for several commercially important fish species. Since the young are generally more susceptible to unfavourable conditions than the adult animals, special attention should be given to those species which remain for a longer period of their life cycle in coastal zones.

For example, coastal waters are known to be a nursery ground for plaice. The young fish spend the first one or two years of their life in the shallow water close to the coast. As they grow, the plaice move out into deeper water.

In the open-ocean area, organisms should be selected to give as wide a selection as possible across trophic levels. However, because of contamination problems associated with sampling phytoplankton, the lowest level in this food chain is the zooplankton. These filter feeding organisms are in close contact with the water and should give an early indication of the appearance of pollutants. Notes should be made of at least the general composition of the collection, e.g. the proportion of salps to crustacea.

Because of (i) the patchiness of both spatial and temporal abundances, (ii) variations in physiological and behavioural states, and (iii) varying age-frequency distributions, large within-habitat

variances of all measured variables may be expected. It is essential, therefore, to conduct pre-sampling studies at each of the sites and for each of the species of organisms and pollutants. The essential purpose of such studies would be to provide some preliminary information on the relationship of the samples to the universe being sampled. A series of replicate samples should be taken of each species at each site to be measured for each of the pollutants. Variance estimates could thus be derived which would be of some use in the interpretation of subsequent samples taken during the baseline survey.

In choosing sampling sites specimens should be taken, as far as possible, from all parts of an organism's range within the region. Nevertheless, if possible, a distinction should be made between obviously polluted areas and apparently unpolluted areas, and specimens should be drawn from both types. Temperature and salinity should be measured when and wherever specimens are collected.

Special care is required in dealing with diadromous and other migratory species, which may pass from a polluted area to an unpolluted area, and vice versa.

With regard to phytoplankton, it may be generally assumed that the bulk of it is to be found above the thermocline, so that similar considerations to those mentioned in the section on water sampling apply. However, it appears difficult to include plankton in a baseline study at the present time.

It is desirable to sample a given species at more than one stage of its life cycle. By sampling at least four times during the year, it should be possible to cover the main age groups of the resident population in the region and even to gain some indication of seasonal build-up of a pollutant in the fish of any particular, easily distinguished age group. Care should be taken in dealing with organisms in which segregation of the sexes is known to occur at certain times; all measurements should if possible be discriminated by sex.

When developing a programme for sampling fish it is preferable to endeavour to draw only samples from one specified age group. Similarly, shellfish samples should be drawn only from a specified size range.

Table 3(b) summarizes the main guidelines for sampling of organisms.

5.3 Sediments

Shore sediment cores should be taken at several stations, particularly in estuaries, but also in coastal and open-ocean areas where sediments are allowed by the prevailing hydrographic régime to settle. Because of the association of some pollutants with fine-grained sediments, such sediments should be preferentially sampled. The station locations, especially in estuaries, should cover the normal range of salinities. Care must be taken that any disturbance of the topmost layer is avoided.

Thus samples should be taken at a network of sites covering the region under study, where appropriate (fine-grained) sedimentary material is known to occur. In general, such a network, though it need not be at all dense (perhaps 25-50 km between stations), should be based on inshore-offshore transects, particularly near known major inputs of pollutants (e.g. rivers, pipelines).

There is usually some initial accumulation, after which an equilibrium is established between sediments and the surrounding seawater. Unless the exact situation in a given area is known, it is probably advisable to sample both sediments and ambient seawater at the same time.

Although a regional baseline study would be concerned with current levels of pollutants in the sediments, and therefore with only the topmost layer of sediment, an effort should be made to determine the vertical distribution of any given pollutant in the core, since such data may be of value in assessing the build-up of a pollutant in the light of local knowledge of the historical development of the probable land-based sources. For this purpose sedimentation rates should be determined.

Table 3(c) summarizes the main guidelines for sampling of sediments.

5.4 Air

Although the atmosphere is an important pathway from the land to the sea for some pollutants, a decision as to whether atmospheric sampling can be conveniently included in a regional baseline study will depend on the nature and technical resources of the region. It is, however, necessary to note the high desirability of analysing air samples.

Less is known about the importance of atmospheric inputs than most others. An initial attempt at a realistic assessment should be made for "designated" pollutants and then appropriate attempts made to measure them, if necessary.

For guidance on potentially significant atmospheric pollutants, the listing produced by the IMCO/FAO/UNESCO/WMO/WHO/IAEA/U. N. Joint Group of Experts on the Scientific Aspects of Marine Pollution (GESAMP) can be used.

Atmospheric inputs have recently been found to be surprisingly significant in inland waters (e. g. Great Lakes).

If a pollutant is expected to be significant, then it is extremely important to consider the input through:

(i) gas-phase exchange;

(ii) precipitation; and

(iii) particulate loading.

Regarding gas-phase exchange, research is necessary to see whether vertical gradients exist (under ideal conditions); it is necessary to sample across the interface.

Regarding precipitation, careful collection techniques are required; sampling at height is necessary; sampling should be done under appropriate meteorological régimes (e. g. wind, precipitation type); and frequent sampling is required because of notorious variability of rain-water composition.

Regarding particulate loading, contamination is a serious problem and it is necessary to sample at height. An alternative approach for gas-phase exchange and particulate loading is to measure concentrations in air upwind and downwind of the region in question and assess downward flux by differences. This is perhaps the best way of determining whether the atmospheric input is important.

If atmospheric samples are taken, they should be of the gaseous and particulate phases (dry fall-out) as well as of rain-water (in which case the particle content of the rain-water itself should be evaluated). Such samples should be taken above a height of at least 100 metres in calm conditions in order to avoid as far as possible the difficulties of interpretation likely to arise from the inclusion of sea spray in a sample.

If feasible, a very low density network of stations (perhaps 50-100 km between stations) covering the region may be established. Such a network should be based on a transect parallel to the direction of the prevailing winds. The main features of the climate will be an important consideration but, if possible, samples should be taken in each season and in each interseasonal period, again bearing in mind discontinuous discharges.

6. Sampling and storage procedures

These are normally established specifically for each type of pollutant, but there are some general principles to be observed. Because the level of most pollutants, particularly in sea-water and in the air, is normally very low, contamination of the samples is a serious problem. It is therefore necessary to leave such sampling to fully trained technicians. The research vessel's paint is likely to be a source of heavy metals (e. g. lead and mercury) and PCBs; its lubricants, fuel and smoke are sources of hydrocarbons. As a rule special samplers must be used in which the chamber to be filled with the water sample must remain sealed until it is in position at the sampling point.

Similar care must be exercised in the storage of samples; again, trained technicians only must be entrusted with such work. Special care may be needed to keep samples in darkness or subdued light, or away from heat sources, to prevent any unwanted chemical activity (as is the case even for sea-water samples being prepared for titration to determine the dissolved oxygen content).

When sampling mollusca (e.g. mussels) care should be taken to avoid including particulate matter from the shell cavity and gut contents, unless sampling is performed to determine exposure of people to a pollutant in the mussels they eat, in which case gut contents should be included. Hence, the need for exclusion of gut contents will depend on the aim of the survey.

Table 4 summarizes the main indications for sampling and storage procedures.

7. Analytical methods

These are specific for each pollutant and there are therefore few general principles, if any, regarding them. They must be accurate and precise enough to measure the low concentrations likely to occur. Intercalibration exercises (see later) generally determine whether the accuracy of the methods is adequate, but their precision is also important. Whenever possible, replicate samples should be taken and replicate measurements made. As far as possible the analyses of a given pollutant should be entrusted to one technician in order to minimize operator bias.

8. Allocation of tasks

In a given region all the candidate laboratories and institutions should be invited to declare their interest in participating in the regional baseline study. Technically qualified representatives of these laboratories and institutions should meet to draw up the plan of operations for the study, defining precisely what each will do and what each is adequately staffed and equipped to do. These arrangements should include contingency plans in case of breakdown of key equipment of research vessels.

It should be agreed that, if possible, only two or three laboratories should be charged with analytical work for each main pollutant; this is a compromise between the need for multiple analyses (as a precautionary measure against analytical error or bias or equipment failure) and the need to minimize the complexity of a regional intercalibration exercise.

In some regions probably only one laboratory will be able to undertake the analyses for the whole region.

In all cases the analytical equipment and methods must be calibrated against a standard or a reference sample.

In allocating the analytical tasks, great care must be taken in determining the true capacity of each laboratory; it is advisable to minimize the delay between sampling and analysis, and the demands made on equipment by the laboratories' regular research programmes must be carefully assessed.

It is inevitable that in most regions the sampling pattern will have to be cut according to the analytical cloth.

9. Intercalibration

For each main group of pollutants it is advisable to assign to one laboratory the responsibility for organizing the intercalibration exercise amongst the laboratories charged with analysing the samples from the region. As far as possible the organizing laboratory should arrange for each co-operating laboratory to receive samples from all the media chosen for the baseline study and from a short range of concentrations (e.g. near the limit of accuracy of the analytical methods; at a low level as found in the environment; and at one or more higher levels). These reference samples should, if possible, be drawn from the natural environment from areas known to be unpolluted by the given pollutant, as well as from areas of moderate or heavy pollution, in order to provide a useful range.

The organizing laboratory should make its own analyses, including standard and reference samples, as part of the intercalibration exercise and to determine the appropriate choices of concentration levels.

Arrangements may have to be made for the preparation of standard reference material, particularly for biological tissues.

For each sample (one from each selected medium and from each of the concentration levels) a small number of subsamples should, if possible, be analysed. The organizing laboratory should be responsible for the statistical analysis of the results.

The final aim of allowing for intercomparison between the results from regional baseline studies in all the different parts of the world ocean makes an intercalibration exercise on a global scale necessary. Such a world-wide programme for carefully selected reference samples for certain marine pollutants is being developed by the International Laboratory of Marine Radioactivity of the International Atomic Energy Agency in Monaco.

10. Compilation and processing of data

Each participating laboratory should be responsible for the compilation and processing of the data relating to the samples it has taken, but a general scheme should be agreed by the laboratories in the region and should be followed.

Again, one laboratory should be given responsibility for bringing together the data for the whole region and presenting them in overall tabulations and charts. All such data should be published in the collective name of the supervisory panel that drew up the plan of operations for the baseline study, or by an appropriate regional body, or, in the absence of such a body, by the Intergovernmental Oceanographic Commission, or by any other body agreed to by the participating laboratories.

The report on the baseline study should include an appropriate tabulation of the answers to the initial questionnaires concerning Present Knowledge and Inputs, and one or more summary tables. The list of laboratories originally questioned should be included, with an identification of those that actually participated in the baseline study.

The report should include the results of the intercalibration exercise, together with a list of those laboratories that took part in it and the analytical methods used.

The results of the baseline survey should be tabulated for each pollutant, for each participating laboratory and country, for each medium, and for each size or year-class and sex of each species in the case of the biological tissue medium. As far as possible maximum, minimum, mean and standard deviation should be given for each type of measurement.

However, for example, the metal concentrations for individual samples of many fish species are usually not normally distributed. Consequently the measurements should be expressed in terms of maximum, minimum and median values. For a given set of observations the median is the middle observation if there is an odd number of cases and is the mean of the two central observations if there is an even number of cases.

All sampling stations and levels should be tabulated, giving geographical co-ordinates or other suitable fixes, and standard sampling depths at each station should be identified.

All major input points, including rivers, pipelines and dumping sites should be mapped. The horizontal distribution of average concentrations for each pollutant in each medium should be mapped if applicable. All station locations, including those at which "zero concentrations" were observed, should be identified in each map.

11. General advice

The planning of the baseline study should aim at a small, easily executed programme of sampling and analysis rather than at a large, difficult or unfeasible programme, the object being to obtain meaningful results, however few.

In any baseline study complete comparability is essential, including sampling procedures, preparation and storage, calibration of methods, and intercalibration.

In some regions it may be necessary to make arrangements for analyses of some pollutants to be done in a laboratory outside the region. Such arrangements should be carefully worked out before the sampling programme starts.

In some regions the availability of suitable research vessels may be a limiting factor, in which cases careful planning of the use of those available, on behalf of the region, may be necessary in order to achieve an adequate set of samples. If necessary, the possibility of using research vessels from other regions should be studied and arrangements made to incorporate such a vessel or vessels opportunely into the sampling programme.

In some cases an adequate baseline study will require some prior training of technical staff. In planning the study the organizing panel should evaluate such needs and make arrangements for satisfying them prior to initiating the baseline work.

12. Special problems concerning tropical and/or developing countries

Generally speaking, the tropical and/or developing countries place a low priority on global marine pollution monitoring. They have only a small number of scientists working on pollution in general and on marine pollution in particular. They have neither the manpower nor the instrumentation to carry out many of the pollutant measurements indicated in Table 3.

However, this does not mean that there exists no interest in marine pollution and, therefore, in global marine pollution. Pollution committees have been formed in several developing countries and, with the help of foreign experts and the literature, evaluations of pollution are made. In Indonesia, for example, the most advanced studies on marine pollution by hydrocarbons are carried out by the laboratories of the national petroleum company.

Some countries may initially be able to participate in a regional marine pollution study only in a limited way; for example, by sample collection. It is also desirable for reasons of economy, among others, that a rational distribution of analytical services be worked out taking into account national capabilities and capacities. It is important, however, that all countries in a given region participate in the regional marine pollution studies, and adequate steps, either at the national or international level, should be taken to increase national capabilities so that all countries would be able to participate as fully as possible.

Concerning tropical countries, the GIPME programme could reveal interesting facts about the behaviour of pollutants in a warm environment. For example, the hydrocarbons and oil are more rapidly decomposed in tropical waters than in temperate areas. The same might be true for organic substances from sewage, particularly in coastal waters with a high suspended load. Also, for the behaviour of bacteria in tropical waters, where diseases are more common than in colder areas, the influence of sewage on coastal waters with a strong fishery is an actual problem about which little information is available.

The pollutants of primary concern are bacteria, oil residues, pesticide residues, and organic matter from sewage. The discharge of sewage is still in its initial stage, and will increase the more the country develops. Industrial products, and therefore the pollutants associated with industries, are scarce.

Table 3 - Recommended criteria for choice of sampling points, and suggested pollutants and parameters to be measured (where appropriate)

(a) Sea-water

SAMPLING STATIONS			SAMPLING DEPTHS (metres) (as appropriate)	POLLUTANTS (quantity per litre)	GENERAL PARAMETERS TO BE DETERMINED (as appropriate)
Place	Geographical co-ordinates	Distance from coast			
Shore*		0 km	Surface 0 m	Hydrocarbons	Tidal current system
Estuary			Sub-surface	Bacteria	Wind and wave conditions
Open sea		10 km	Thermocline 10-40 m	Heavy metals (espec. Hg, Zn, Cd, Pb)	Rainfall
		50 km	Deep water 100 m	Pesticides and other chlorinated organics (total PCB, total DDT, BMC and those pesticides applied in or near the area)	Salinity
		100 km	" 500 m		Temperature
			" 1,000 m		Oxygen
Open ocean		diverse	" 1,500 m	Radionuclides (Pu-239, Sr-90, Cs-137)	Phosphate
			10 m above bottom		Suspended matter

* Brackish fish-culture ponds included.

Table 3 (cont.)

(b) Organisms

SAMPLING STATIONS				ORGANISMS AND SPECIFIC TISSUE (if applicable)	POLLUTANTS Quantity per unit dry weight of tissue	GENERAL PARAMETERS TO BE DETERMINED
Place	Geographical co-ordinates	Distance from coast	Depth of sample (metres)			
Shore Estuary Offshore "		1 km. 10 km. etc.		Oysters, mussels or cockles (flesh) Shrimp (exoskeleton; flesh) Sole or other bottom fish (flesh; liver; brain) Sardines (whole fish) Tuna or shark (flesh; liver; brain)	Pesticides or other chlorinated organics Heavy metals Hydrocarbons (?) Radionuclides Bacteria (?)	Latin name Length of organism Weight of organism Age class* Wet/dry ratio in sub-samples Fat/dry weight ratio in sub-samples

* In tropical areas it may be difficult to determine this from annual rings on the scales or otoliths.

Table 3 (cont.)

(c) Sediments

SAMPLING STATIONS			DEPTH IN SEDIMENT	POLLUTANTS Quantity per unit dry weight sediment	GENERAL PARAMETERS TO BE DETERMINED (as appropriate)
Place	Geographical co-ordinates	Bottom depth (metres)			
Shore HW line Shore LW line Estuary Offshore 1 km. Offshore 10 km.			Surface 0- 1 cm. Subsurface 9-10 cm. 19-20 cm.	Bacteria Heavy metals Pesticides and other chlorinated organics Radionuclides Hydrocarbons (?)	% water pH Anoxic/aerobic (Eh) Grain-size distribution (sand, silt, clay) Clay mineral composition Structure (layered or mixed) Ion-exchange capacity Organic carbon content (C_{org}) Carbonate content

Table 4 - General indications for sampling and storage or packing

MEDIUM	POLLUTANTS OR MATERIAL	TYPES OF SAMPLERS		STORAGE OR PACKING	
		METAL SAMPLERS	PLASTIC SAMPLERS	BOTTLE SIZES	ADDITIVES
SEA-WATER	Hydrocarbons	* but without grease	* but without grease	1 litre	-
	Bacteria	* sterilized	* sterilized	100 ml	-
	Heavy metals	-	*	1 litre	-
	Pesticides, etc.	* thoroughly cleaned	-	60 litres	-
	Radionuclides	*	*	60-200 litres	-
SEDIMENT		GRAB OR DREDGE	CORE	PACKING	ADDITIVES
	Bacteria	*	*	100 g. in sterile vessels	-
	Heavy metals	* but sub-sampled on board	* PVC-lined	Plastic bags	-
	Pesticides, etc.	*	* carefully sub-sample top	Aluminium foil	-
	Radionuclides	*	* carefully sub-sample top	Plastic bags	-
	Hydrocarbons (?)	*	*	Plastic bags	-

* Means acceptable
\- Means contra-indicated

Table 4 (cont.)

MEDIUM	POLLUTANTS OR MATERIAL	METHOD OF COLLECTION	PACKING*	ADDITIVES ETC.**
ORGANISMS	Shellfish	By hand	Pesticides: dissection in glass or aluminium	5-10% formalin or Na_2SO_4 or deep frozen
	Shrimp	Trawling	Heavy metals: dissection in glass or plastic	As for pesticides
	Sardines	Pelagic trawling or seine	Hydrocarbons(?): in plastic	Deep frozen
	Tuna	Line fishing	Radionuclides: in plastic	5-10% formalin or deep frozen
			Bacteria(?): sterile vessels	Deep frozen, but fresh analysis better

* About 100 g. dry weight of tissue are normally required.
** Additive treatment also applies to blank samples.

Baseline study - A study of the present distribution and concentration of specified pollutants in specified media related where possible to an estimate of the input of that pollutant via specified pathways.

Regulatory action - Any action taken by national, regional or international authorities with the intent of regulating the levels of pollutants entering the marine environment.

Marine environment - That portion of the natural environment pertaining to the oceans, including sea-water, marine organisms, bottom deposits, and adjacent portions of the river systems, the land mass and the atmosphere.

Monitoring - (a) The repetitive observing, for defined purposes, of elements or indicators of the marine environment according to pre-arranged schedules in space and time, including the interpretation and the assessment of the collected data.

(b) In a regulatory context, the assessment of the effects of pollutants on man or specified elements of the marine resources for reasons related to the control of the effects of those pollutants.

Process - A physical, chemical or biological link between adjacent stages of the pollutant's pathway through the marine environment.

Exposure standard - An acceptable level of exposure of a target based on an agreed dose-response model for the effect(s) under consideration.

LIST OF ACRONYMS

ACMRR	Advisory Committee on Marine Resources Research (FAO)
ACOMR	Advisory Committee on Oceanic Meteorological Research (WMO)
ASFIS	Aquatic Sciences and Fisheries Information System
CICAR	Co-operative Investigations of the Caribbean and Adjacent Regions (IOC)
CSK	Co-operative Study of the Kuroshio and Adjacent Regions (IOC)
DDT	Dichloro-diphenyl-trichloroethane
ECOR	Engineering Committee on Oceanic Resources
FAO	Food and Agriculture Organization of the United Nations
GARP	Global Atmospheric Research Programme (WMO/ICSU)
GEMS	Global Environmental Monitoring System (UNEP)
GEOSECS	Geochemical Sections Study (IDOE)
GESAMP	Group of Experts on the Scientific Aspects of Marine Pollution
GFCM	General Fisheries Council for the Mediterranean (FAO)
GIPME	Global Investigation of Pollution in the Marine Environment (IOC)
IABO	International Association of Biological Oceanography (IUBS)
IAEA	International Atomic Energy Agency
IAHS	International Association of Hydrological Sciences (ICSU)
IAMAP	International Association of Meteorology and Atmospheric Physics (IUGG)
IAMS	International Association of Microbiological Societies (ICSU)
ICES	International Council for the Exploration of the Sea
ICG	International Co-ordination Group (IOC subsidiary body)
ICRP	International Commission on Radiological Protection
ICSEM	International Commission for the Scientific Exploration of the Mediterranean Sea
ICSPRO	Inter-secretariat Committee on Scientific Programmes Relating to Oceanography

ICSU	International Council of Scientific Unions
IDOE	International Decade of Ocean Exploration (IOC)
IGOSS	Integrated Global Ocean Station System (of IOC/WMO)
IHD	International Hydrological Decade
ILMR	International Laboratory of Marine Radioactivity, Monaco (IAEA)
IMCO	Inter-governmental Maritime Consultative Organization
IOC	Intergovernmental Oceanographic Commission
IODE	International Oceanographic Data Exchange (IOC)
IPFC	Indo-Pacific Fisheries Council (FAO)
IRS	International Referral System (UNEP)
IUBS	International Union of Biological Sciences (ICSU) - see IABO
IUGG	International Union of Geodesy and Geophysics (ICSU) - see IAMAP
PCB	Polychlorinated biphenyl
POOL	Ad hoc Group on Pollution of the Ocean Originating on Land (IOC)
PVC	Polyvinyl chloride
RIOS	Working Group on River Inputs to Ocean Systems, SCOR/ACMRR/ECOR/IAHS/ UNESCO
SCOR	Scientific Committee on Oceanic Research
TEMA	Working Committee on Training, Education and Mutual Assistance (IOC)
TTP	SCOR/ACOMR/IAMAP Working Group on Tropospheric Transport of Pollutants
UN	United Nations Organization
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
WECAFC	Western Central Atlantic Fishery Commission (FAO)
WHO	World Health Organization
WMO	World Meteorological Organization