



**CONVENTION ON
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AND TECHNOLOGICAL ADVICE**

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**SCIENTIFIC, TECHNICAL AND TECHNOLOGICAL ASPECTS OF THE CONSERVATION
AND SUSTAINABLE USE OF COASTAL AND MARINE BIOLOGICAL DIVERSITY**

Note by the Secretariat

1. INTRODUCTION

1. Article 25 of the Convention on Biological Diversity establishes the Subsidiary Body on Scientific, Technical and Technological Advice (SBSTTA) to provide the Conference of the Parties and, as appropriate, its other subsidiary bodies with timely advice relating to the implementation of the Convention. Paragraph 2 of Article 25 of the Convention provides that "under the authority of and in accordance with guidelines laid down by the Conference of the Parties, and upon its request, this body shall:

- (a) Provide scientific and technical assessments of the status of biological diversity;
- (b) Prepare scientific and technical assessments of the effects of types of measures taken in accordance with the provision of this Convention;
- (c) Identify innovative, efficient and state-of-the-art technologies and know-how relating to the conservation and sustainable use of biological diversity and advise on the ways and means of promoting development and/or transferring such technologies;
- (d) Provide advice on scientific programmes and international cooperation in research and development related to conservation and sustainable use of biological diversity; and



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(e) Respond to scientific, technical, technological and methodological questions that the Conference of the Parties and its subsidiary bodies may put to the body."

2. At its first meeting (Nassau, 28 November - 9 December 1994), the Conference of the Parties (COP) decided, in accordance with the Convention, that the Subsidiary Body on Scientific, Technical and Technological Advice shall consider at its first meeting (i) its *modus operandi*; and (ii) prepare a proposal for a medium-term programme of work (1995-1997) based on the priorities set out in the programme of work adopted by the Conference of the Parties (UNEP/CBD/COP/1/13) and on Article 25 of the Convention and submit it to the Conference of the Parties at its second meeting.

3. In keeping with the high priority given by the Conference of the Parties to addressing issues related to the conservation of marine biological diversity in its own work programme, one of the matters on which advice from SBSTTA was requested by the Conference of the Parties for its second meeting includes:

"Provision of advice on the scientific, technical and technological aspects of the conservation and sustainable use of coastal and marine biological diversity (also taking into account the other provisions in Article 25, paragraph 2)." (UNEP/ CBD/ COP/ 1/17: paragraph 5.5.3 of the annex refers)

Within the context of these terms of reference, in particular for (e), the SBSTTA would wish to be in a position to advise governments on actions which they should take at the national level concerning marine and coastal biodiversity conservation and sustainable use in order to fulfill their obligations to the Convention.

4. In addition to the specific terms of reference given in Article 25 of the Convention, there are four elements of the work programme adopted by the Conference of the Parties which relate to the specific mandate on coastal and marine biodiversity given to the SBSTTA. These four elements should be taken into account in the draft work programme to be submitted by SBSTTA to the second meeting of the Conference of the Parties:

(a) "Relationships with the Commission on Sustainable Development: to consider the outcome of its third session on biodiversity-related matters" (UNEP/ CBD/ COP/1/ 13; paragraph 15, d);

(b) "Cooperation with other Conventions: (i) to consider the relationship with biodiversity-related conventions; and (ii) to identify approaches to and areas for cooperation" (UNEP/CBD/COP/1/13; paragraph 15, e);

(c) the "Special Session of the General Assembly to review implementation of Agenda 21: to prepare an input from the perspective of the Convention" (UNEP/CBD/COP/1/13; paragraph 16, b); and

(d) "Cooperation with other Conventions: to consider the relationship of the [United Nations] Convention on the Law of the Sea with specific reference to measures for conservation and sustainable use of marine biological resources" (UNEP/ CBD/ COP/1/ 13; paragraph 16, c).

5. In addition, it should be noted that the fourth session of the Commission on Sustainable Development, scheduled to take place in April-May 1996, will have as one focus Agenda 21's

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Chapter 17: "Protection of oceans and all kinds of seas including enclosed, semi-enclosed seas and coastal areas and the protection, rational use and development of their living resources."

6. Therefore, at its first meeting, a major task of the SBSTTA in preparing its overall draft medium-term programme of work is to decide on those activities needed to address "Scientific, Technical and Technological Aspects of the Conservation and Sustainable Use of Coastal and Marine Biological Diversity". The proposed activities should address the issues outlined in sub-paragraphs (a)-(e) in 1 above, and take into account elements of the work programme of the Conference of the Parties which are related to marine and coastal issues but which are not explicit in (a)-(e). Finally, sight must not be lost of the fact that the activities proposed are to be taken in the context of the Convention's provisions and its three-fold objective: the conservation of biological diversity; the sustainable use of its components; and the fair and equitable sharing of the benefits arising out of the utilization of genetic resources.

7. This document was prepared by the Secretariat of the Convention in order to:

- (i) assist the SBSTTA in advising the second meeting of the COP on the implementation of certain priority actions within its medium-term programme of work; and
- (ii) help the SBSTTA to prepare a draft of its own programme of work for consideration by the COP at its second meeting.

8. The remainder of this document is divided into 5 parts:

- (i) Section 2 is a brief overview of the *problems and challenges* related to the conservation and sustainable use of coastal and marine biodiversity;
- (ii) Section 3 highlights other *international and regional legal instruments* related to coastal and marine biological diversity, including the United Nations Convention on the Law of the Sea, with which the SBSTTA and the COP may wish to collaborate;
- (iii) Section 4 discusses the relationship between the *objectives of the Convention* and the conservation and sustainable use of coastal and marine resources;
- (iv) Section 5 presents the rationale for and a *suggested programme of work* of the SBSTTA on coastal and marine issues according to the tasks given in paragraph 7 above. It includes references to proposals for the procedural arrangements for its development and implementation presented in UNEP/CBD/SBSTTA/1/2, *Modus Operandi* of the Subsidiary Body on Scientific, Technical and Technological Advice;
- (v) Section 6 provides concluding remarks.

2. CONSERVATION AND SUSTAINABLE USE OF MARINE BIOLOGICAL DIVERSITY: PROBLEMS AND CHALLENGES

9. In spite of the availability of a number of publications, the status of marine and, to a lesser degree, coastal biodiversity is in general poorly known and documented. Nevertheless, there are reliable indications that it is being lost at an alarming rate, mainly due to the degradation of habitats and the unsustainable exploitation of resources.

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10. *The State of the Marine Environment*, prepared by the United Nations Joint Group of Experts on the Scientific Aspects of Marine Pollution (GESAMP¹, 1990), provides an overview of the extent of human activities affecting oceans and coasts and indicates that the main damages are caused by:

- (a) industrial and urban development in coastal areas;
- (b) discharge of waste waters;
- (c) disposal of dredged material, sewage sludge and other waste directly into the sea and into the marine and atmospheric environment;
- (d) disposal of litter, mainly plastics;
- (e) manipulation of hydrological cycles;
- (f) poor land-use practices;
- (g) transport of hazardous substances;
- (h) exploitation of non-living marine resources;
- (i) exploitation of living marine resources; and
- (j) extreme events (accidents).

11. The changes brought about by these activities which may have effects on marine biodiversity can be summarized as follows:

- (a) changes in the chemical composition of the marine environment;
- (b) accelerated changes in sea-level;
- (c) changes in physical characteristics such as temperature, wave and current patterns;
- (d) altered rainfall and weather patterns;
- (e) changes in exposure to ultra-violet radiation;
- (f) species introductions or invasions;
- (g) chemical and biological contamination of marine organisms;
- (h) decline in populations; and
- (i) disruptions in life-cycles.

These effects contribute to changes in the health of organisms, populations, species composition of communities, ecosystems, and landscapes, which in turn can alter or destroy marine habitats.

12. Environmental change presents increased risk when biological diversity is already under threat. This is because the loss of genetic diversity weakens a population's ability to adapt; the loss of species diversity weakens a community's ability to adapt; the loss of functional diversity weakens an ecosystem's ability to adapt; and the loss of ecological diversity weakens the whole biosphere's ability to adapt. Because biological and physical processes are interactive, losses of biological diversity may also precipitate further environmental change. Such a destructive circularity results in impoverished biological systems which are susceptible to collapse when faced with further environmental changes.

13. There is a fairly direct relationship between the activities listed in paragraph 10 and the effects listed in paragraph 11. While presenting a similar list of causes and effects, *The Global Biodiversity Strategy* (UNEP, WRI, IUCN, 1992) also noted that the real root causes are of an indirect nature.

¹GESAMP is now the Group of Experts on the Scientific Aspects of Marine Environmental Protection

14. *The Biodiversity Strategy* lists the following as the fundamental causes of biodiversity loss:

- (a) the unsustainably high rate of human population growth and natural resource consumption;
- (b) the steadily narrowing spectrum of traded products from agriculture, forestry and fisheries;
- (c) economic systems and policies that fail to value the environment and its resources;
- (d) inequity in the ownership, management and flow of benefits from both the use and conservation of biological resources;
- (e) deficiencies in knowledge and its application; and
- (f) legal and institutional systems that promote unsustainable exploitation.

15. There are a number of factors which should be taken into account in formulating strategies and actions that can slow the loss of marine biodiversity resulting from direct or indirect causes. These factors include:

(a) A wide variety of socio-economic factors drive human activities which affect the marine and coastal environment. Those factors operate in different spheres of influence over time, ranging in scale from the local community to the nation-state to the global level, with many gradations in between;

(b) Little is known about the relationship between the extent of biological diversity in marine systems and the production by those systems of biomass. It is difficult to quantify the interactions between various species that make up communities in terms of biological diversity, particularly in the open ocean. As a consequence, most management advice, particularly on fisheries and a few systems like coral reefs and mangroves, is drawn from scientific studies that are limited to very narrow, single species approaches;

(c) The institutional approaches to managing marine and coastal resources are still largely concerned with sectoral interests (transport, fisheries, tourism, etc) with little or no attempt to foster institutions that pursue integrated approaches. These are mirrored by an array of intergovernmental organizations that have been established along sectoral lines as well (science, industry, conservation, tourism, etc). Related to this is a legacy of national and international laws which are based on the sectoral planning approach and on the "free access" principle and are generally aimed at solving relatively narrowly defined problems. The inertia created by this legacy is difficult to counter.

16. Overcoming the problems related to these issues constitutes one of the challenges to the Conference of the Parties in pursuing the conservation and sustainable use of marine and coastal biological diversity under the auspices of the Convention.

3. INTERNATIONAL AND REGIONAL LEGAL REGIMES RELATED TO THE CONVENTION ON BIOLOGICAL DIVERSITY

17. The number of agreements and instruments in place today which are of relevance to marine and coastal biological diversity is enormous. For example, a recently published compendium on selected

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treaties, international agreements and other instruments concerning marine resources, wildlife and environment runs to over 3500 pages and lists over 500 such instruments (Marine Mammal Commission, 1994). A similar number of instruments are referred to in a recent review of the priorities and responsibilities for implementing UNCLOS, many of the provisions of which are related to marine and coastal biological diversity conservation and sustainable use (Kimball, 1995). As a point of reference, some of these instruments are listed in annex I of this document.

18. The Convention is therefore going to be implemented within the context of many activities which are taking place under the auspices of a number of legal instruments. Many of these legal instruments and activities are not harmonized and some have targets which may be less stringent than others. Some instruments are being implemented vigorously and some have been nearly forgotten. By contrast the sum of the aims of all the conventions and legal instruments does not provide for comprehensive conservation and sustainable use of marine and coastal biological resources. Conventions and other instruments which should receive priority attention include:

- (a) regional marine conventions and their associated protocols such as: Convention for the Protection of the Mediterranean Sea against Pollution; Regional Convention for the Conservation of the Marine Environment of the Red Sea and the Gulf of Aden Environment; and Convention for the Protection and Development of the Marine Environment of the Wider Caribbean;
- (b) the 1982 United Nations Convention on the Law of the Sea (UNCLOS);
- (c) the International Convention on the Regulation of Whaling;
- (d) the Convention on the Conservation of Migratory Species of Wild Animals;
- (e) the Convention on Wetlands of International Importance Especially as Waterfowl Habitat (RAMSAR);
- (f) the Convention on International Trade in Endangered Species (CITES);
- (g) the Framework Convention on Climate Change;
- (h) the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter; and
- (i) The FAO Strategy for Fisheries Management and Development; and the FAO Fisheries Code of Practice.

19. The SBSTTA may wish to consider how work under the Convention can coordinate and benefit from existing and planned activities under other Conventions and programmes. This would ensure that efforts are mutually supportive and do not duplicate one another.

4. RELEVANCE OF MARINE AND COASTAL RESOURCES TO THE CONVENTION'S OBJECTIVES

20. Article 1 of the Convention gives the objectives of the Convention as:

- (a) the conservation of biological diversity;

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- (b) the sustainable use of its components; and
- (c) the fair and equitable sharing of the benefits arising out of the utilization of genetic resources...

21. much of the negotiation that took place over the objectives and principles of the Convention concentrated on the terrestrial environment. By contrast, there was little, if any, discussion concerning marine biological diversity and its importance to human well-being. Nonetheless, the objectives of the Convention provide a framework for addressing all of biological diversity, including marine and coastal components.

22. Section 2 highlights the fact that many human activities are responsible for the degradation of the marine and coastal environment, which in turn can lead to loss of biological diversity and the consequent collapse of marine and coastal ecosystems. Planning for sustainable use of marine and coastal biological resources requires not only the recognition of necessary limits on human use of the marine environment and its resources, but also an integrated and holistic approach to planning, management and multiple use of the oceans. At present, fishermen, navies, coastal developers, shipping, mining, oil companies, sportsmen and tour operators all use the environmental goods and services provided by the sea without considering each others' needs, interests or plans. The sectoral approach to development, use and management of the seas is reflected in haphazard and reactive national policies; fragmented decision-making processes; weak or no linkages between the decisions and policies in different sectors; and a failure both nationally and internationally to calculate the net benefits which would result from a balanced choice between various options for development.

23. In planning for use of the marine and coastal biological diversity, each island or coastal state needs to determine its overall development objectives and to evaluate the extent to which ocean and coastal resources might provide the means to achieve those objectives. It is important, therefore, to undertake a full identification and evaluation of the possible options. The costs and benefits of potential services and opportunities for use of the marine and coastal environment (for example: waste disposal, transport, energy, fisheries, tourism) should be considered. Decisions on the choice of use need to be made in the light of the relative contributions the different uses could make to achieving the overall development goals without substantially degrading marine and coastal biological diversity. Balanced decision making, based on a consideration of the economic and environmental consequences, will then be possible. Prevention of conflicts between different uses and identification of compatible development strategies and projects will lead to an integrated planning process. Preventing conflicts, rather than reacting to them after they have already occurred, will ease management burdens.

24. Socio-economic constraints and present-day management capabilities may limit the range of options available in particular countries and regions. A phased management approach may therefore be necessary. In general, a more integrated approach to managing marine and coastal systems will result in improved conservation and sustainable use of these environments and their resources.

5. POSSIBLE MEDIUM-TERM PROGRAMME OF WORK OF THE SUBSIDIARY BODY ON SCIENTIFIC, TECHNICAL AND TECHNOLOGICAL ADVICE

25. Sections 1-4 of this document provide a context within which the SBSTTA will implement its terms of reference and carry out its medium-term programme of work. It is worth reemphasizing (see paragraph 6 here that the activities in the work programme of SBSTTA should be in harmony with the objectives of the Convention as stated in Article 1: the conservation of biological diversity; the

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sustainable use of its components; and the fair and equitable sharing of the benefits arising out of the utilization of genetic resources. For example, the task of advising on technology transfer relating to conservation and sustainable use of marine biodiversity should be undertaken within the context of conservation and sustainable use and promoting the fair and equitable sharing of benefits arising from use of marine genetic resources. The rationale provided below for each of the activities that may become part of the medium-term programme of work for the SBSTTA should be understood to be within the context of the Convention and its objectives.

5.1 Considerations for the SBSTTA's Work Programme

26. Based on the SBSTTA's mandate, the following tasks may be considered for the coastal and marine component of its medium-term programme of work:

- (a) periodic assessments of the status of marine biological diversity;
- (b) identification of components and marine biological diversity under threat;
- (c) advising on technology transfer relating to conservation and sustainable use of marine biodiversity;
- (d) advising on international cooperation in marine and coastal research and development;
- (e) assessments of the effectiveness of the measures taken under the auspices of the Convention;
- (f) advising on scientific, technical and technological aspects of cooperation with other Conventions, in particular UNCLOS and those Conventions related to marine biodiversity conservation and sustainable use (eg, RAMSAR, CMS, CITES, and others);
- (g) monitoring and advising on the scientific and technological aspects of the marine and coastal components of: the deliberations of the third session of the Commission on Sustainable Development; and the preparations for the Special Session of the General Assembly on Agenda 21; and
- (h) providing advice on actions that Parties can take in the implementation of their own national biodiversity action plans and strategies in accordance with Article 6 of the Convention.

27. The SBSTTA will need to consider the most appropriate means to carry out its work programme on marine and coastal biodiversity (see *Modus Operandi*...UNEP/CBD/SBSTTA/1/2). Briefly, it is unlikely that the SBSTTA would itself be able to engage in gathering primary information or formulating advice to the Conference of the Parties on marine and coastal biological diversity. It will therefore need to draw on data and other information that is made available to it from other sources or by making arrangements for the necessary information to be compiled intersessionally and prepared for deliberation by the SBSTTA. Options for conducting intersessional work include convening *ad hoc* panels of the SBSTTA; establishing collaborative arrangements with bodies undertaking similar work; arranging for information to be compiled on a voluntary basis from governments or other institutions; and charging the Secretariat of the Convention with compiling information itself. The SBSTTA should bear in mind that any of these decisions will have budgetary implications that will need to be reflected in the budget the COP adopts at its second meeting. An incongruity between the SBSTTA's tasks and *modus operandi* on the one hand, and the adopted budget on the other, will have obvious implications

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for the SBSTTA's ability to carry out its functions in this area.

28. Among the various options envisaged in UNEP/CBD/SBSTTA/1/2 for ensuring that the SBSTTA accomplishes its work in a timely fashion is the establishment of a limited number of panels of experts to consider specific issues relating to the work of the SBSTTA. At a meeting of the nominees to the Bureau of the first meeting of the SBSTTA, held in Geneva on 6-7 June 1995, it was suggested that one of these panels should address marine and coastal biological diversity. The SBSTTA may therefore wish to establish a Marine and Coastal Biological Diversity Advisory Panel which would be charged with overseeing the implementation of the tasks outlined in (a)-(g), paragraph 26.

29. It is suggested (UNEP/CBD/SBSTTA/1/2) that similar panels might be established for other issues, such as technology transfer and biological indicators. For each of these the SBSTTA may wish to recommend that, when appropriate, the issues of relevance to marine and coastal biodiversity be taken into account. A useful model for such an approach is that used by the Intergovernmental Panel on Climate Change in setting up its numerous working groups. Each of these working groups must ensure that the information it produces is in harmony with that produced by the other.

5.1.1 Periodic assessments of the status of marine biological diversity

30. Article 25, paragraph 2(a), of the Convention requires the SBSTTA to provide the scientific and technical assessments of the status of biological diversity. In order to accomplish this task with respect to marine biological diversity, the SBSTTA needs to (a) review scientific and technical literature and reports; (b) compile and synthesize the information relevant to the status of the conservation and sustainable use of marine biological resources; and (c) formulate requests for specific information from appropriate bodies with which the SBSTTA may enter into collaboration.

31. The periodic assessments of marine biological diversity could be approached and reported in a number of ways. The components of marine biodiversity to be assessed could be chosen in an *ad hoc* way at each meeting of the SBSTTA and then reported on when information about their status has been compiled and analyzed. Such analysis could also be reported in a regular publication.

32. Whatever approach the SBSTTA wishes to take for conducting and reporting on assessments of marine biological diversity, the substantive areas will be similar. Some suggested topic areas to be discussed for inclusion in the periodic assessments are:

(a) coastal systems: rocky intertidal and subtidal; sandy shores and mudflats; estuaries and wetlands; coral reefs, mangroves, sea-grass areas; subtidal shelves; coastal pelagic and basin systems;

(b) deep sea benthic systems: hydrothermal vents; submarine canyons; sea-mounts;

(c) open ocean pelagic systems: major basins (Pacific, Indian Ocean, Atlantic); enclosed and semi-enclosed seas (Mediterranean, Baltic, Black Sea, etc); tropics; sub-tropics; temperate; polar; etc.;

(d) specific marine organisms of concern: cetaceans, sirenians, corals, marine birds, sea-turtles, sponges, algae, etc.;

(e) direct threats to marine biodiversity and their consequences: pollution, habitat loss, alien species, coastal engineering, overexploitation, etc (see paragraph 10);

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(f) indirect threats to marine biodiversity: trade, economic policy, inadequate information, legal and institutional systems ; and

(g) other areas and special topics such as communities, genes, genomes, seascapes and physiologically active substances from marine organisms.

During the next biennium, the SBSTTA may wish to consider giving priority to producing a general overview of the status of marine and coastal biological diversity which would form the basis for setting priorities for further work.

33. As indicated in UNEP/CBD/SBSTTA/1/2, paragraph 9 and above, the SBSTTA would not itself be able to undertake the compilation of the primary data that it needs in order to complete its tasks. Instead, the SBSTTA should focus on reviewing material and assessing data and analyses from competent national, regional and international organizations and institutions. It is therefore anticipated that the SBSTTA would develop an extensive collaborative network involving a number of these national, regional and international organizations and institutions.

34. Article 7 of the Convention requires each Contracting Party to identify and monitor components of biological diversity relevant to the indicative list of categories provided in annex I of the Convention, which includes ecosystems, habitats, species, communities, genes and genomes. In accordance with Article 26 of the Convention, "Each Contracting Party shall, at intervals to be determined by the Conference of the Parties, present to the Conference of the Parties, reports on the measures which it has taken for the implementation of the provisions of [the] Convention...". The Conference of the Parties will consider, at its second meeting, the form and interval of reporting. Given the priority the Conference of the Parties has accorded to marine biological diversity, the SBSTTA may wish to suggest to the Conference of the Parties the kind of scientific and technical information on marine and coastal biodiversity that may be included in national reports. If the COP chooses to focus national reports on specific topics, the SBSTTA may wish to advise the COP that marine and coastal biological diversity be accorded high priority.

35. The SBSTTA may wish to establish collaborative linkages with the following competent regional and international bodies concerned with marine and coastal biological diversity assessment:

(a) those regional marine conventions that have or are developing protocols on marine species and marine protected areas (examples are the Mediterranean, Pacific, East Africa, South Asia);

(b) the United Nations Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection (GESAMP), which will most likely establish a working group on marine biological diversity;

(c) the Species Survival Commission and the Commission on National Parks and Protected Areas of the International Union for the Conservation of Nature, which have specialist and working groups that review the status of various marine species and habitats a continuing basis;

(d) those Conventions, such as the Whaling Convention, the Migratory Species Convention, CITES, etc., that are concerned with species. The status of a number of species is kept under review through the work of these conventions;

(e) intergovernmental organizations such as IOC, UNESCO, FAO and others that have

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programmes concerning the assessment and management of marine habitats such as coral reefs, mangroves and seagrasses;

(f) the International Centre for Living Aquatic Resources, which is establishing a data base on coral reefs world wide.

36. In order to help fulfill its responsibility to provide assessments on the status of marine biological diversity, the SBSTTA may wish to propose that a review be made of existing programmes that are focussed on the status of marine biological diversity. The SBSTTA could then recommend these programmes with which the Convention might establish collaborative linkages. This work might be commissioned to the Marine and Coastal Biological Diversity Advisory Panel referred to in paragraph 28 above.

5.1.2 Assessments of the effectiveness of the measures taken under the auspices of the Convention

37. Under Article 25, paragraph 2 (b), of the Convention, the SBSTTA is to prepare scientific and technical assessments of the types of measures taken in accordance with the provisions of the Convention. The SBSTTA will therefore need to:

(a) prepare a compilation of measures reported on by governments, in accordance with Articles 8, 9, 10 and 26, which calls for each Contracting Party "to present to the Conference of the Parties reports on measures which it has taken for the implementation of the provisions of the Convention and their effectiveness in meeting the objectives of this Convention";

(b) compile the measure taken within the framework of other related international conventions and legal instruments; and

(c) on the basis of these two compilations, undertake an evaluation of the effectiveness of the measures taken in meeting the objectives of the Convention.

38. Evaluating the effectiveness of measures will be a complex task because: (i) it is doubtful that there will be conformity in the approaches that have been used to assess the effectiveness of measures; and (ii) these measures will be focussed on a very wide variety of marine and coastal biodiversity components. Therefore, as a preliminary step in addressing this task, the SBSTTA may wish to charge the suggested panel on marine and coastal biological diversity with designing the scope and the approach of the assessment. This would be a useful exercise not only for the evaluation itself, but also for the Conference of the Parties in its deliberations about a mechanism for considering national reports.

39. The SBSTTA may also wish to advise the Conference of the Parties on use of various methods for assessing the effectiveness of measures taken to implement the Convention. The use of indicator species for determining the status of marine biological diversity is an example of these methods. An *ad hoc* panel on biological indicators could be charged with compiling and reporting on methodological approaches for assessing the effectiveness of measures taken concerning marine biological diversity (UNEP/CBD/SBSTTA/1/2, paragraph 32 refers). This responsibility could also be given to the suggested Marine and Coastal Biological Diversity Advisory Panel.

40. Since there are a number of global and regional conventions concerned with different components of marine and coastal biological diversity, the SBSTTA may wish to enter into collaborative arrangements with some of them for the purpose of fulfilling the task of assessing the

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effectiveness of measures. These should at least include:

- (a) the regional marine conventions;
- (b) the 1982 United Nations Convention on the Law of the Sea (UNCLOS);
- (c) the Convention on Migratory Species;
- (d) the International Convention on Whaling;
- (e) the Convention on international Trade in Endangered Species (CITES);
- (f) the Convention on Wetlands of International Importance Especially as Waterfowl Habitat (RAMSAR);
- (g) the Framework Convention on Climate Change;
- (h) the International Convention for the Prevention of Pollution from Ships (MARPOL); and
- (i) various fisheries agreements (in particular those associated with highly migratory and transboundary stocks).

41. The SBSTTA may wish assign the responsibility for making proposals for collaboration to the proposed panel on marine and coastal biological diversity.

5.1.3 Identification of Promoting and Advising on Technology Transfer

42. Article 25, paragraph 2 (c), of the Convention requires the SBSTTA to identify innovative, efficient, and state-of-the-art technologies and know-how relating to the conservation and sustainable use of biological diversity and advise on the ways and means of promoting development and/or transferring such technologies. The Secretariat paper UNEP/CBD/SBSTTA/1/5 (Ways and Means to Promote and Facilitate Access to, and Transfer and Development of Technology) provides the SBSTTA with an analysis of this task and suggests various options for its accomplishment.

43. In order to accomplish this task with respect to marine and coastal biodiversity, the SBSTTA would undertake a survey of marine activities involving technology transfer (eg: mariculture, fishing techniques, marine pollution monitoring and control, survey methodology) and identify those technologies that promote the conservation and sustainable use of marine and coastal resources including, as appropriate, technologies of indigenous and local communities. Annex II presents a more complete list of areas in which the SBSTTA may wish to provide advice to the Conference of the Parties. The SBSTTA may wish to suggest that this task is given to the Marine and Coastal Biological Diversity Advisory Panel. Alternatively, the SBSTTA might suggest that the COP include a marine and coastal component in the annual consideration of technology transfer, or that this component be included in the terms of reference of a potential panel on technology transfer.

5.1.4 Advice on scientific programmes and international cooperation in research and development related to conservation and sustainable use of biological diversity

44. Under Article 25, paragraph 2 (d), of the Convention, the SBSTTA is to provide advice on scientific programmes and international cooperation in research and development related to conservation and sustainable use of biological diversity. In order to accomplish this with respect to the marine and coastal environment, the SBSTTA will have to conduct a comprehensive survey of scientific programmes and international cooperation in research development.

45. On the basis of such a survey, the SBSTTA would then identify existing gaps and recommend areas of priority for international cooperation in research and development related to conservation and

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sustainable use of marine and coastal biological diversity. The SBSTTA may wish to consult intergovernmental and other institutions involved in scientific programmes and international cooperation on marine issues. Such institutions may include *inter alia*:

- (a) the Intergovernmental Oceanographic Commission (UNESCO);
- (b) the Ocean and Coastal Areas Programme of UNEP;
- (c) the Fisheries Division of FAO;
- (d) the Marine Science Division of Unesco;
- (e) the International Council for the Exploration of the Sea;
- (f) the International Council for the Scientific Exploration of the Mediterranean;
- (g) the International Laboratory for Marine Radioactivity (IAEA);
- (h) the International Council of Scientific Unions;
- (i) the International Geosphere-Biosphere Programme--Land-Ocean Interactions in the Coastal Zone Project;
- (j) the European Science foundation and the Commission for European Communities;
- (k) the Scientific Committee on Ocean Research.

46. The SBSTTA may wish to charge the possible Marine and Coastal Biological Diversity Advisory Panel with the task of: (i) undertaking a survey of programmes for scientific research and international cooperation; and (ii) advising the SBSTTA on issue areas in which research on marine and coastal biological diversity should be given priority.

47. The SBSTTA may also wish to consider the elements of the agenda for scientific and technological research relevant to the conservation and sustainable use of biological diversity proposed by the Open-ended Intergovernmental Meeting of Scientific Experts on Biological Diversity (UNEP/CBD/COP/1/16, annex X).

5.1.5 Cooperation with other conventions, in particular UNCLOS

48. The work programme of the Conference of the Parties specifies that it should "consider the relationship with biodiversity related conventions; [and] identify approaches to and areas for cooperation (UNEP/CBD/COP/1/13; paragraph 15 e); and consider the relationship of the [United Nations] Convention on the Law of the Sea with specific reference to measures for conservation and sustainable use of marine biological resources." Section 3 of this note discusses the substantive relationship between the Convention and other conventions, including UNCLOS.

49. In order to advise the Conference of the Parties on areas for and approaches to cooperation in the marine and coastal realm, the SBSTTA will have to draw upon a detailed analysis of the relationship between the Convention and other biodiversity-related conventions, including UNCLOS, as well as an analysis of the progress in implementing these conventions. This would allow the SBSTTA to identify commonalities and differences in substantive issues and, therefore, possibilities for collaboration. A number of in-depth analyses of UNCLOS have been undertaken already by the Commission on Environmental Law of the International Union for the Conservation of Nature, the United Nations Division of Ocean Affairs and the Law of the Sea, the Commission on Ocean Law, the International Ocean Institute, a number of law schools, and others. Similarly, a number of reviews of conservation related conventions have been produced by the Commission on Environmental Law, the Environmental Law and Institutions Programme Activity Centre of UNEP, and others. The SBSTTA may wish to note the preliminary study that is being carried out by the Secretariat for the second meeting of the Conference of the Parties and that analyzes specific conventions to explore the potential

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cooperation.

5.1.6 The Commission on Sustainable Development and the Special Session of the General Assembly to Review Implementation of Agenda 21

50. The work programme of the Conference of the Parties specifies that the COP will consider the outcome of the third session of the Commission on Sustainable Development (CSD) on "biodiversity-related" matters (UNEP/CBD/COP/1/13; paragraph 15, d) and prepare the Special Session of the General Assembly to review implementation of Agenda 21.

51. In order to ensure that marine and coastal biodiversity issues are included in the perspective of the Convention, the SBSTTA may wish to consider its contribution on marine and coastal biological diversity to be included as input by the COP to the Special Session of the General Assembly, to be held in 1997, on the assessment of the implementation of Agenda 21, including Chapter 17 on the protection of oceans and all kinds of seas.

52. At its fourth session in 1996, the CSD will also review Agenda 21, Chapter 17. The SBSTTA may therefore wish to suggest to the Conference of the Parties that the deliberations of the CSD on Chapter 17 be taken into account in the elaboration of the SBSTTA programme of work on marine and coastal biological diversity.

53. Under Article 25, paragraph 2 (e), of the Convention, the SBSTTA is to respond to scientific, technical, technological and methodological questions that the Conference of the Parties may put to it. The SBSTTA may wish to recommend that any such tasks concerning marine and coastal biological diversity be given to the possible Marine and Coastal Biological Diversity Advisory Panel.

5.1.7 Advising governments on national actions to conserve and use marine and coastal biological diversity sustainably

54. Article 6 of the Convention on General Measures for Conservation and Sustainable Use requires that each Contracting Party shall, in accordance with its particular conditions and capabilities:

(a) develop national strategies, plans or programmes for the conservation and sustainable use of biological diversity or adapt for this purpose existing strategies, plans or programmes which shall reflect, *inter alia*, the measures set out in this Convention relevant to the Contracting Party Concerned; and

(b) integrate, as far as possible and as appropriate, the conservation and sustainable use of biological diversity into relevant sectoral or cross-sectoral plans, programmes and policies.

55. The SBSTTA may wish to formulate a set of recommendations and guidelines that governments can follow in order to carry out these obligations under the Convention. These recommendations and guidelines could, for example, address the following issues:

- (a) identification and monitoring of marine and coastal biodiversity components;
- (b) developing strategies for conservation and sustainable use, including ecosystem and habitat focussed approaches instead of single species approaches;
- (c) bioprospecting of marine taxa and genera that might yield new classes of biologically active substances;

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- (d) mechanisms for managing and benefitting from access to marine and coastal genetic resources;
- (e) research and training;
- (f) education and awareness activities;
- (g) impact assessment;
- (h) community approaches to managing marine resources and marine reserves;
- (i) ways and means of identifying components of biological diversity under threat and actions that could be taken under the Convention;
- (j) scientific and technical cooperation; and
- (k) transfer of technology.

56. UNEP/CBD/SBSTTA/1/4 presents proposals for alternative ways and means for taking action to identify components of biodiversity under threat and action that could be taken under the Convention. The SBSTTA may wish to recommend to the Conference of the Parties that marine and coastal biological diversity components be taken into account in following up on any recommendations adopted by SBSTTA and related to the components of biological diversity under threat. Scientific and technical cooperation and transfer of technology are discussed under sub-sections 5.3 and 5.4.

5.2 Summary of specific tasks suggested for inclusion in the SBSTTA medium-term work programme

57. The tasks suggested for the medium-term work programme of the SBSTTA are:

A. Periodic assessments of the status of marine biological diversity

- (i) Formulate a plan for conducting periodic assessments of marine biological diversity. The plan should include a list of priority topics to be reviewed; a work plan and time-table for undertaking the reviews; and a programme for reporting on and publishing the results;
- (ii) On the basis of a review of various options, make recommendations on establishing a network of cooperative agreements with other international organizations, governments or institutions for conducting some or all of the periodic assessments;
- (iii) Formulate recommendations to the Conference of the Parties on the information which countries should include in their national reports on marine and coastal biological diversity;
- (iv) Formulate recommendations to the Conference of the Parties on the "form and interval of reporting" from the point of view of conducting the periodic marine and coastal biodiversity assessments;
- (v) Review scientific and technical literature and reports on the status of marine and coastal biological diversity, compile and synthesize the information gathered in the reviews and prepare reports within the agreed framework for reporting. Priority should be given to drafting a broad assessment of the status of marine and coastal biological diversity with the aim to establish priorities for conducting further assessments.

B. Assessments of the effectiveness of the measures taken under the auspices of the Convention for conservation and sustainable use of marine and coastal biodiversity

- (i) Agree on the scope and the approach to be taken in the assessment, including a consideration of methods for assessment (eg, use of indicator species);
- (ii) Assemble a compilation of measures taken by Parties under the auspices of the Convention;
- (iii) Assemble a compilation of measures taken within the framework of other related conventions and legal instruments;
- (iv) Evaluate the effectiveness of various measures taken to meet the objectives of the Convention on the conservation and sustainable use of marine and coastal biological diversity;
- (v) Advise the Conference of the Parties on other conventions with which the Convention might seek linkages for the purpose of evaluating the effectiveness of measures taken under the Convention.

C. Technology Transfer

- (i) Undertake a review of innovative, efficient and state-of-the-art technologies and know-how relating to the conservation and sustainable use of marine and coastal biological diversity;
- (ii) Formulate recommendations on the ways and means of promoting the development and transfer of such technologies in coordination with the COP activities related to technology transfer, including their annual review of the subject.

D. Scientific Programmes and International Cooperation

- (i) Undertake a comprehensive survey of scientific programmes and international cooperation in research and development related to conservation and sustainable use of marine and coastal biological diversity;
- (ii) On the basis of the survey, identify areas of commonality between the work programme of the Convention and these programmes. In addition, identify gaps and recommend areas which should be given priority in research and development concerning the conservation and sustainable use of marine and coastal biological diversity;
- (iii) Review and monitor the results of the Open-ended Intergovernmental Meeting of Scientific Experts on Biological Diversity and take these into account in making recommendations.

E. Cooperation with other Conventions, in Particular UNCLOS

- (i) Carry out a comprehensive analysis of the relationship between the Convention and UNCLOS, mainly by reviewing published information;
- (ii) Formulate a set of recommendations on areas of activity in which the Convention and UNCLOS might cooperate in pursuing common aims;

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- (iii) Carry out a comprehensive analysis of the relationship between the Convention and other biodiversity related legal instruments such as the regional seas protocols on species, CITES, RAMSAR, etc.;
- (iv) Formulate a framework that could be used as the basis on which the Biological Diversity Convention and other conventions might cooperate:
- (v) On the basis of these exercises, explore the possibility of establishing a coordinating mechanism that involves UNCLOS and those other conventions that might enter into collaboration with the Convention and make recommendations to the Conference of the Parties on the best way to proceed.

F. Commission on Sustainable Development and the Special Session of the General Assembly on Implementation of Agenda 21

- (i) Monitor and analyze the outcome of the third session of the CSD on "biodiversity related matters" with respect to marine and coastal biological diversity;
- (ii) Monitor and analyze the outcome of the CSD deliberations on the "Oceans" chapter of Agenda 21 with respect to marine and coastal biological diversity. Suggest to the Conference of the Parties that concern for the review of the CSD on "Oceans" should be incorporated into its own work programme;
- (iii) Prepare the possible contributions of the COP on marine and coastal biological diversity for the Special Session of the General Assembly concerning marine and coastal biological diversity issues in the further implementation of Agenda 21.

G. Advise on compliance with Article 6 of the Convention

- (i) Develop a plan for formulating a series of recommendations and guidelines that could be used by governments in fulfilling obligations under Article 6 of the Convention. In consultation with the Conference of the Parties, implement the plan;
- (ii) Formulate recommendations on the ways and means of identifying components of biodiversity under threat and action that could be taken under the Convention and convey these to the Conference of the Parties.

6. CONCLUSION

58. Whatever the final content of the work programme, the SBSTTA will need to consider the implications of the marine and coastal biodiversity components on: (i) its *modus operandi*; and (ii) the budget the COP will adopt at its second meeting. In addition, the programme, *modus operandi* and budget must have enough flexibility to respond to questions which the COP may put to it under Article 25, paragraph 2 (e).

Annex I

EXAMPLES OF INTERNATIONAL AGREEMENTS RELATED TO MARINE AND COASTAL BIOLOGICAL DIVERSITY

PROTECTION AND PRESERVATION OF THE MARINE ENVIRONMENT

Antarctica

Antarctic Treaty, Washington (1959).

Protocol on Environmental Protection, Madrid (1991).

Europe

Convention for the Protection of the Marine Environment of the North East Atlantic, Paris (1992).

This agreement supersedes the 1974 Paris Convention on land-based sources and the 1972 Oslo Convention on dumping. It includes a small segment of the Arctic Ocean.

Convention on the Protection of the Marine Environment of the Baltic Sea Area, Helsinki (1992).

This supersedes the 1974 Baltic Convention.

Convention for the Protection of the Mediterranean Sea against Pollution, Barcelona (1976).

Convention on the Protection of the Black Sea against Pollution, Bucharest (1992).

Middle East and North Africa

Regional Convention for Co-operation on the Protection of the Marine Environment from Pollution, Kuwait (1978).

Regional Convention for the Conservation of the Marine Environment of the Red Sea and the Gulf of Aden Environment, Jeddah (1982).

Africa

Convention for Co-operation in the Protection and Development of the Marine and Coastal Environment of the West and Central African Region, Abidjan (1981).

Convention for the Protection, Management and Development of the Marine and Coastal Environment of the Eastern African Region, Nairobi (1985).

South America and Pacific

Convention for the Protection of the Marine Environment and Coastal Areas of the South East Pacific, Lima (1981).

Convention for the Protection and Development of Natural Resources and Environment of the South Pacific Region, Noumea (1986).

Caribbean

Convention for the Protection and Development of the Marine Environment of the Wider Caribbean Region, Cartagena (1983).

Soft Law:

Arctic Environmental Protection Strategy, Rovaniemi (1991).

MARINE POLLUTION EMERGENCIES

Convention on the Protection of the Environment between Denmark, Finland, Norway and Sweden, Stockholm (1974).

Protocol concerning Co-operation in Combating Pollution of the *Mediterranean* Sea by Oil and Other Harmful Substances in Cases of Emergency, Barcelona (1976).

Protocol concerning Regional Co-operation in Combating Pollution by Oil and Other Harmful Substances in Cases of Emergency, *Kuwait* (1978).

Agreement on Regional Co-operation in Combating Pollution of the *South East Pacific* by Hydrocarbons and Other Harmful Substances in Cases of Emergency, Lima (1981), and 1983 Supplementary Protocol.

Protocol concerning Regional Co-operation in Combating Marine Pollution by Oil and Other Harmful Substances in Cases of Emergency (*Red Sea*), Jeddah (1982).

Protocol concerning Co-operation in Combating Oil Spills in the Wider Caribbean Region, Cartagena (1983).

International Convention on Oil Pollution Preparedness, Response and Cooperation, London (1990) - International Maritime Organization (IMO). (OPRC)

VESSEL SOURCE MARINE POLLUTION

International Convention on Civil Liability for Oil Pollution Damage, Brussels (1969), and 1976, 1984, and 1992 Protocols - IMO. (CLC)

International Convention relating to intervention on the High Seas in Cases of Oil Pollution Casualties, Brussels (1969), and 1973 Protocol - IMO. (INTERVENTION)

International Convention on the Establishment of an International Fund for Compensation for Oil Pollution Damage, Brussels (1971), and 1976, 1984, and 1992 Protocols - IMO. (FUND)

International Convention for the Prevention of Pollution from Ships and its 1978 Protocol, London - IMO. (MARPOL 73/78)

Annex I - Oil Discharges.

Annex II - Noxious Liquid Substance Discharges.

Annex III - Harmful Substances in Packaged Form and Containers.

Annex IV - Sewage Discharges.

Annex V - Garbage Discharges.

FISHING AND THE CONSERVATION OF MARINE LIVING RESOURCES

International Convention on the Regulation of Whaling, Washington (1946), and 1956 Protocol - International Whaling Commission (IWC).

Convention for the Establishment of an *Inter-American* Tropical Tuna Commission. Washington (1949). (IATTC)

Agreement to Reduce Dolphin Mortality in the Eastern Tropical Pacific Tuna Fishery, La Jolla (1992).

Interim Convention on Conservation of *North Pacific* Fur Seals, Washington (1957), and Protocols.

International Convention for the Conservation of *Atlantic* Tunas, Rio de Janeiro (1966), and 1984 and 1992 Protocols. (ICCAT)

Convention on Fishing and Conservation of the Living Resources in the *Baltic* Sea and Belts, Gdansk (1973).

Convention on the Conservation of *Antarctic* Marine Living Resources, Canberra (1980). (CCAMLR)

Convention for the Conservation of Salmon in the *North Atlantic* Ocean, Reykjavik (1982).

MARINE AND COASTAL SPECIALLY PROTECTED AREAS AND SPECIES

International Convention on the Regulations of Whaling, Washington (1946) - International Whaling Commission (IWC).

Interim Convention on Conservation of *North Pacific* Fur Seals, Washington (1957).

MARPOL 73/78 Annexes I, II, and V: special area provisions in relation to pollution by oil, noxious liquid substances in bulk, and garbage. Special areas have been designated in the *Mediterranean, Baltic Sea, Black Sea, Red Sea, the Gulf area, Gulf of Aden, North Sea, Antarctic, and Caribbean*.

Protocol concerning *Mediterranean* Specially Protected Areas, Geneva (1982).

Protocol for the Conservation and Management of Protected Marine and Coastal Areas of the South-East Pacific, Paipa (1989).

Annex II to the Protocol on Environmental Protection to the Antarctic Treaty: Conservation of Antarctic Fauna and Flora, Madrid (1991).

Annex II

**IDENTIFICATION OF STATE-OF-THE-ART TECHNOLOGIES AND THEIR
TRANSFER/REVIEW OF TECHNOLOGIES**

TECHNOLOGY	APPLICATION
Remote Sensing Satellite sensing including visible spectrum, infra-red and radar	Sea surface sensing of temperatures, status of phytoplankton, shallow water ecosystems, mangrove swamps, pollution, fishing vessel surveillance, cartographic data, communicating data from remote automated instruments
Air-borne sensing including photo/video, radar, laser, etc.	As above (except the latter) with finer resolution, capacity to penetrate deeper
Ship-borne sensing with side-scan and recording sonar	Detecting benthic impacts of trawls and dredges, locating "ghost" fishing gear for retrieval, monitoring coral reef rugosity as an index of reef health
Automated oceanographic stations and eco-bugs	For collecting, recording and (sometimes) transmitting environmental data including temperature, salinities, and many other potential parameters (an eco-bug is a small recording station for a specific goal)
Biodiversity data bases	Biodiversity data bases provide species, geographic and other information for conservation, sustainable use, and locating resources for new technologies, and GIS analyses (below). Source: museums, biological surveys and the literature
Geographic analysis GIS - <i>geographic information systems</i>	To explore and analyze relationships between various "layers" of mapped data, including conservation of biodiversity, fisheries management (Rubec and O'Hop 1995), integrated coastal area management, and research
GPS - global positioning systems	To provide precise location on the earth's surface for biological surveys, mapping, navigating, etc. Receivers can now link up to laptop computers and other small devices
EAGG - Equal-area global grid systems	Providing equal-sized units to facilitate geographic comparison (counties, states, islands etc. are unequal), to plan biological survey coverage (McAllister et al. 1994)
RAP - rapid assessment process, TAP - taxonomic assessment process, Gap, etc.	To identify potential protected areas/ecosystems using various kinds of species (RAP), taxonomic (TAP) and habitat data, in short (RAP) or longer time frames (McAllister 1994)
ATBI - all taxa biodiversity inventor	To carry out a complete census of species in an area, to better understand ecological relationships and sustainable use (Janzen and Hallwachs 1994)

TECHNOLOGY	APPLICATION
Species-area curves/ island biogeographic theory	To understand relationship between geographic area and number of species to plan better protected areas and sustainably manage biological resources
Communications Internet	To provide rapid communication capacity, to facilitate answering queries, to offer access to a wide variety of data bases, and to support regional and global networks for conservation, sustainable use and research
WWW - World Wide Web	As above but with added capacity to transmit images, video clips and sounds
CD ROMs	To increase awareness, assist education and training, share research data, provide access to voluminous documentation with search capacity, lower library costs, provide lower cost of illustrated books as in the ETI program (Schalk and Los 1994), to enable modelling with large data sets as in Alada 21
Fisheries - TEDs - turtle excluding devices	Conservation. Prevent the unintended capture of sea turtles in shrimp trawls
Fish grates	Conservation, sustainable use and reduction of labour costs. Grates help exclude fishes from shrimp trawl catches
FADs - fish attracting devices	Attract and concentrate mobile fishes to enhance harvesting
Artificial reefs	Attract and concentrate fishes & invertebrates. May permit development of surplus larvae from real reefs. May provide new habitat, help exclude mobile gear from small-scale fishers' grounds. May also be ineffective/harmful to fisheries
Bioremediation	Using bacteria, algae and other species to clean up petroleum, domestic and industrial pollution
Eco-labelling	The labelling of products, such as those of capture and culture fisheries, that have been harvested or cultured in a sustainable manner without impacts for other species or ecosystems. identifying products for better marketing and facilitating consumer choice
ICAM - integrated coastal area management	To provide better management by integrating resources, ecosystems and people into the management system
LME - large marine ecosystems, and Seascapes	LMEs - to provide better management by managing environmentally uniform fisheries geographic units (Sherman et al. 1993). Seascapes - to improve biodiversity protection by including ecologically linked units, in place of isolated ones

TECHNOLOGY	APPLICATION
Co-management	To improve fisheries management by involving fishers with fisheries scientists in collecting information, establishing quotas and other regulations, enforcement, etc.
TEK - traditional ecological knowledge and know-how	Traditional societies have built up knowledge on marine resource use, harvesting, fish behavior, migration, reproduction, etc. that complements scientific knowledge (Johannes 1981)
Submersibles, manned and unmanned	To carry out biodiversity and fisheries research. To enable undersea ecotourism
Genetics DNA and mtDNA analysis, genetic engineering and fingerprinting	Stock identification, discrimination of hatchery and wild fish, identification of fillets in illegal catches, helping discover and classify new species (Wirgin et al. 1994). Develop new varieties for aquaculture, combining genes from related or distant species. Discover the country of origin of genetic resources to prevent evasion of sharing of benefits
Cryopreservation	To conserve genetic resources for research, conservation, and biotechnological development (Harvey 1994)