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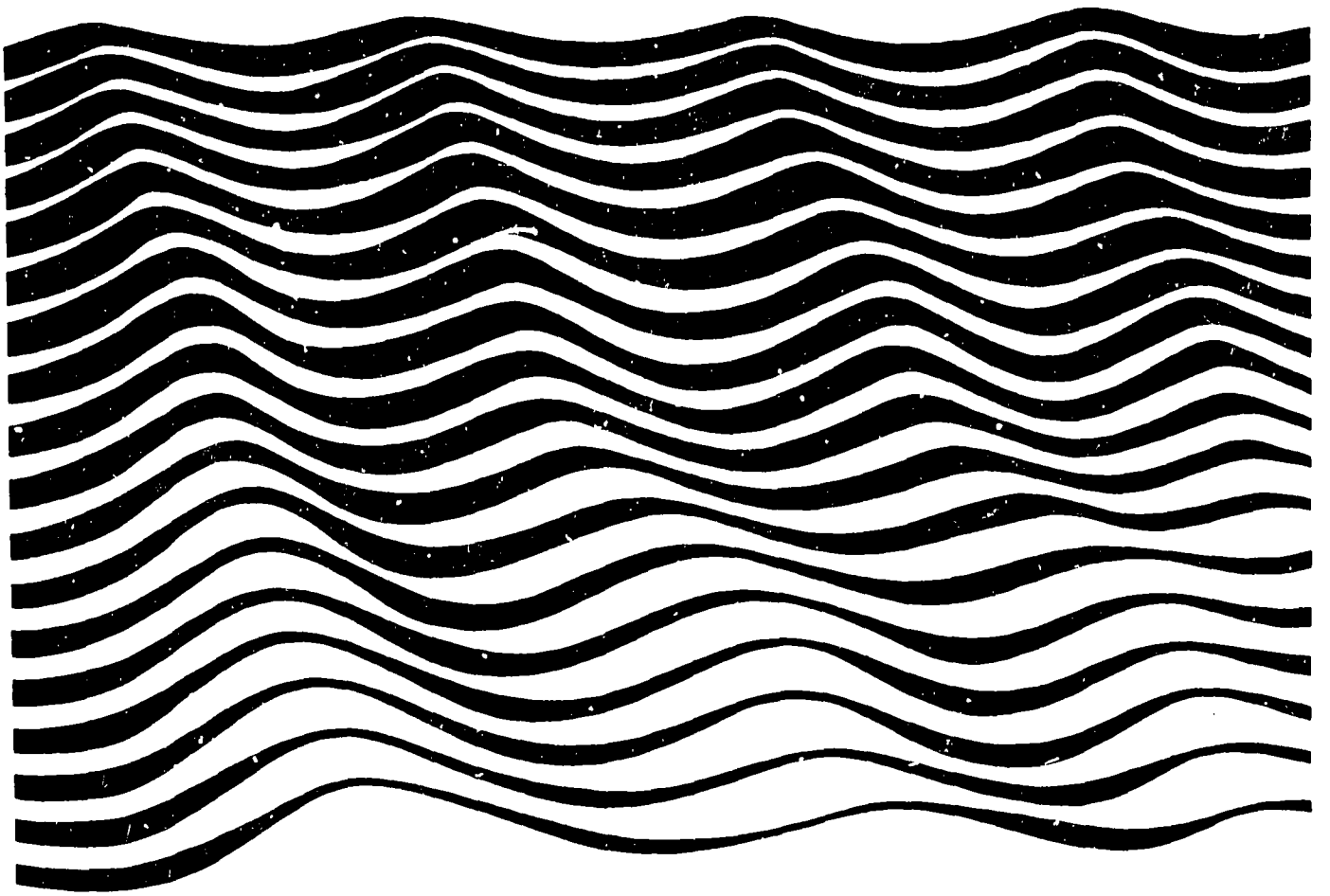
Marine science syllabus for secondary schools

Report of an IOC workshop held at
United World College of the Atlantic,
United Kingdom, 5-9 June 1978



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Report of an IOC workshop on the preparation of a marine science syllabus for secondary schools United World College of the Atlantic, United Kingdom, 5-9 June 1978

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PREFACE

Unesco reports in marine science are issued by the Unesco Division of Marine Sciences. The series includes papers designed to serve specific programme needs and to report on project development. Collaborative activities of the Division and the Intergovernmental Oceanographic Commission, particularly in the field of training and education, are also represented in the series.

Designed to serve as a complement to the series *Unesco technical papers in marine science*, the *Reports* are distributed according to the subject area of each title on an *ad hoc* basis. Individual requests for titles within the series may be sent to :

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The Challenge of the Sea

The history of mankind has been intimately associated with the oceans from the earliest times, ever since sailing pioneers such as the Polynesians and Indians ventured out well beyond the limits of their native shores to explore what hitherto was considered an impenetrable natural barrier. The maritime activities of man through the ages, often epic in nature, have been well documented following the voyages inside and outside the Mediterranean Sea of the Phoenician sailors in search of trade. The contemporary use of the ocean is not restricted to being a means of transportation or a place for warfare, as it was often in the past, but most importantly it provides a plentiful reservoir of biotic and abiotic resources and an inexhaustible recreational asset.

The first cosmonauts and astronauts that viewed the Earth from outer space described it as a 'blue' planet, which is not at all surprising since nearly three-quarters of its surface is covered by water. Yet, even today, a large number of coastal countries have a predominantly land-based economic, social and cultural development that seems to disregard the potential of the ocean for the betterment of mankind.

It is clear that in order to understand the world in which we are living, we need to study this 'inner-space' and its effects on and relationship with other parts of our planet. Although some ocean resources are already utilized for the benefit of mankind, these represent only a small fraction of their total potential. Some scientists and engineers believe that the ocean holds the key to the future needs of food and mineral resources of the world. At the same time, it has become apparent that the state of the ocean's health has been rapidly deteriorating in recent years and that measures must be taken at the local, national and international levels to overturn that trend and control pollution.

To better assess the research challenges posed in this field, extensive and long-term programmes for studying the ocean, harnessing its resources, and ensuring its continuous health are now being carried out or are under consideration by the specialized agencies of the United Nations and the oceanographic community in general. Successful fulfilment of these programmes in the years to come must largely depend upon the new generation of people who will take over this responsibility and develop their own ideas regarding the management of ocean affairs. This is especially important in the developing countries, faced as they are with the need to develop their marine science infrastructure, particularly with respect to a trained workforce.

It is important to inform the public and create a general awareness in regard to marine problems, promote an appreciation of environmental health, and demonstrate that marine protection is vital to the future well-being of man. In this respect, the international aspects involved in such endeavours should be emphasized. It must be remembered also that ocean waters arriving at the shores of any country had their origin elsewhere. During their propagation, water masses are modified not only by natural mixing processes but also by people of different countries using the ocean in various ways, with the result that foreign materials introduced into the ocean may eventually find its way to any seashore. All nations

share a common ocean and, therefore, must also share the responsibility to protect and use it wisely.

A similar philosophy applies to the sea bed areas beyond national jurisdiction. The nations of the world now realize that these areas cannot indefinitely be regarded as a no-man's land between nations. It has been declared and generally accepted that the deep-sea bed and its mineral resources shall remain the common heritage of mankind and be used for the benefit of all nations and only for peaceful purposes. The Third United Nations Conference on the Law of the Sea has been considering the establishment of an international administration of the resources of the sea-bed and of the profits from their exploitation, in order that they be shared by all countries for the benefit of mankind. This may be achieved only through mutual understanding among nations in search of world peace and justice.

Role of Marine Science Education

Since the need to develop and use marine resources while preserving at the same time the health of the marine environment is now a matter of world-wide concern, it is being given considerable international attention. It is particularly timely to promote international understanding through the introduction of marine science elements at the secondary school level, as well as programmes to encourage out-of-school marine science activities for young people. An international programme of this type appears even more essential when one considers that only a small number of developed countries are engaged in marine science education and that no developing countries are involved except in a rather perfunctory manner.

There are several ways in which the existing situation could be improved. One approach implies the establishment of better communication channels between marine scientists and secondary school teachers. Marine scientists should be encouraged to assist school teachers in introducing elements of oceanography and the marine environment in secondary schools' curricula. This may be accomplished by the loan or gift of special teaching materials, by giving talks to secondary school students on specific marine science topics as well as on career opportunities in its various disciplines, by inviting teachers to bring their classes on short visits to marine laboratories and by providing opportunities for both teachers and students to participate on short research cruises. In addition, special summer courses for teachers and instructors could be organized to facilitate the adaptation of curricula and teaching methods.

The goal of introducing marine studies in the curricula of secondary schools can be accomplished only if basic courses related to oceanography are established for natural and social science teachers, as part of their formal education which, in turn, may require the recruitment of more oceanographers to conduct such training. The prerequisite for this innovation in the conventional school system is that the world-wide interest of educational authorities be aroused and that they be convinced that the introduction of marine elements in natural and social science courses is both justified and feasible. To stimulate such interest concerted action is needed, calling for co-operation at the national and international levels.

It should be clearly understood that marine environmental education is part of a more comprehensive programme which also includes the atmospheric and terrestrial environments and their interrelationships. By

the same token, it follows that the approach to environmental understanding, and to marine science teaching in particular, must be multidisciplinary since oceanography is a 'hybrid' science concerned with the study of phenomena that are neither isolated nor independent. However, for the purposes of the present syllabus, it would not suffice to compile a detailed, exhaustive list of interrelated subjects dealing with oceanography and the marine environment to be included in the curricula of secondary schools.

Preparation of the Syllabus

The development of a strategy aimed at enhancing the interest of coastal countries in oceanography and the marine environment at the secondary schools level has been discussed in several meetings that subsidiary bodies of the Intergovernmental Oceanographic Commission dealing with training and education have held during the past ten years. The present workshop, jointly sponsored by the Commission and the Division of Marine Sciences of Unesco, was organized in response to the recommendations adopted by those bodies, in consultation with the Education Sector of Unesco which has the primary responsibility for educational matters at the secondary school level. (June, 1978. See Appendices I and II for a listing of the participants and a brief background to the events and concerns that led to the decision to hold the workshop). In this case, the roles of the Commission and the Division are to ensure that the syllabus developed is scientifically sound and in line with the experiences gained in teaching similar courses in secondary schools. The decision to initiate marine science courses within the framework of modified secondary school curricula is a prerogative of the Member States and, in such an endeavour, the assistance of the Education Sector of Unesco might be requested.

Conscious of the problems raised in the preceding analysis and aware of the limitations in any specific solutions that might be proposed concerning the syllabus for introducing oceanography and the marine environment into secondary schools' curricula, the Workshop arrived at the following conclusions:

a) The syllabus should be designed for the use of all IOC Member States, whether developed or developing. Its adaptability to the particular needs of developing countries might pose some special problems because of the major emphasis laid on broad-based educational patterns to meet the trained manpower requirements of those countries. The topics included in the syllabus must take into consideration the varying conditions derived from geographical, cultural, social and economic differences among Member States and thus should allow enough flexibility to reflect those variations.

b) The syllabus should be action-oriented and output-oriented, as well as comprehensive and multidisciplinary in approach. Since it is required that the student possess a good background in the natural and social sciences it might more profitably be incorporated in the latter part of secondary school, and accordingly it should be designed for the 14-18 years age range.

c) The main purpose of the syllabus is to promote an understanding of oceanography and the marine environment, independent of the

particular professional inclinations that the students might develop later on. Therefore, it should not be considered a preparatory course for marine science training.

d) Even though the possibility exists that the syllabus could be adopted as a whole and the various topics proposed therein presented as separate courses, it should be designed in such a way that modules could be taken separately and integrated into established natural and social sciences courses. The extent to which a particular topic would provide subject matter for a given course should depend upon the particular interests of the country, region or school concerned. In other words, the syllabus should provide useful guidelines and serve as a model to be modified according to existing local conditions.

e) The application of this syllabus will be difficult where there does not exist sufficient human and material resources. There needs to be some follow-up action for training the secondary school teachers and instructors who will be responsible for teaching the students, for preparing sets of teacher and student guides and other types of printed material, for developing experimental sets for marine science studies, and for making use of audio-visual material available. These teaching materials should be made available in all the official languages of Unesco.

On the basis of these premises, the Workshop selected the following topics for inclusion in the syllabus:

1. Man and the Sea
2. The Marine Environment
3. Energy and the Sea in Motion
4. Marine Ecosystems
5. Living (Biotic) Marine Resources - Uses and Conservation
6. Non-Living (Abiotic) Marine Resources
7. Study of a Local Marine Problem

    -Estuaries
    -Beach Erosion
    -Artisanal Fisheries

8. Marine Pollution

GENERAL AIMS OF THE SYLLABUS

Towards the production of a scientifically literate person

1. To impart basic knowledge regarding the main aspects contained in the various disciplines of marine science, through an integrated approach based on the study of interdisciplinary topics of general interest.

2. To describe and explain the main characteristics of selected oceanographic phenomena or types of marine environments in order to ascertain the nature of the relationships and interactions that may exist among the different variables affecting them and to understand the environmental complexities emanating therefrom.

3. To be introduced to some of the most common methods and techniques through the use of which scientific knowledge is acquired, interpreted and applied, as well as with the nature of scientific evidence, its reliability and its potential value in the creation of a predictive science.

Towards the production of an environmentally literate person

1. To develop an appreciation of man's relationships to the oceans, both past and present; of the multiple effects of the marine environment upon our daily lives; and of the need to create in the public an awareness and a sense of responsibility for water and its resources.

2. To consider the problems involved in the proper management of the marine environment from the scientific, technological, managerial, economic, social, cultural, aesthetic and conservationist points of view; and to identify ways and means for its better use and protection.

3. To use the medium of a 'marine environmental education' as a basis for developing general environmental awareness under the premise that the liquid, gaseous and solid Earth's environments are mutually interactive and thus need to be understood, utilized and protected as a whole.

Towards the greater understanding of international problems

1. To acquaint the public with the international aspects involved in the management of the marine environment, derived from the fact that the oceans communicate among themselves and thus their proper use, protection and conservation are matters of common interest to all countries.

2. To bring to the attention of the public the need to develop a legal framework of coastal zone management achieved by international agreement, especially the efforts being made in this regard by the Third United Nations Conference on the Law of the Sea.

3. To awaken an interest in increasing the degree of collaboration that already exists at the international level among nations, both through regional and international organizations and bilaterally, in the fields of scientific research, training and education, and technology transfer.

1. MAN AND THE SEA

1.1 Aims and Objectives

1.1.1 To impart to the students an appreciation of the overall involvement of mankind and the oceans through history and of the necessity for a comprehensive understanding of the ever increasing importance of the marine environment and its resources for the benefit of the countries of the world.

1.1.2 To make the students conscious of the fact that a proper understanding of global marine affairs and of the corresponding role of their country in such endeavours requires, because of its great complexity, the use of an integrated multidisciplinary approach.

1.1.3 To awaken the interest of the students to carry out an analytical examination of particular aspects of marine affairs of special interest to them, through direct participation in study projects addressed to local problems.

1.1.4 To acquaint the students with the present and future uses of the marine environment and its resources, under the existing juridical regime or under an eventual convention on the law of the sea, and of the opportunities for mutual collaboration among the developed and developing countries of the world in this realm.

1.1.5 To provide the students with a clear, realistic understanding of career potentials in marine-related fields, such as marine science, marine engineering, conservation, coastal area development and management, service in the navy or merchant marine technology and maritime law.

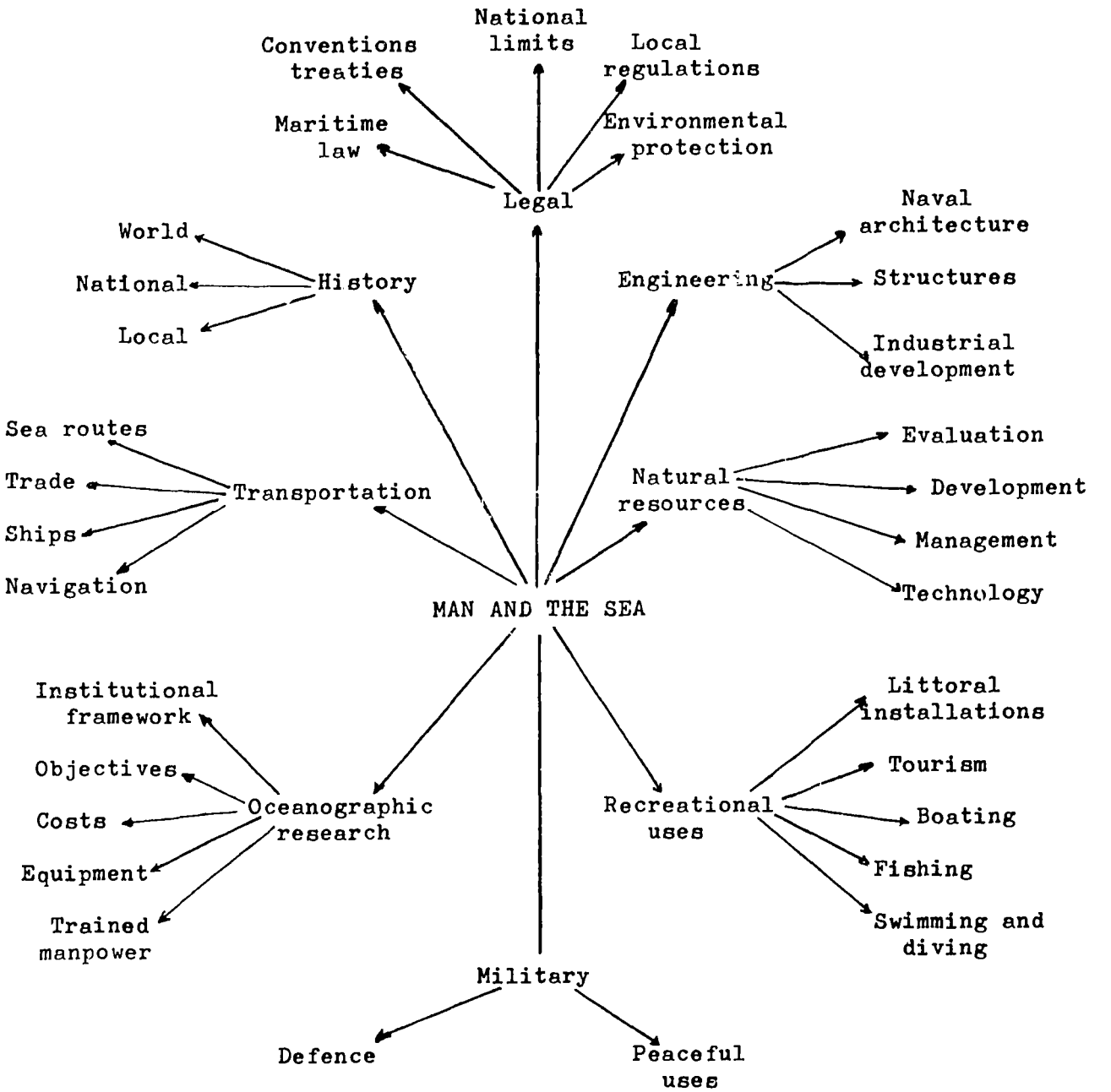
1.2 Course Content

The topic 'Man and the Sea' covers a vast expanse of subjects and thus should be studied in a broad way with certain of the topics being selected for more detailed coverage with attention to the specific interests of the school or region. Nonetheless, it is recommended that the following topics be included in one fashion or another:

Introduction to world maritime history from the early times to the present day. Local maritime history and national perspectives. Future outlook for a coastal country with a land-centred national approach versus another with a strong maritime commitment. Marine law and politics. Implications of recent developments on the law of the sea. The problems of conflicting interests. The territorial sea. The Extended Economic Zone. Evaluation, development and management of oil and mineral offshore resources. Assessment, exploitation and conservation of living marine resources. The problem of the transfer of appropriate technology. The sea as a means of transportation. Main features of the world shipping industry. Types of trade. Types of ships. Cargo management. Navigation. Salvage. Pollution.

The activities of the military in the peaceful uses of the oceans. The use of coastal area for recreational purposes: tourism, boating, fishing, swimming, diving. Advantages and disadvantages in developing coastal areas for touristic and industrial purposes. Importance and problems of marine scientific research: objectives, institutional framework, trained manpower, financial requirements, equipment, practical applications.

The main aspects covered in the topic 'Man and the Sea' can be illustrated by the following diagram:



1.3 Methods

This topic should be developed mainly on theoretical grounds by means of seminars, invited lecturers and guided course work, and illustrated with posters, diagrams, slides, films, local press reports, etc. Practical work may include management 'games' aimed at applying the knowledge gained on the course, as well as the interpretation of data obtained from journals and other sources. Visits to harbours, docks, research institutions, centres for tourism, maritime museums and governmental offices dealing with the marine environment will provide material and motivation for further discussions.

1.4 Facilities, Resources and Materials

No special facilities or materials are needed for a fruitful development of this topic, although reproduction facilities, slide and film projectors, and transportation arrangements are desirable. Extensive use may be made of printed material from different sources. Visits to local organizations arranged beforehand are one of the main resources for this particular topic.

2. THE MARINE ENVIRONMENT

2.1 Aims and Objectives

2.1.1 To familiarize the students with the most recent knowledge about the origin, evolution, nature and extent of the marine environment and to point out the differences and similarities that exist with respect to terrestrial environments.

2.1.2 To acquaint the students with the principal physical, chemical, geological and biological processes that take place in the marine environment, as well as with their distribution and variations in time and space.

2.1.3 To illustrate the integration and interrelation in nature of the various oceanographic factors and the environmental complexities resulting therefrom, in particular the existence of equilibrium conditions and the dynamic response of the various types of environments encountered in the oceans to the action of exogenous factors.

2.1.4 To develop a clear understanding of the close interrelationships that exist between the lithosphere, the atmosphere, the biosphere and the marine environment.

2.1.5 To stimulate an interest and develop an understanding among the students of the different environmental variables which may influence the characteristics, diversity, and evolution of life in the sea.

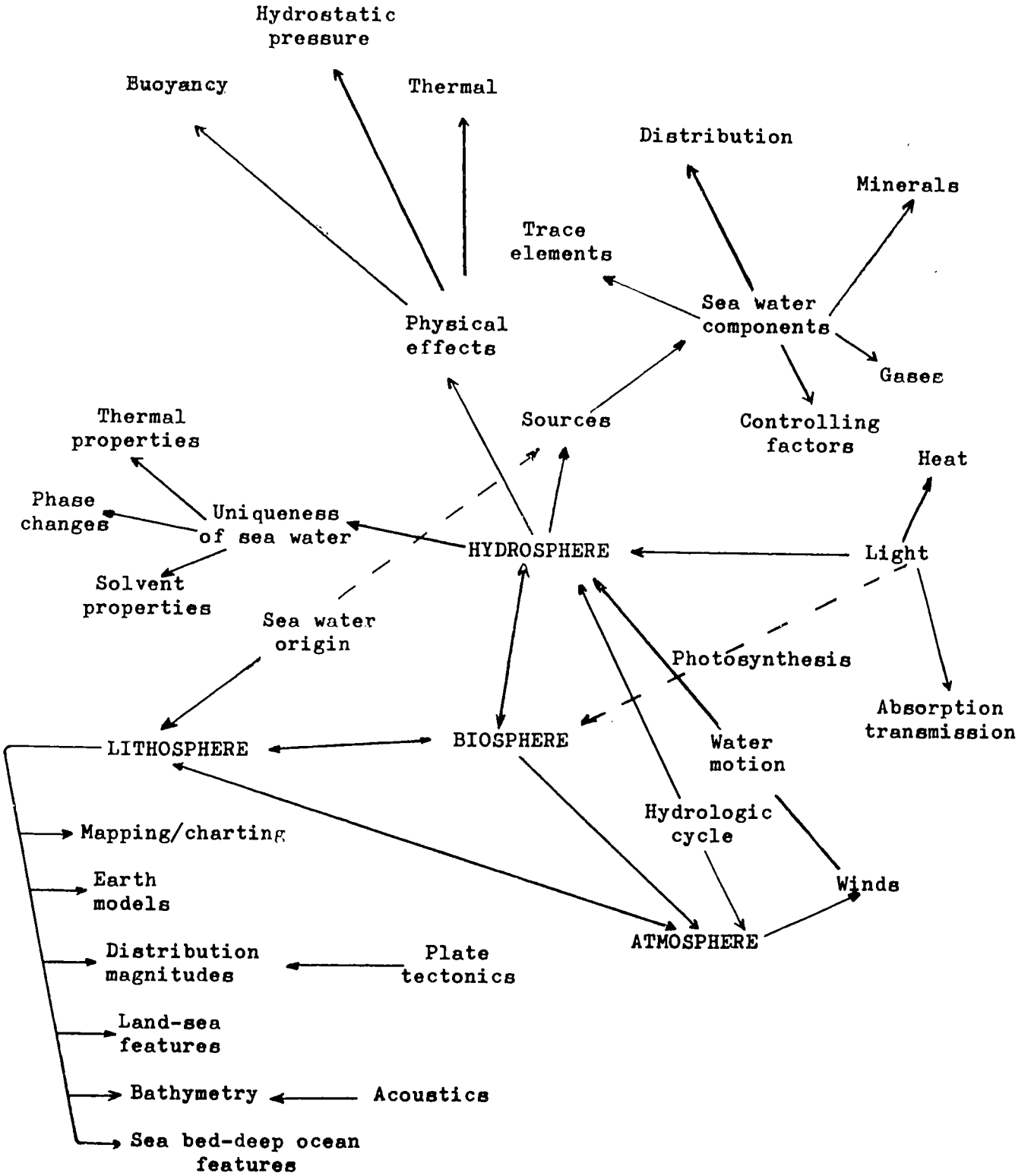
2.1.6 To provide the students with the necessary background knowledge for a better comprehension of the subject matters contained in the other topics of this syllabus.

2.1 Course Content

The topic 'The Marine Environment' has been intended as a broad, general scientific foundation for other specialized subjects covered in this syllabus. Although there may appear to be some duplication with respect to the content of the other proposed topics, this is a situation easily solved when applying the syllabus by teaching in a logical sequence of increasing complexity. The content of this topic is as follows:

The Whole Earth model. The cross-section model. The interaction model: atmosphere-hydrosphere-lithosphere-biosphere. The earth crust. General charting and mapping. Distribution and magnitude of the oceans and continents. Land-sea boundary features. Beaches, cliffs, estuaries, continental shelves, continental slopes, submarine canyons. Deep ocean features. Abyssal depths, ridges, rises, trenches, sea mounts, reefs, islands, island arcs. Erosion, transport and deposition of sediments. The hydrosphere. Uniqueness of water. Solvent properties. Phase changes. Thermal properties of pure water and sea water. Major components of sea water. Minor components of sea water. Sources and distribution. Dissolved gases in sea water. Chemical effects of constituents. Salinity, pH and alkalinity. Hydrostatic pressure. Buoyancy. Expansion. The atmosphere and the marine environment. The hydrologic cycle. The biosphere and the marine environment.

The main aspects included under this topic may be illustrated by the diagram that follows:



2.3 Methods

This topic is intended as a comprehensive, general introduction to marine science and is to be developed mainly on theoretical grounds in the classroom through guided seminars, illustrated lectures, analysis of reference materials, homework assignments and audio-visual sessions. The physiographic features of the land-sea boundaries can be recognized by means of photographs. Simple laboratory experiments to demonstrate the physical and chemical properties of water and also some of the processes which take place on a global scale in the hydrologic cycle, can easily be designed using standard laboratory equipment and student-built inexpensive apparatus. This is to be complemented by local field work observations and sample collections for further analysis, whenever possible e.g., with the use of a small boat (even a row boat) where it may be available. Visits to local marine science research institutions and meteorological stations are advisable.

2.4 Facilities, Resources and Materials

The standard facilities encountered in secondary schools are sufficient for the development of this topic. Textbooks, reference materials, teacher and student guides, audio-visual equipment, and routine classroom facilities are needed. Profitable use can be made of physics and chemistry laboratory installations endowed with simple, inexpensive equipment. Reproduction facilities allow for the preparation of handout literature. Transportation may be required for visiting local institutions.

3. ENERGY AND THE SEA IN MOTION

3.1. Aims and Objectives

3.1.1 To made the students aware of the different types of energy systems which act through the oceanic interfaces (air-sea, landsea, and water-marine organism) and their transport, transformations and effects within the aquatic environment.

3.1.2 To demonstrate, discuss and if possible use practical techniques for the investigation of relevant aspects of ocean dynamics, in particular waves, tides and currents; and to identify the generating forces of each of those phenomena, as well as to ascertain their main effects upon the marine environment.

3.1.3 To develop an appreciation of the close interdependence which characterizes the natural phenomena occurring in the hydrosphere, atmosphere, lithosphere and biosphere, and of the need to follow an integrated multidisciplinary approach in order to arrive at a proper understanding of their dynamics and interactions.

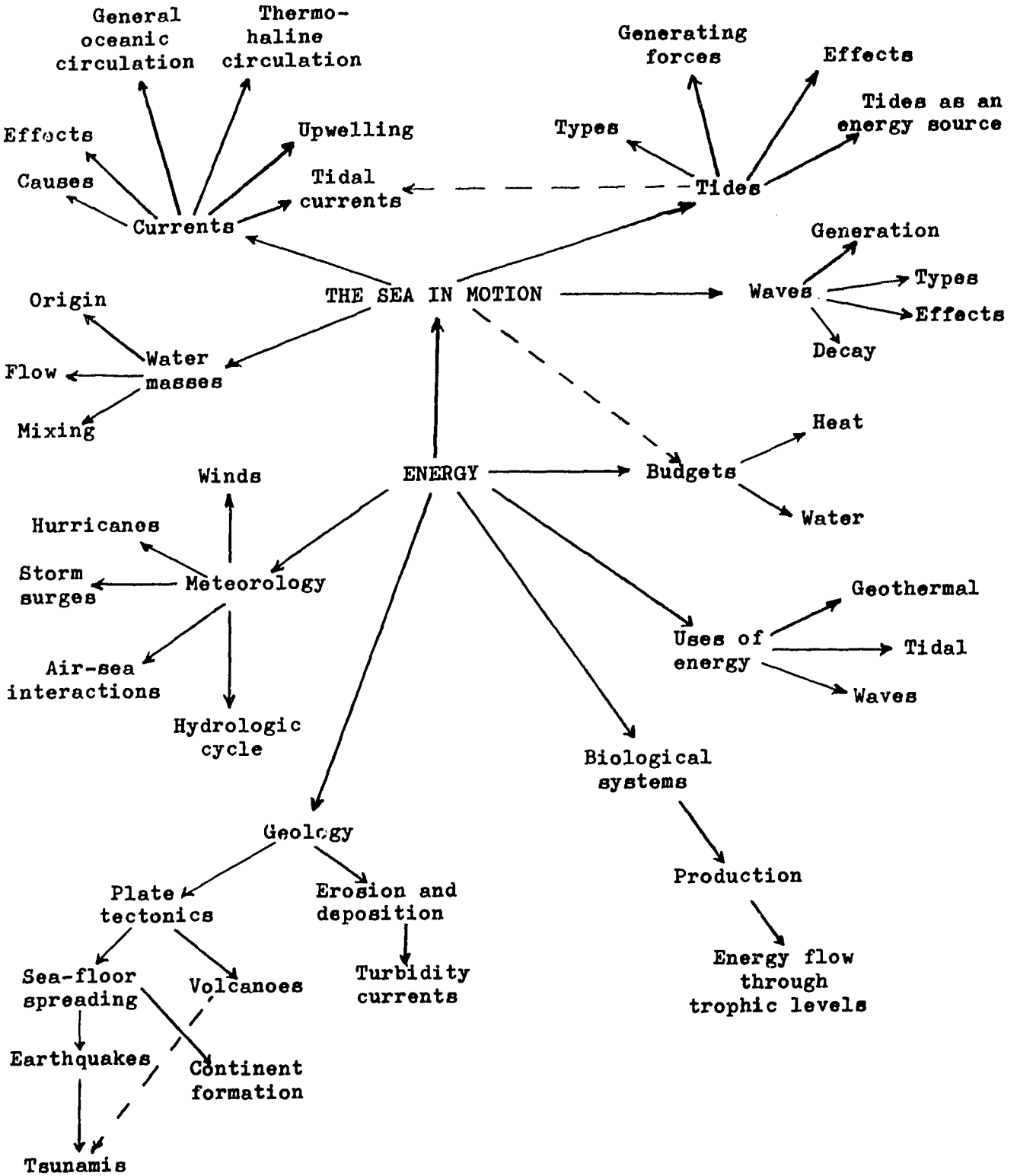
3.1.4 To develop in the students the skills and abilities to design small scale experiments, to construct laboratory models, and to participate in field study projects aimed at providing an empirical understanding of energy systems in the ocean.

3.1.5 To familiarize the students with the possible beneficial uses of the energy resources from the ocean, as well as with the measures that might be needed to protect coastal environments against any natural destructive effects arising from the oceans.

3.2 Course Content

Energy and energy systems. Energy in biological systems. Production. Energy flow through trophic levels in the food chain. Energy and the shaping of the earth. Plate tectonics. Sea floor spreading. Deformation and mountain building. Earthquakes. Volcanoes. Tsunamis and their effects. Erosion and deposition of sediments. Turbidity currents. The atmosphere and the oceans in motion. Air-sea interactions. The hydrologic cycle. Wind systems. Effects of winds on ocean dynamics. Hurricanes. Storm surges. Weather modification by man. Generation of ocean currents. General oceanic circulation. Thermohaline circulation. Upwelling processes and their importance. Generation of ocean tides. Types of tides. Tidal currents. Tides as a source of energy. Generation of ocean waves. Classification of waves. Formation of sea and swell. Wave decay. Waves in shallow water and their effects in shaping the coastlines. Solar radiation as the ultimate source of all energy for the aceans and the atmosphere. The heat budget. Horizontal and vertical temperature distribution. The water budget. Salinity. Origin of water masses. Mixing processes. Density distribution in the oceans. Water stratification. Introduction to the dynamic method for computing geostrophic currents.

The main sub-divisions of the topic 'Energy and the Sea in Motion' may be illustrated by the following diagram:


General oceanic circulation
Thermo-haline circulation
Upwelling
Effects
Causes
Currents
Tidal currents
Generating forces
Effects
Tides as an energy source
Types
Tides
THE SEA IN MOTION
Generation
Types
Effects
Decay
Waves
Origin
Water masses
Flow
Mixing
Heat
Water
Budgets
ENERGY
Winds
Hurricanes
Storm surges
Meteorology
Air-sea interactions
Hydrologic cycle
Geothermal
Tidal
Waves
Uses of energy
Biological systems
Production
Energy flow through trophic levels
Geology
Plate tectonics
Erosion and deposition
Turbidity currents
Sea-floor spreading
Volcanoes
Earthquakes
Continent formation
Tsunamis

3.3 Methods

Because of the nature of this topic, it will have to be taught mainly from a theoretical standpoint through lectures, guided seminars, poster sessions, group discussions, audio-visual sessions and literature research projects. It should be noted here that the subject matter included in the topic is partially covered in other topics, in particular in 'The Marine Environment'. Care should be taken, therefore, to avoid wasteful overlapping. Simple laboratory experiments may be devised to demonstrate the transmission and transformation of energy. Practical work may also include the preparation of models and mockups. Field work should include visits to the seashore to observe the sea in motion and to apply simple techniques for estimating the most outstanding dynamic characteristics. Whenever possible, access to a small boat would be helpful.

3.4 Facilities, Resources and Materials

At it is the case with most of the topics, no special facilities other than those expected of adequate secondary schools are needed to develop this topic. The degree of sophistication in teaching this topic will depend on several factors, including time availability and existing resources. Teachers and students should use their ingenuity to design various types of experiment for their out-of-school activities, as this topic is especially prone to practical demonstrations. Visits to meteorological, seismological and tidal stations, as well as to existing oceanographic institutions are highly advisable.

4. MARINE ECOSYSTEMS

4.1 Aims and Objectives

4.1.1 To illustrate the multidisciplinary nature of marine scientific research by the use of examples which deal with marine ecosystems, in order that the students realize the shortcomings encountered in the analysis of given phenomena from a single point of view and without recourse to other related disciplines.

4.1.2 To familiarize the students with marine ecosystems and to develop an appreciation for their unity and the complex interactions that take place between marine organisms and their natural environment.

4.1.3 To acquaint the students with the marine plants and animals which belong to a variety of ecosystems and to develop the ability to identify and explain the effects of the physical and chemical variables and properties upon marine organisms.

4.1.4 To describe and explain to the students the main characteristics of the primary and secondary production processes that occur in representative marine ecosystems.

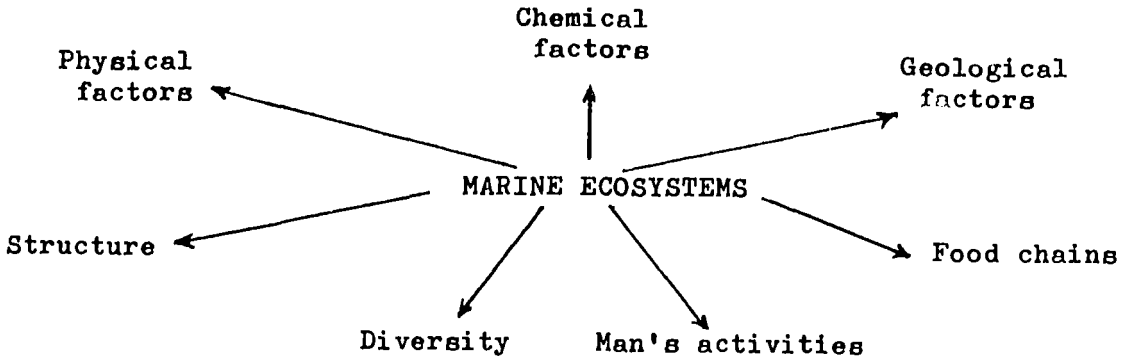
4.1.5 To develop in the students the skills and abilities to use basic, simple techniques to observe and measure the biological, chemical and physical properties of an actual local marine ecosystem.

4.1.6 To appreciate the importance of the proper evaluation of the beneficial as well as the adverse effects upon marine ecosystems that may be brought about by man's activities.

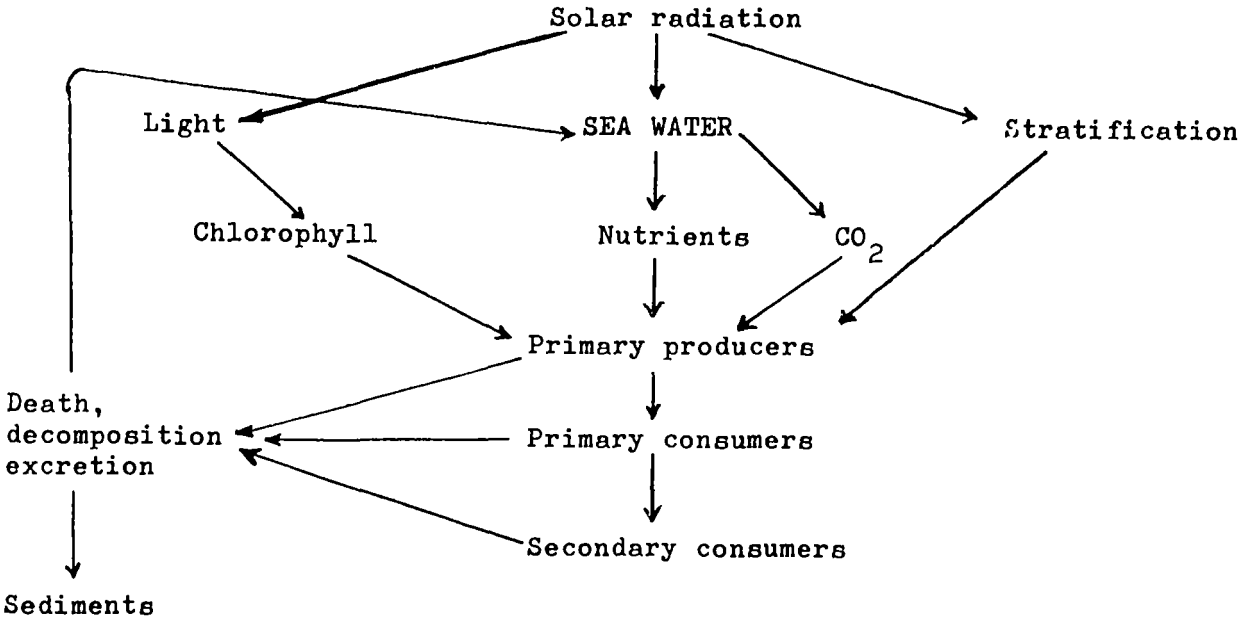
4.2 Course Content

Classification of marine organisms. The ocean as a favourable biological environment. Dissolved nutrients and trace elements. The carbonate system, pH, and buffer capacity of sea water. Sediments. Photosynthesis and respiration. Primary production. Factors affecting productivity: light, mixing, nutrient supply. Thermoclines. Biological conditions and productivity in different environments: coastal and upwelling areas, tropical seas, polar and sub-polar regions, anoxic basins. Animals in the ocean, planktonic and benthic. The nekton. Effects of temperature, water motion and other physical variables on the distribution and migration of marine animals. Adaptations of marine organisms. The food chain. Interrelationships among animals, plants and environmental variables. Biomass studies. Categories of ecosystems: beaches: sandy, rocky, pebbles; coastal legoons; mangrove swamps; tidal marshes; estuaries; coral reefs; shallow coastal waters; continental shelves and slopes; open ocean: surface, pelagic, benthic. Modification of ecosystems by man: pollution, over-exploitation, aquaculture, marine parks.

The main subdivisions of the topic 'Marine Ecosystems' are illustrated by the following diagram:



A more specific graphic example, which deals with the food chain and its interaction with the marine environment, can be given by the following diagram:



4.3 Methods

A variety of possible experiments and assignments could be chosen, in addition to classroom work, for evaluation of the physical, chemical and biological components of a marine ecosystem. A selection could be made from the items in the following list, depending upon the facilities and resources available as well as on the time allotted for such studies.

4.3.1 Physical components

Temperatures at different depths, localities and times. Estimation of currents with drifting objects. Salinity determination by titration or estimation with hydrometers in areas with large variations, such as in estuaries. Measurements of transparency and estimation of light attenuation by means of a Secchi disc. Meteorological observations. Sea conditions.

4.3.2 Chemical components

Determination of dissolved oxygen concentration by the Winkler method. Measurement of alkalinity and pH and demonstration of the buffer capacity of sea water. Dissolved nutrient determination : particular phosphates, by visual colorimetry unless a photoelectric colorimeter or a spectrophotometer is available. Computation of oxygen saturation.

4.3.3 Biological components and processes

Field trips for the collection and identification of marine organisms. Plankton tows. Study of sediment samples to determine texture and organisms present. Notation and measurement of vertical zonation of organisms and comparison between different exposures. Mapping and area of shoreline with respect to organisms' distribution. Collection, preservation and identification of seaweeds and seagrasses. Growth rates of macroalgae and/or seagrasses and biomass estimations. Population studies of individual species to show interspecific and intraspecific relationships. Stomach content analyses and relation to food chain studies. Productivity studies using light and dark bottle techniques. Study of succession in a fouling community by using microscope slides suspended in the sea. Laboratory aquaria to simulate particular ecosystems. Determination of the responses of marine invertebrates in artificial and natural sea water.

4.4 Facilities, Resources and Materials

Most of the subject matter contained in this topic may be taught through lectures illustrated with simple diagrams, posters, slides and/or films, and by means of basic experiments and observations using inexpensive materials for laboratory and field work. Although basic experiments and field work are possible at this level without special equipment, teachers and students should be encouraged to design more complex experiments and to build up some pieces of equipment with readily available materials. Access to a small boat would be very valuable. In addition, visits to local marine science centres or museums will be most helpful. A number of selected references to assist the students in the identification of the marine organisms collected or in the interpretation of the results of a given experiment will be needed.

5. LIVING (BIOTIC) MARINE RESOURCES - USES AND CONSERVATION

5.1 Aims and Objectives

5.1.1 To familiarize the students with the major biotic marine resources of the oceans of the world, both animals and plants, and with the main features of their exploitation by species and according to geographical regions, with special emphasis on those living resources of local importance.

5.1.2 To describe and explain to the students the relationships that exist between the distribution of marine species of commercial importance and the density of plankton (phytoplankton and zooplankton), on the one hand, and the physical and chemical characteristics of the water masses (upwelling, nutrient supply, etc.), on the other.

5.1.3 To make the students aware of the present level and the potential for further utilization of biotic marine resources as a supplementary food supply (especially of animal proteins) for the ever increasing population of the world.

5.1.4 To involve the students in the evaluation of the impact of man's utilization of biotic marine resources from economic, social, environmental and purely biological points of view, as well as in the recognition and analysis of cases where over-exploitation of certain species has occurred.

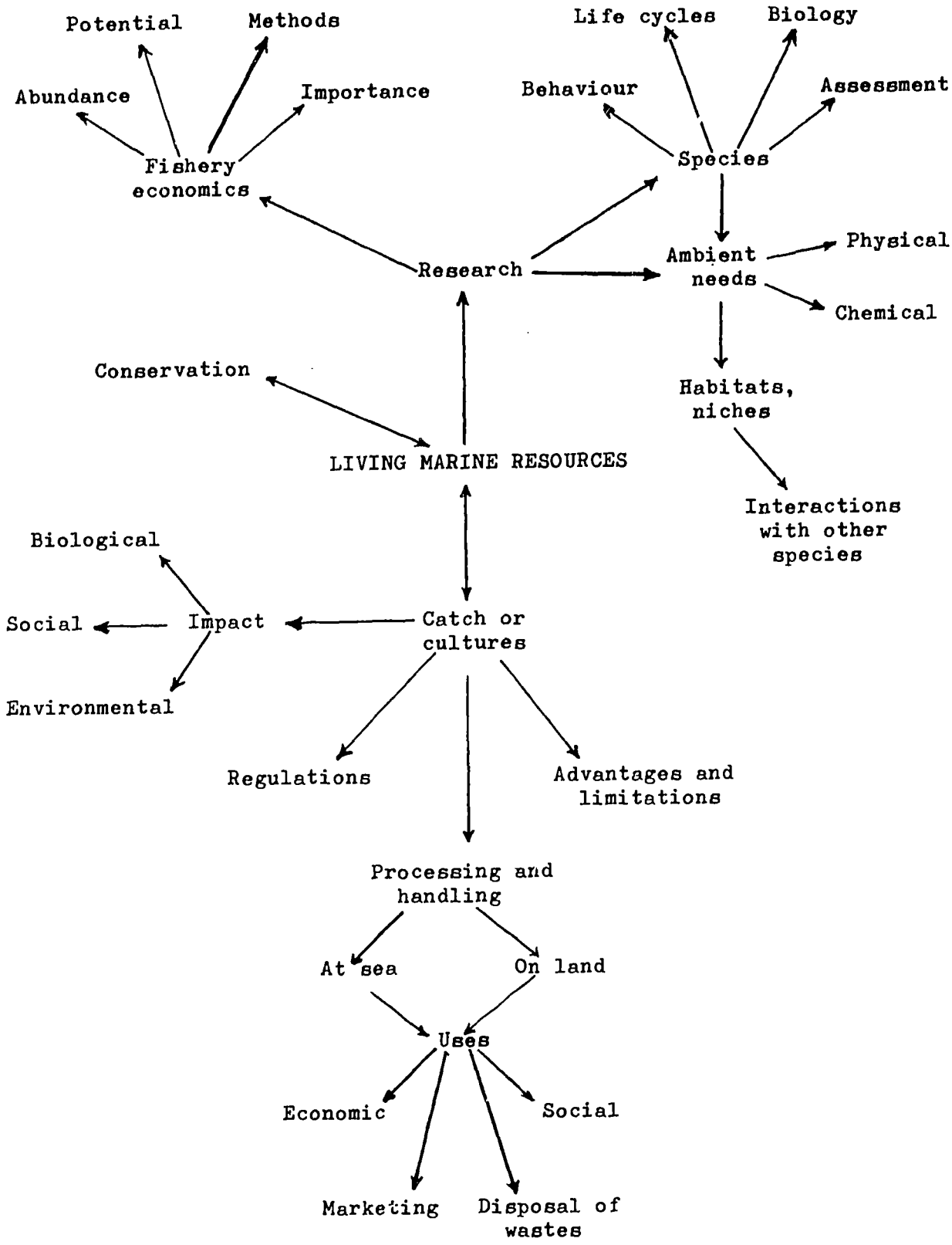
5.1.5 To describe and explain to the students how rational exploitation of a biotic marine resource can be based on information obtained through marine scientific research in a variety of aspects, such as age and size analyses of species, feeding and spawning migrations, study of spawning and nursery areas, outcome of spawning and survival of fish larvae, food conditions, and other physical and chemical variables.

5.1.6 To develop an appreciation of the necessity to base national and international fisheries regulations on the results of stock assessement studies designed in such a way as to ensure the maximum sustainable yield of the biotic resource under exploitation, and to evaluate the effectiveness of such actions.

5.2 Course Content

Living marine resources of economic importance. Fish (pelagic and benthic). Crustacea. Molluscs. Mammals. Reptiles. Algae. Mangroves. Distribution of major fishing areas in the world. Phytoplankton. Zooplankton. Nutrient distribution. Methods of estimating productivity. Stock assessment. Primary productivity measurements. Food potential of the oceans. Total production estimates. Exploitable organic matter taking into account different trophic levels. Ways to increase the yield. Mariculture of fish, shellfish, crustaceans and edible plants. Biology and life history of fish, crustaceans and molluscs of commercial importance. Microalgae and their uses in different parts of the world. Sea mammals, their economic exploitation including cultural interdependence in certain areas; protection; extinction. Brief history, past and recent, of fishing methods and research. Elementary aspects of population dynamics. Re-stocking programmes, fish hatcheries. Society and its interaction with living resources: aesthetic uses, marine parks, fishing regulations, recreation (sport fishing), conservation groups.

Some of the relevant aspects included in the topic 'Living (Biotic) Marine Resources - Uses and Conservation' are illustrated by the diagram that follows:


Potential
Methods
Abundance
Importance
Fishery economics
Life cycles
Biology
Behaviour
Assessment
Species
Research
Ambient needs
Physical
Chemical
Habitats, niches
Interactions with other species
Conservation
LIVING MARINE RESOURCES
Biological
Social
Impact
Environmental
Catch or cultures
Regulations
Advantages and limitations
Processing and handling
At sea
On land
Uses
Economic
Social
Marketing
Disposal of wastes

5.3 Methods

In addition to regular classroom work consisting of lectures, guided seminars, group discussions, oral presentation of homework assignments and audio-visual sessions, a number of practical exercises can be carried out. In the laboratory, the students may dissect specimens of fish, crustaceans and/or molluscs. Field trips to institutes engaged in research on biotic marine resources, to a fish hatchery and other mariculture sites, to a fish processing plant, cannery,market and/or fishing dock are highly recommended. Other activities may include the collection of fishery statistics, in particular local and national, and simple calculations relating to stock evaluation, as well as the study of maps and data on biomass, primary productivity, and world fisheries production. The students could undertake a group project to construct,install and maintain simple mariculture floats.

5.4 Facilities, Resources and Materials

Textbooks, reference materials, manuals and student guides may be needed for this course. Audio-visual equipment for the projection of films and slides is also required. The value of this course would be increased a great deal by having access to a biology laboratory with standard equipment, such as a balance, microscopes, glassware, trays, and common reagents. Fishery maps and statistics should be available and, for the analysis of the latter, a desk or hand calculator would be most useful. Aquaculture floats could be built quite inexpensively using surplus, discarded or readily available materials, such as empty drums, old telephone wires, ropes, chicken wire, and bamboo.

6. NON-LIVING (ABIOTIC) MARINE RESOURCES

6.1 Aims and Objectives

6.1.1 To describe and explain to the students the methods employed and the technical difficulties encountered in the exploration, assessment, exploitation and management of the abiotic resources extisting in the ocean environment or underneath the sea floor.

6.1.2 To develop an appreciation of the characteristics and time scales of the natural processes involved in the origin and accumulation of abiotic marine resources in contrast to the increasingly faster pace at which these non-renewable resources are being extracted.

6.1.3 To make the students aware of the potential value of abiotic marine resources as an instrument for enhancing the social and economic development of the less advanced countries of the world, and of the problems and limitations that might be encountered in establishing the infrastructure required for their utilization.

6.1.4 To help the students to understand that a country with exploitable abiotic marine resources has to take steps to train the scientific, technical and managerial workforce required to apply, adapt and/or develop technologies and marketing procedures for an optimum use and worldwide access to market of those resources.

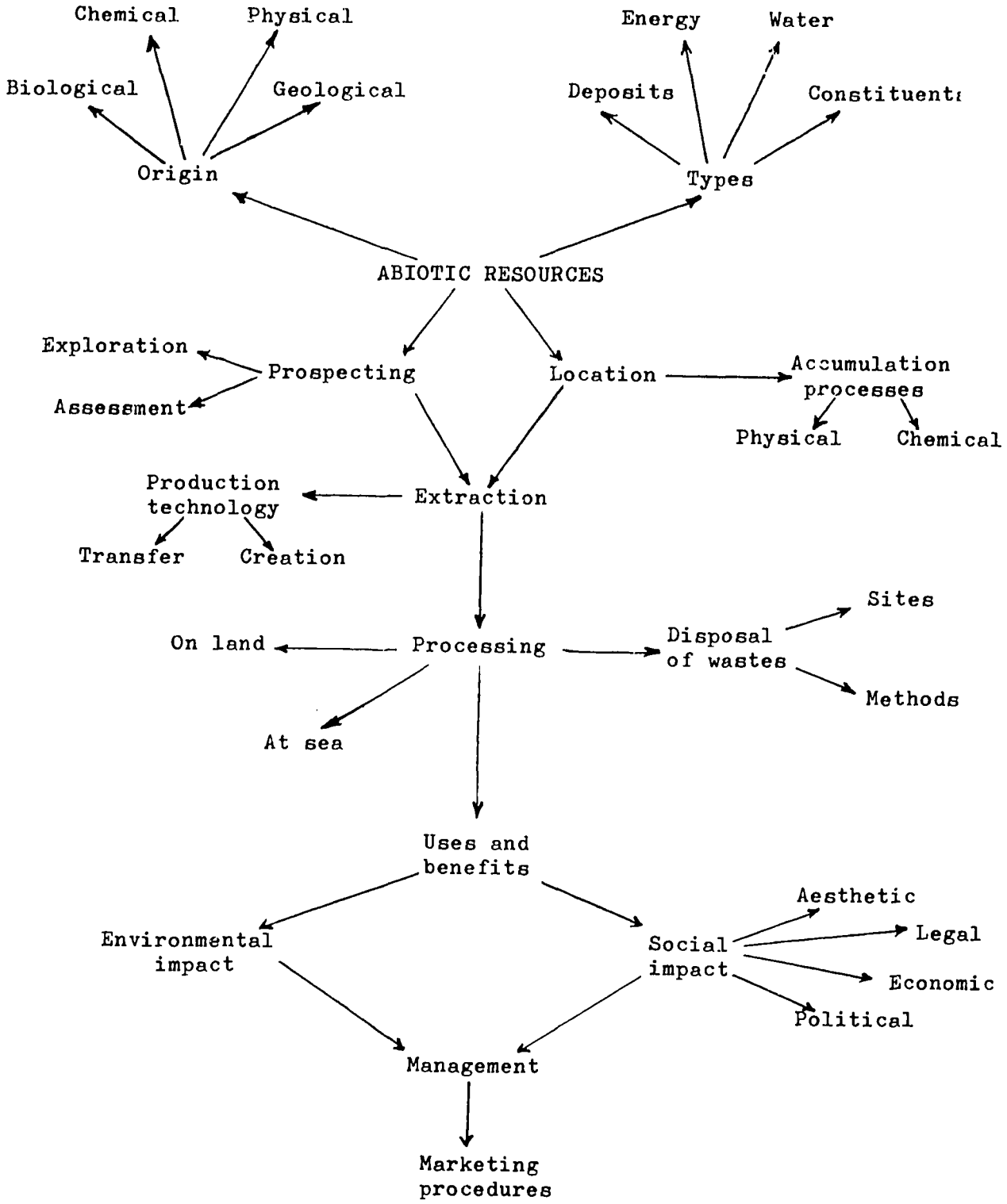
6.1.5 To examine the potential impact of the negotiations taking place under the United Nations Conference on the Law of the Sea on the determination of national jurisdictions over areas with abiotic marine resources and on the establishment of international enterprises for the exploitation of those resources found beyond the limits of the Extended Economic Zone.

6.1.6 To analyze with the students the present status and future national possibilities in relation to the use of the abiotic marine resources of their own country.

6.2 Course Content

Origin of the various types of abiotic marine resources: biological, chemical, physical and geological processes. Types of abiotic marine resources: water, water constituents (NaCl, Mg, Br_2, etc.), deposits (petroleum, natural gas, manganese nodules, sand, $CaCO_3$, phosphorite, glucanite, etc.) Energy resources of the ocean: thermal, wind, current, tide, wave, salinity, etc. Location of abiotic marine resources. Chemical and physical accumulation processes. Resource prospecting by chemical, geological and physical means. Mining and processing techniques. Main uses of abiotic marine resources. Technology market. Environmental impact. Management practices. Legal framework. Social and economic values. Political and aesthetic considerations. Disposal of wastes. Sites and methods.

The main subdivisions of the topic 'Abiotic Marine Resources' are illustrated by the following diagram:


Chemical
Physical
Biological
Geological
Origin
Energy
Water
Deposits
Constituents
Types
ABIOTIC RESOURCES
Exploration
Prospecting
Assessment
Location
Accumulation processes
Physical
Chemical
Production technology
Transfer
Creation
Extraction
Sites
On land
Processing
Disposal of wastes
Methods
At sea
Uses and benefits
Environmental impact
Aesthetic
Social impact
Legal
Economic
Political
Management
Marketing procedures

6.3 Methods

This topic is to be developed mostly on theoretical grounds by means of lectures, guided seminars and group discussions, analysis of local press reports, and audio-visual sessions. Management 'games' in which the knowledge gained in the classroom is applied may be particularly effective. If the opportunity arises, visits to research institutions, salt factories, deslination plants, or any other centres where abiotic marine resources are investigated or processed, should be organized. Homework assignments may be partitularly useful in teching this topic.

6.4 Facilities, Resources and Materials

No special facilities or materials are required for a fruitful development of this topic, other than those commonly found in secondary schools such as reproduction facilities, library, slide and film projectors. Transportation arrangements should be made for the visits to local centres.

7. STUDY OF A LOCAL MARINE PROBLEM

In view of the exceedingly large number of different local marine problems that may be encountered in the various coastal countries of the world, it has been considered advisable to present this topic through the following representative examples:

(a) Estuaries

(b) Beach erosion

(c) Artisanal fisheries

It is anticipated, nonetheless, that the approach utilized herein for determining the objectives, the possible course content, the methods to be employed in teaching, and the facilities and resources needed for these examples can be readily extrapolated to other local marine problems even if they are quite different in nature. This approach will allow individual secondary schools to concentrate their efforts on cases of special interest to them.

7.1 Aims and objectives

7.1.1 To create an awareness among the students of the importance of an integral understanding of the local marine environment, its main characteristics and recent evolution, and any special problems that may be derived therefrom.

7.1.2 To familiarize the students with the ways and means required for a comprehensive interdisciplinary study of the local marine environment, including its biological, chemical, physical, geological and geographical features.

7.1.3 To involve the students, either through active participation in field work, simulation techniques, or a combination of both, in the application of science and technology to decision making and problem solving with respect to real or potential problems that may threaten the local marine environment.

7.1.4 To develop an appreciation of the dynamic interrelationships that exist among the different factors which affect the local marine environment and of the need to understand them fully in order to make wise use of that marine resource.

7.1.5 To explore with the students possible ways for improving the quality, yield and benefits, and hence the social and economic impact, of locally exploited marine resources, including among these the recreaional use of the marine environment.

7.1.6 To make the students conscious that, from an ecological point of view, local marine environments are more fragile than deep ocean areas and that it may be difficult to re-establish equilibrium conditions once the adverse effects brought about by man's activities, such as pollution, surpass certain limits.

7.1.7 To describe and explain to the students how an information system where scientific, technological and managerial data are entered and analyzed can provide a solid foundation for wise management of the local marine environment.

7.2 Course content

In view of the fact that three different examples have been selected for the topic 'Study of a Local Marine Problem', their respective course content is outlined below.

7.2.1 Estuaries

Origin of estuaries. Types of estuaries as characterized by their physical, chemical and geographic characteristics. Salt-wedge estuaries. Moderately stratified estuaries. Coastal-plain estuaries (drowned river valleys). Bar-built estuaries (lagoons). Estuarine dynamics. River runoff. Estuarine circulation. Tides in estuaries. Mixing processes. Erosion and deposition of sediments. Land reclamation. Biological systems in estuaries. Productivity. Replenishment of nutrients by upwelling, river runoff and waste discharges. Food webs. Use, abuse, conservation and potential of estuarine areas. Pollution. Management of estuaries. Estuarine resources.

7.2.2 Beach erosion

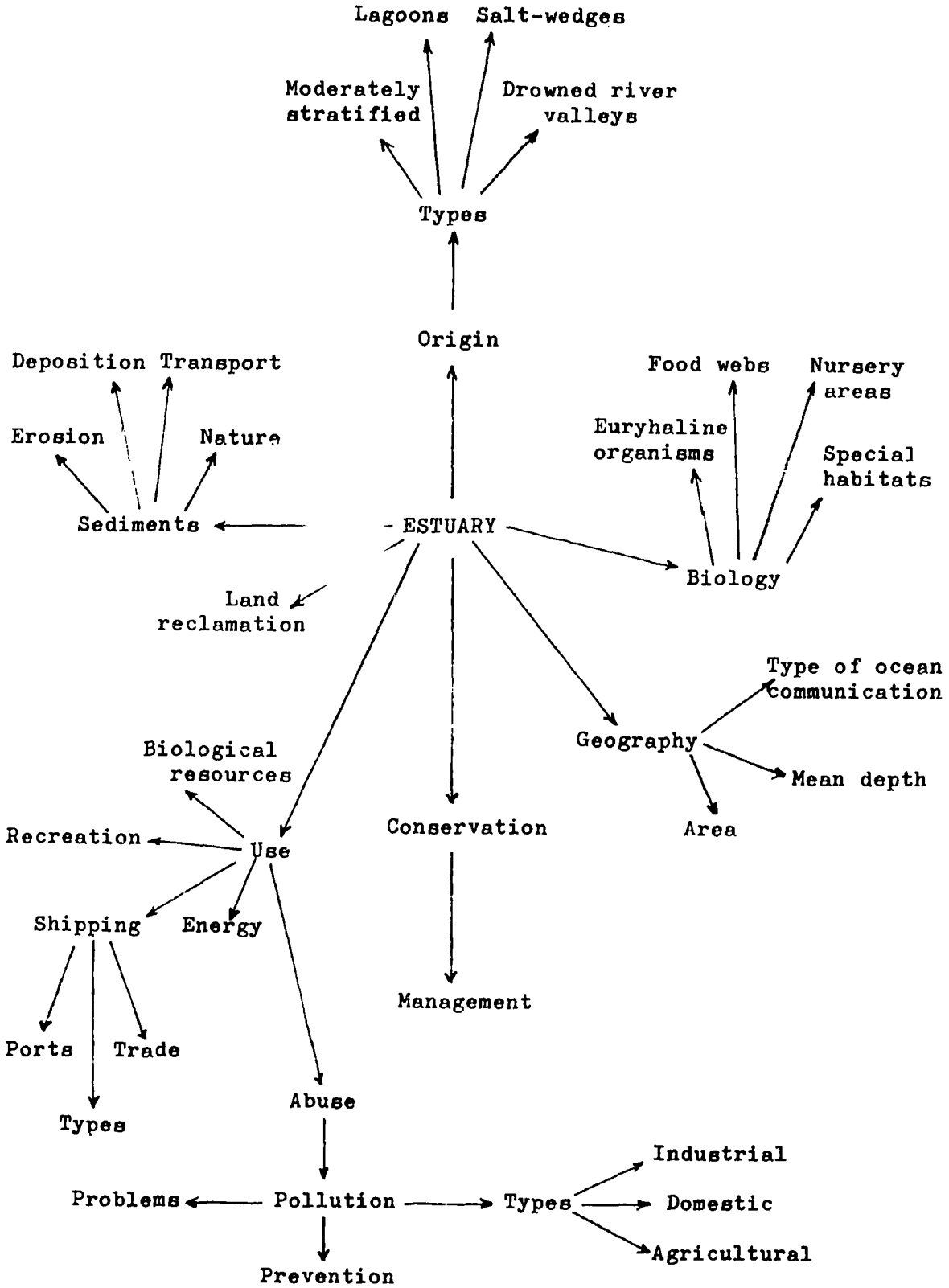
Processes affecting shorelines. Typical beach coastlines: sand bars, troughs, low-tide terraces, beach faces, berm crests, dunes. Nature, transport and distribution of sediments.

Equilibrium conditions. Periodic variations. Genesis of beach erosion. Wind action. Effects of waves, swells and storm surges. Rip currents. Longshore currents. Tidal action. River runoff. Jetties. Transport and deposition of sediments. Orders of magnitude involved. Seasonal changes in sediment distribution. Implication of beach erosion for coastal communities. Environmental and social impact: damage to structures, tourism losses, ecological damage. Feasibility study of the beach erosion problem. Possible remedial actions: dredging, fills, stabilization by plants, stabilization by jetties, groynes. Potential effects on adjoining areas. Finances and decision-making processes. Actions by governmental and private sectors.

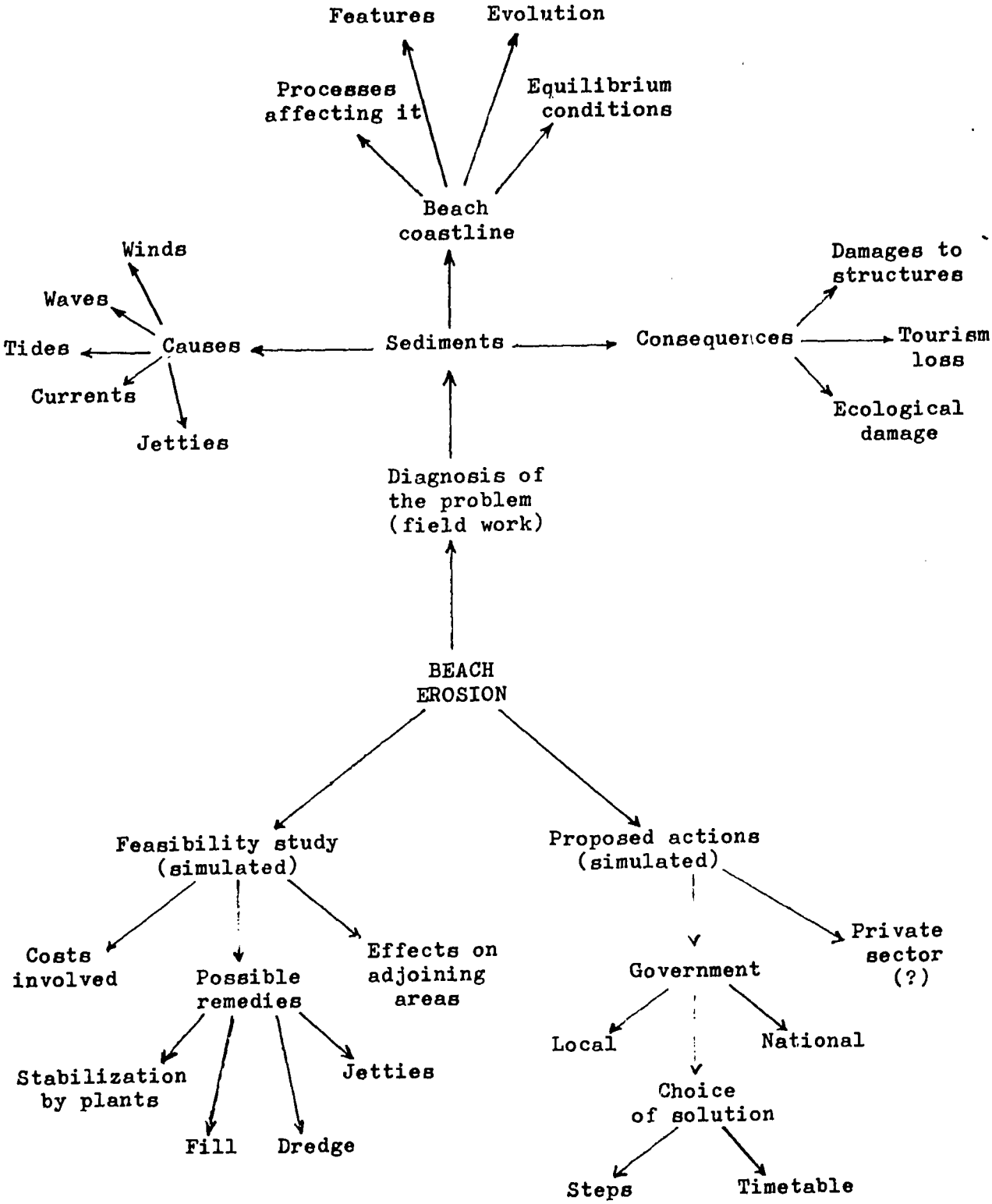
7.2.3 Artisanal Fisheries

Types of artisanal fisheries: bottom, mid-water, shellfish. Artisanal and indigenous fishing gear. Boats and equipment. Relative volume of catch. Common exploited commercial species and their biology. Life cycles, behaviour, predators, food chains. Influence of environmental variables on the catch of artisanal fishermen (water quality, winds, currents, tides, bottom conditions, man-made conditions). The artisanal fisherman in a sociological context: family situation, income, education, governmental assistance, outlook for the future. Competition with other fishermen, with users of the fishing area, and with aquaculture operations. Labour market. Marketing of the catch of artisanal fishermen: investment, benefits, supply to industries, dock-side sales, transportation, handling of the product. Contribution of artisanal fisheries to the fishing economy of a nation.

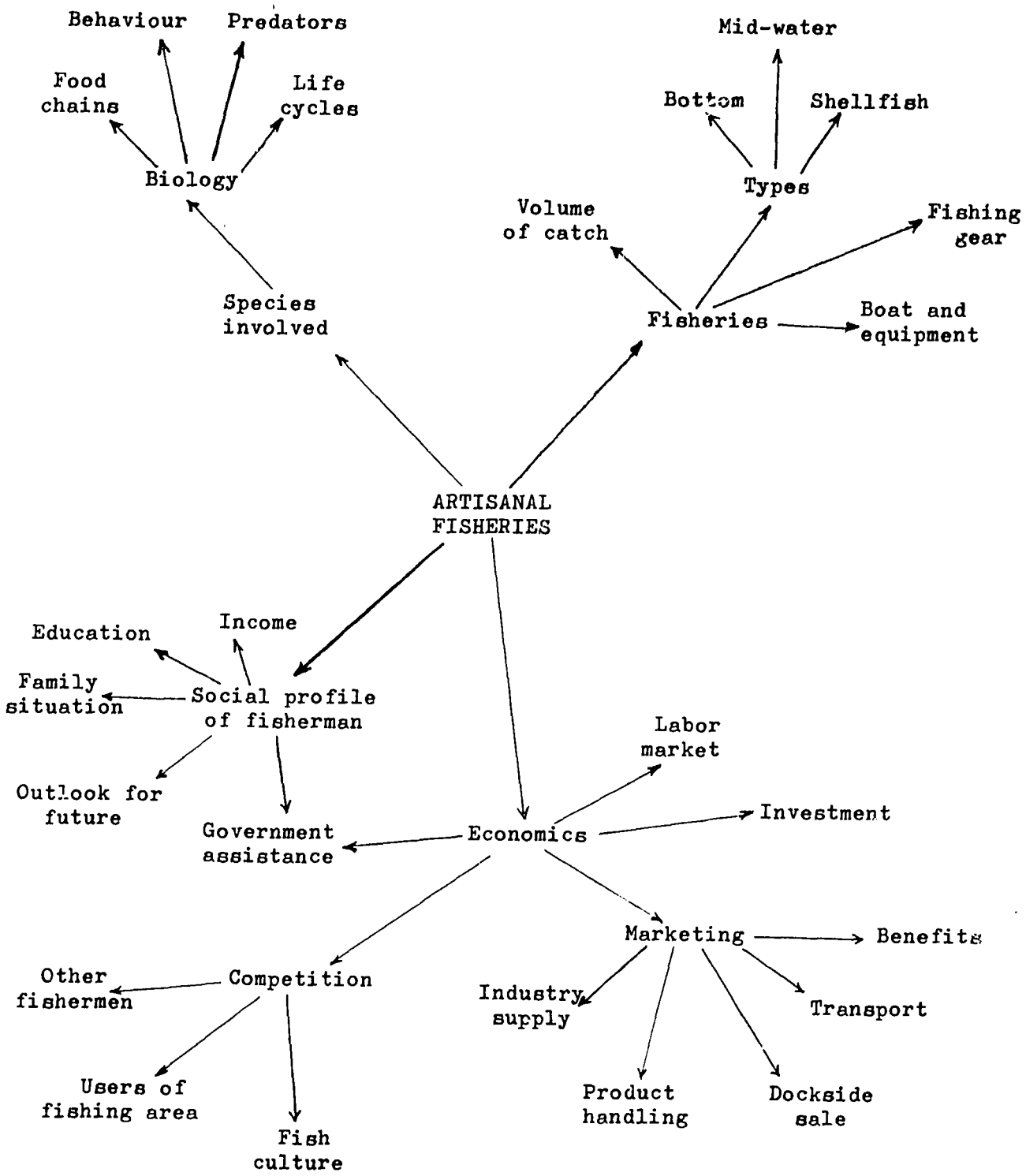
The main subdivisions of the topic 'Estuaries' are illustrated by the following diagram:


Lagoons
Salt-wedges
Moderately stratified
Drowned river valleys
Types
Origin
Deposition
Transport
Erosion
Nature
Sediments
ESTUARY
Food webs
Nursery areas
Euryhaline organisms
Special habitats
Biology
Land reclamation
Type of ocean communication
Geography
Mean depth
Area
Biological resources
Recreation
Use
Conservation
Shipping
Energy
Management
Ports
Trade
Types
Abuse
Industrial
Problems
Pollution
Types
Domestic
Agricultural
Prevention

The main subdivisions of the topic 'Beach Erosion' are illustrated by the following diagram:



The main subdivisions of the topic 'Artisanal Fisheries' are illustrated by the following diagram:



7.3 Methods

The development of the three examples presented under the general topic 'Study of a Local Marine Problem' requires regular classroom methods, i.e., lectures, guided group discussions, seminars, audio-visual sessions, oral presentation of homework assignments, and analysis of reference materials. In addition, management 'games' using simulation techniques might be especially applicable to these examples, for instance in studying the management of estuarine areas, the prevention of beach erosion or the improvement of the social and economic standing of artisanal fishermen. Field observations are particularly advisable for the topics 'Estuaries' and 'Beach Erosion', whereas a sea-going excursion on a fishing boat and visits to fishermen and their families are recommended for the topic 'Artisanal Fisheries'. Visits to government officials, recreation centres, fishing docks, processing plants, fish ponds, etc., will also be very useful.

7.4 Facilities, Resources and Materials

As has been the case with the other topics, most of the subject matter contained in the examples given may be taught to the students with the normal facilities encountered in secondary schools. Thus, illustrated materials available to the school, such as films and slides, or even the simple drawings and diagrams prepared by the students themselves will provide a more comprehensive and dynamic classroom environment. Extensive use may be made of reference materials of various types, including technical reports, fishery statistics, feasibility studies. One of the main resources for the development of this topic is the arrangement of visits to local organizations.

8. MARINE POLLUTION

8.1 Aims and Objectives

8.1.1 To familiarize the students with the main types of pollutants which enter the marine environment, as well as with their sources, modes of entry, pathways, and eventual fate in the sea.

8.1.2 To describe and explain to the students that even aquatic bodies as large as the oceans have a finite capacity to absorb pollutants and that adverse effects to marine organisms and man result when certain tolerance limits are exceeded.

8.1.3 To explore with the students possible means for reducing or preventing pollution in the sea through local, national, regional, and/or international actions and regulations, and to recognize any efforts being made at the various levels to prevent or control the deterioration of the marine environment.

8.1.4 To involve the students in the diagnosis of a community pollution problem and in an action programme designed at combating it, as part of a more encompassing effort to educate the public about the magnitude, dangers, and solution of

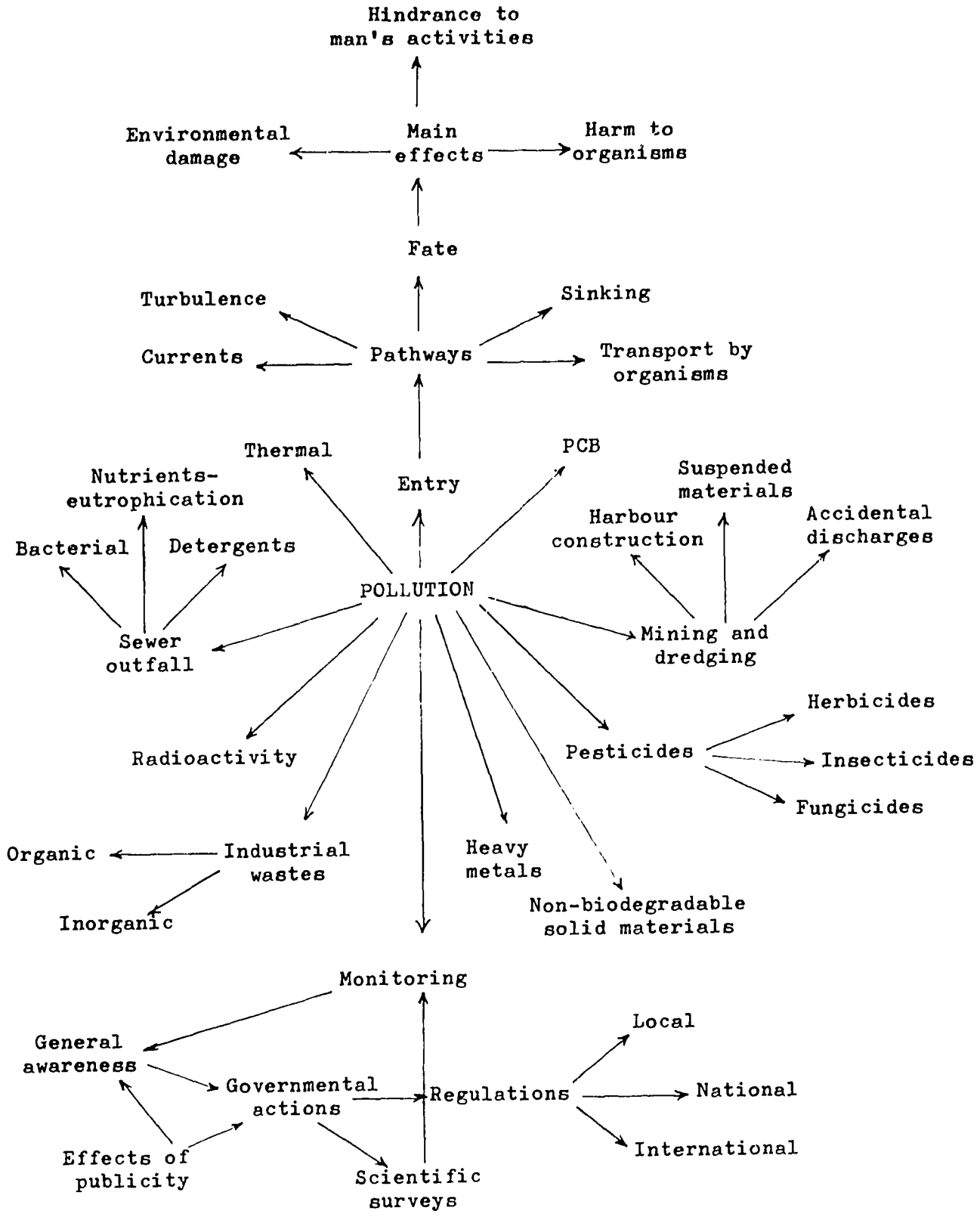
pollution problems.

8.1.5 To develop an appreciation of the benefits to mankind of a clean and healthy marine environment, of the ways and means to develop and enjoy it to the fullest in a positive way and without causing harm to it, and of the opportunity it provides for sharing a common natural asset with others.

8.2 Course Content

Review of the major pollutants in the marine environment. Sewage. Industrial wastes, both inorganic and organic, such as food and paper industry discharges, plastics, paints and dyes, tanning, electroplating, transport of wood by floating. Pesticides, including herbicides, insecticides and fungicides. Poly-chlorinated hydrocarbons such as PCB. Heavy metals, in particular lead and mercury. Radioactive wastes. Oil pollution from various sources. Detergents. Thermal pollution. Dredging and mining operations. Non-biodegradable solid materials. Mode of entry of pollutants: sewer outfalls, rivers, agricultural drainage, winds, precipitation, accidental and intentional dumping. Pathways of pollutants in the marine environment (turbulent diffusion, sinking, currents, transport of organisms) and distribution. Effect on organisms: bio-accumulation, toxic and lethal effects, concentration in food chains, eutrophication. Effects of pollution on man's health. Hindrance to man's activities. Reduction of amenities. Pollution monitoring and prevention. Biological indicators of pollution. Sociological aspects of marine pollution. General awareness. Positive and negative aspects of publicity. Governmental and international regulations.

The main subdivisions of the topic 'Pollution' may be illustrated by means of the following diagram:


Hindrance to man's activities
Environmental damage
Main effects
Harm to organisms
Fate
Turbulence
Sinking
Currents
Pathways
Transport by organisms
Thermal
PCB
Nutrients-eutrophication
Entry
Suspended materials
Harbour construction
Accidental discharges
Bacterial
Detergents
POLLUTION
Sewer outfall
Mining and dredging
Herbicides
Radioactivity
Pesticides
Insecticides
Fungicides
Organic
Industrial wastes
Heavy metals
Inorganic
Non-biodegradable solid materials
Monitoring
Local
General awareness
Governmental actions
Regulations
National
Effects of publicity
Scientific surveys
International

8.3 Methods

In addition to regular classroom work, a number of experiments and field work activities could be carried out for a fruitful development of this topic. Studies of oil pollution may be made by visual observations, photography and mapping of affected areas. In case of a major oil spill or another equally important pollution accident, the students may evaluate the extent of the problem and the actions taken by local and national authorities. Visits to industrial sites and collection of information on pollutant discharge by those industries is also advisable. Among the laboratory activities that could be undertaken, if the necessary means are available, are measurements of nutrients, oxygen and bacterial counts in sewage areas and studies of tolerance levels of marine organisms with respect to various types of pollutants. A simpler activity is the study of a typical community problem, such as beach pollution due to the accumulation of non-biodegradable wastes which may consist of a weekly clean-up of the beach, together with a public display of a chart containing the variations in weight of the refuse gathered during a period of several weeks.

8.4 Facilities, Resources and Materials

Monitoring of most pollutants in the sea requires expensive, sophisticated instrumentation and higly trained personnel, which is beyond the means of secondary schools. Therefore, the practical work suggested above has been restricted to very simple observations. Since a pollution problem usually is of such a nature that the community is directly affected, it is recommended that local authorities be contacted for information and assistance. For instance, posters relating to clean-up operations or signs forbidding the littering of beach areas might be installed by local authorities. To obtain statistics on specific problems, government agencies may have to be contacted for unpublished information. Bags, trucks or other items needed for clean-up operations might be furnished by the local authorities or private industry. The idea is to encourage the community to assist young people in the creation of environmental awareness.

9. STAFF AND TEACHING FACILITIES

The members of the Workshop wish to emphasize that the correct application of this syllabus requires that the instructors involved have sufficient familiarity with marine science so as to be able to teach the pertinent elements included in natural or social sciences courses. In addition, they must understand thoroughly the aims, objectives and overall philosophy guiding the introduction of oceanography and the marine environment into the curricula of secondary schools. This is conceivably the most difficult problem to be solved before the inception of the programme since very few scondary school teachers have the breadth of training and experience required to deal with all the varied aspects of the syllabus. Among the possible solutions to this problem, the following may be mentioned:

1. Training scondary school teachers in marine science disciplines at universities, eithe by the addition of specialized courses to the regular curricula or by means of ad hoc courses. This training may include faculties or departments of education, natural sciences, social sciences and law. Some of the teachers could take in-service training, night classes or special courses; others may be exchanged with other institutions or obtain a sabbatical or other type of leave.

2. Making available to the secondary schools concerned teaching aids, textbooks containing marine sections, manuals, teacher and student guides, films, slides, videotapes, laboratory and field work guides, and sets for marine science experiments. Technical support and advice may be given by existing marine science centres or by consultants in the field. A great deal can be accomplished in this regard through the assistance programmes of international organizations.

3. Marine scientists or graduate students may be hired to undertake teaching as part of a team effort involving the natural and social sciences secondary school teachers. In this way, different parts of a given course could be covered by different persons according to their field of expertise.

It is illusory to expect that the preparation of teachers and instructors is a simple task to be accomplished in a relatively short time. Nonetheless,it is possible to compress the time frame somewhat by concentrating initial attention on the training of teachers at a few secondary schools, located by or near the seashore, in which the syllabus could be introduced on an experimental basis.

The full development of a marine education programme in secondary shools requires, in addition to a good teaching staff, many facilities that may call for a high initial investment. Most modest efforts could be very fruitful, even in developing countries with financial constrains, if there is a real commitment to create marine environmental awareness and the ingenuity of administrators, teachers, and students is applied to further marine education through first-hand experiences. All through this syllabus it has been stated that marine education could benefit from having at its disposal highly trained teachers, sophisticated equipment and abundant teaching materials. Each time, however, it has been added that the objectives pursued could be attained with the barest minimum in staff, equipment and facilities.

10. USE OF THE SYLLABUS

The present syllabus is not intended as a substitute for basic science courses, but solely as a presentation of interesting marine science topics that can be worked out into existing curricula in natural and social sciences courses or offered as separate courses. It is not expected that the countries using this syllabus will adopt it immediately without carrying out beforehand systematic curriculum research and development which has come to be regarded as an integral part of educational planning within the overall framework and objectives of the educational system.

RECOMMENDATIONS

The following recommendations represent the collective advice of the Workshop participants. Their inclusion in the present document does not imply acceptance by the governing bodies of Unesco and its Intergovernmental Oceanographic Commission.

The Workshop on the Preparation of a Syllabus for introducing Oceanography and the Marine Environment into Secondary Schools' Curricula:

1. Recalling that the subsidiary bodies of the Intergovernmental Oceanographic Commission dealing with training and education have emphasized the importance of an early and universal introduction to marine science in order to create a general awareness of the potential and proper utilization of the marine environment,

   Recommends that IOC Member States wishing to introduce oceanography and the marine environment into their secondary schools' curricula should consider the present syllabus only as a useful model to be analyzed and applied following necessary modifications in light of local conditions. The syllabus is intended to provide useful guidelines, but not to be copied indiscriminately.

2. Being aware that one of the primary difficulties faced by IOC Member States wishing to apply the present syllabus is to choose between including the topics suggested herein as separate courses or integrating their subject matter into natural and social science courses,

   Being conscious of the legal obstacles that must be surmonted to adopt the former procedure, especially in view of the fact that in some countries official curricula are applied nationally whereas the present syllabus may be used more profitably in the secondary schools of coastal communities,

   Recommends that marine science aspects be incorporated into regular courses on biology, chemistry, physics, earth sciences and, where appropriate, also history and sociology.

3. Recognizing that the eventual usefulness of the present syllabus will be increased by a distribution of the document throughout the world as widely as possible,

   Recommends that:

   3.1 the Workshop report be translated into all of the working languages of the Commission, as well as in Arabic;

   3.2 IOC National Training Contacts be encouraged to publicize this Workshop report in their respective countries;

   3.3 in addition to the copies sent to all correspondents of the Commission, the Workshop report be made available to

other pertinent national bodies with the assistance of the Education Sector of Unesco.

Notes with appreciation the assurance given by the representative of the International Baccalaureate Office that the present syllabus will be reproduced in a forthcoming issue of the 'General Guide to the International Baccalaureate' and that there is a strong likelihood that it will be made a part of the IBS programmes and applied on an experimental basis at the United World College of the Atlantic and, perhaps, adopted in due course by three or four IBS schools around the world.

4. Cognizant of the fact that a number of problems will have to be faced by IOC Member States for the implementation of the syllabus proposed herein, including financial difficulties,

Recommends that Unesco convene a meeting of a group of experts to devise ways and means to implement the application of the syllabus as widely as possible world-wide, once sufficient time has elapsed after the distribution of the Workshop report;

Further recommends that the United Nations Environmental Programme consider providing financial support for the implementation of this syllabus in view of the importance given therein to environmental understanding and protection.

5. Realizing that a necessary condition for the use of the syllabus to introduce oceanography and the marine environment into secondary schools curricula is the existence of teachers with sufficient knowledge in the marine sciences,

Advises IOC Member States to make use of the facilities existing at universities, teacher training colleges and marine science centres, for training the instructors who will impart marine science teaching at the secondary school level, or to develop such facilities if they do not exist, and also to involve IOC National Training Contacts in the preparation of these teacher training programmes.

6. Being of the opinion that an active participation of Unesco through its Education and Science Sectors will considerably enhance the potential effectiveness of teaching marine science at the secondary school level,
Recommends that:

6.1 Unesco consider the possibility of commissioning outside experts to prepare printed materials in the marine sciences, such as textbooks, and sets of teacher and student guides;

6.2 information about existing marine science programmes for secondary schools of IOC Member States, such as those of the National Marine Education Association in the United States, be compiled and utilized as reference material in the preparation of teacher and student guides.

6.3 Unesco actively explore the possibility of providing support for the development of inexpensive experimental sets for marine studies at the secondary school level and that, once this is accomplished, a number of such sets be distributed as part of a pilot project;

6.4 extensive use be made of the audio-visual course on oceanography developed by the Open University of the United Kingdom, with the financial support of Unesco, both in training the instructors and in the actual teaching of secondary school students.

BACKGROUND

At the first meeting of the Intergovernmental Oceanographic Commission Working Group on Training and Education, held in Paris, 2-4 December 1968, there was general agreement on the merits of introducing elements of marine science at the secondary school level with the purpose of promoting an appreciation for oceanography and the marine environment, independent of the particular professional inclinations that the students might develop later on. The participants realized, however, that there were a number of difficulties to be solved beforehand, among which were the facts that the principal oceanographic topics are seldom treated in textbooks of secondary schools and are thus unknown to the teachers, and that the required teaching materials most likely would be unavailable.

The participants in the joint session of the IOC Working Groups on Training and Education in Marine Science and on Mutual Assistance, held in Malta, 5-12 January 1971, noted that there had been an increase in national activity as well as some international actions to introduce secondary school students to the analysis of marine problems. Among the recommendations and comments of the joint session, the following are worthy of mention:

- the IOC Secretariat should seek the assistance of the appropriate specialized departments of Unesco, and the International Institute for Educational Planning, in implementing recommendations;

- the main object is to better inform young people about marine affairs, especially in view of the United Nations concern to nurture a peaceful evolution of ocean activities, not necessarily to encourage them to choose marine science as a career;

- with repsect to in-school instruction the main need is to introduce marine science into the traditional subjects, especially geography and natural sciences, and in this regard preparation of an appropriate textbook is essential;

- out-of-school activities to supplement the marine content of the normal school syllabus, whether exclusively marine-oriented or as elements of broader science activities, were considered very important;

- the IOC Secretariat should seek ways and means to have a handbook prepared on this matter, along the lines of the Unesco publication "Out-of-school Science Activities for Young People", including guidance to teachers on specialized in-school activities such as environmental study projects.

The IOC, at its seventh session (Paris, 26 October-5 November 1971), considered the report of the joint session and decided to request the Unesco Division of Science Teaching to develop, in collaboration with the IOC Secretariat, recommendations as to the introduction of elements of

marine science into the curricula of primary and secondary schools. This task was to be completed by the second half of 1972 and the findings made known to Member States. As an initial step towards achieving this goal, questionnaires were sent to a few selected Member States requesting information on the marine content of textbooks, the extent to which marine science was represented in secondary school examinations, training in marine science of secondary school teachers, and inclusion in the school systems of pilot programmes related to the marine environment.

A number of related activities were undertaken during the period following the seventh session of the Commission in preparation for the first session of the IOC Working Group on Training, Education and Mutual Assistance (TEMA) (Paris, 7-13 March 1973). One of the most relevant involved collaboration between staff members of the IOC and the Unesco Division of Marine Sciences and the Office of the International Baccalaureate (IOB). Advice was given on the content of the IOB syllabus on the marine environment to be offered as a subsidiary subject at the United World College of the Atlantic and the first examination papers were moderated by an IOC staff member. This led to the presentation of a paer on the syllabus at the first session of WG/TEMA. In addition several papers were presented to various fora convened on the subject of early education to draw participants' attention to the advisability of including marine elements within primary and secondary school programmes.

At the first session of the WG/TEMA it was recognized that a successful programme to create public awareness in marine affairs could best be achieved by the inclusion of the important elements of marine science in the curricula of elementary and secondary schools. In this regard, some serious steps taken by Member States to accommodate such elements in their pre-university educational programmes were noted. Other Member States were advised to take action along the same lines and in this connection it was recommended that the IOC Secretary, in co-operation with the Unesco Division of Science Teaching and with the full participation of the ICSPRO agencies, should find ways and means to formulate specific suggestions and guidelines for introducing marine science elements into the pre-university curricula.

This problem was also paid attention to in three of the regional ad hoc TEMA meetings convened by the IOC during the 1975-1976 biennium. The participants in the third regional meeting (Manila, Philippines, 15-19 September 1975), considering the importance of an early and universal introduction to marine science in order to create an awareness of the potential and proper utilization of the marine environment, recommended that the Commission sponsor a symposium to discuss the introduction of marine science in the secondary schools of the region, followed by a Workshop to prepare guidelines and curricula. At the fourth regional meeting (Cairo, Arab Republic of Egypt, 4-8 January 1976) there was agreement both on the importance of educating young people to respect the environment and on the need to educate all elements of society on the marine environment, one additional benefit being the opportunity to attract young people to marine science studies. Participants in the fifth regional meeting (Montevideo, Uruguay, 15-19 November 1976) discussed the implications of an IOC workshop to prepare a syllabus of marine science. It was pointed out that it could prove difficult for the education

ministries to modify the curricula by including one more subject and that geography teachers at secondary schools are not usually qualified to explain oceanographic phenomena adequately.

The second session of the IOC Working Committee for Training, Education and Mutual Assistance in the marine sciences (TEMA-II), held in New York, 18-23 July 1977, fully endorsed in concept the sense of the recommendations of the regional ad hoc TEMA meetings, although no specific mention was made of the problem with which we are now concerned.

On that basis, the Workshop on the Preparation of a Syllabus to introduce Oceanography and the Marine Environment into Secondary Schools was convened at the United World College of the Atlantic, St. Donat's Castle, Llantwit Major, South Wales, United Kingdom, 5-9 June 1978, with the persons indicated in the List of Participants in attendance. The following agenda was adopted:

1. Opening of the Meeting

2. Selection of the Chairman and Rapporteur

3. Aims of the Syllabus

4. Means of introducing Marine Science in Secondary Schools' Curricula

   4.1 National vs Universal Interests
   4.2 Preparation of Teachers/Instructors
   4.3 Separate Courses vs Subject Matter Integrated into Regular Courses

5. Preparation of the Syllabus and Recommendations

6. Resources

7. Closure of the Meeting

Mr. Colin D.O. Jenkins and Mr. Gary L. Fletcher were elected as Chairman and Rapporteur, respectively.

The preceding report contains the ideas, conclusions and recommendations of the participants in the Workshop.

APPENDIX II

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