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REPORT OF THE

STUDY GROUP ON ECOSYSTEM ASSESSMENT AND MONITORING

ICES Headquarters
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International Council for the Exploration of the Sea

Conseil International pour l'Exploration de la Mer

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TABLE OF CONTENTS

Section **Page**

EXECUTIVE SUMMARY 1

1 OPENING OF THE MEETING 1

2 ADOPTION OF THE AGENDA 1

3 ARRANGEMENT FOR THE PREPARATION OF THE REPORT 1

4 REPORTS OF ACTIVITIES IN OTHER FORA OF INTEREST TO THE MEETING 2
4.1 Global International Waters Assessment (GIWA) 2
4.2 GEF/Baltic Sea Regional Project 2
4.3 Report on the Status of Fisheries and Related Environment of Northern Seas 3

5 PRESENTATION OF SOME RESULTS FROM THE SGEAM 2000 DISCUSSION OF THE SCIENTIFIC FRAMEWORK FOR AN ECOSYSTEM APPROACH FOR SUSTAINABLE USE AND PROTECTION OF THE MARINE ENVIRONMENT 4
5.1 Presentation of the work conducted in SGEAM and WGECO. 4
5.2 Further development of a framework for integrated ecosystem assessment and management and implementation of EcoQOs 4
5.2.1 Recommendation from SGEAM 2000 4
5.2.2 Framework for monitoring, assessment, advice and management 5

6 REVIEW OF THE EXTENT TO WHICH HOLISTIC ENVIRONMENTAL ASSESSMENTS ARE SUPPORTED BY RESULTS FROM MONITORING PROGRAMMES 8
6.1 OSPAR QSR 2000 and HELCOM Fourth Periodic Assessment 8
6.2 Examples of Practical Ecosystem Management Use of Monitoring 8

7 REVIEW THE ENVIRONMENTAL ASSESSMENTS CONDUCTED BY OSPAR, HELCOM, AND EEA 13
7.1 OSPAR QSR 2000 13
7.2 HELCOM Fourth Periodic Assessment 13
7.3 EEA Assessment 14

8 DISCUSSION AND CONTRIBUTION TO THE FURTHER DEVELOPMENT AND IMPLEMENTATION OF ECOLOGICAL QUALITY OBJECTIVES IN GENERAL, AND IN PARTICULAR FOR MARINE MAMMALS AND SEABIRDS 14

9 ANY OTHER BUSINESS 15

10 CONSIDERATION AND APPROVAL OF RECOMMENDATIONS 15

11 PROPOSAL FOR A FURTHER MEETING 17

12 CONSIDERATION AND APPROVAL OF THE MEETING REPORT 17

13 CLOSURE OF THE MEETING 17

ANNEX 1: LIST OF PARTICIPANTS 17

ANNEX 1: LIST OF PARTICIPANTS 18

ANNEX 2: AGENDA 19

ANNEX 3: APPLICATION OF ENVIRONMENTAL INDICATORS FOR GLOBAL INTERNATIONAL WATERS ASSESSMENT (GIWA) 20

ANNEX 4: DEVELOPING INDICATORS FOR ECOSYSTEM QUALITY ASSESSMENT (WORKING DOCUMENT) 70

EXECUTIVE SUMMARY

SGEAM was introduced to recent developments within the work of GIWA and the GEF/Baltic Sea Regional Project. The Study Group noted with enthusiasm the assessment made by ICES for the Northern Seas in a report to the Nordic Council of Ministers. This work was seen in contrast in particular to the OSPAR QSR 2000, which suffers from inconsistency in its presentation and a lack of use of available information. Therefore, among others, SGEAM recommends that ICES is best placed to coordinate via ACE reports on ecosystem assessment to OSPAR. The short popular version of the HELCOM Fourth Periodic Assessment, available for SGEAM, was noted for the positive development in terms of its contents.

The Study Group developed further the framework for an ecosystem-based management that was presented in SGEAM 2000 and concluded that Regional Ecosystem Groups (REGs) should be established within the framework of ICES. Taking into account the work already done and proposed in the Baltic, the Study Group proposes that ecosystem-based management could be introduced for the Baltic.

1 OPENING OF THE MEETING

The second meeting of the Study Group on Ecosystem Assessment and Monitoring (SGEAM) was opened by the Chair, Lars Føyn, at 10.00 hrs on 30 April 2001 at the ICES Headquarters in Copenhagen. The ICES Environment Adviser, Janet Pawlak, welcomed the Group to the ICES Headquarters. The Chair described the ongoing activity of the Working Group on Ecosystem Effects of Fishing Activities (WGECO) and highlighted that a planned joint session between SGEAM and WGECO was scheduled in order to facilitate an exchange of views. It was noted that some of the nominated members of SGEAM are also members of WGECO.

As already mentioned in his letter to the members of SGEAM, the Chair expressed some worries about the confusion of membership in relation to the actual participation of interested scientists and the official ICES list. For the purpose of further communication only with interested scientists, the Chair explained that it is important to know who is interested in receiving documents about the group and hoped that those who are on the official list of members, but have not responded to information about SGEAM activities, should at least inform their national Delegates in order to have their names withdrawn from the list. The list of active participants is given in Annex 1.

Terms of Reference

At the 87th Statutory Meeting, SGEAM was given the following terms of reference (C. Res. 2000/2E05):

a) continue, and complete, the review of the extent to which holistic environmental assessments (e.g., OSPAR QSR 2000, HELCOM Fourth Periodic Assessment) are supported by results from monitoring programmes;

b) review the environmental assessments conducted by OSPAR, HELCOM, and EEA;

c) contribute to the further development and implementation of Ecological Quality Objectives in general, and in particular for marine mammals and seabirds [OSPAR 2001/2.2 and 2.3].

SGEAM will report by the designated deadline for the attention of the Marine Habitat Committee and the Advisory Committees to be decided by MCAP.

2 ADOPTION OF THE AGENDA

The draft agenda (Annex 2) was adopted. It was decided that agenda item 5 should be dealt with during a joint session between SGEAM and WGECO.

3 ARRANGEMENT FOR THE PREPARATION OF THE REPORT

The participants were asked to take proper notes of the discussion and it was agreed that the task of writing should be decided upon when dealing with the various sections. The time schedule for the preparation and finalisation of the report were agreed as follows: 1) first draft presented at the morning session of the last day of the meeting and recommendation prepared and added before closing of the meeting; 2) the complete draft report sent via e-mail to the participants for comments no later than 7 May; 3) all comments have to be returned to the Chair no later than 21 May; 4) final version of the report to be sent to ICES before 23 May.

4 REPORTS OF ACTIVITIES IN OTHER FORA OF INTEREST TO THE MEETING

4.1 Global International Waters Assessment (GIWA)

The objective of the GIWA project, funded by the Global Environment Facility (GEF), UNEP and other donors, is to develop a comprehensive, strategic framework for the identification of priorities for remedial and mitigatory actions in international waters, designed to achieve significant environmental benefits at national, regional and global levels. The assessment will be organized in 66 sub-regions as basic units, grouped into nine mega-regions. A number of these sub-regions are similar to the designations for so-called Large Marine Ecosystems (LMEs).

A selection of GIWA-related documents was made available to SGEAM, including the GIWA Project Brief as approved by the GEF Council Meeting of November 1997, the Application of Environmental Indicators for GIWA including Criteria for Scoring Environmental Impacts, and the Impacts Table selected from the Baltic Test Team (BTT) Report.

Considering the relevance of GIWA, SGEAM noted that socioeconomic assessment aspects form an important component in accordance with the framework for an ecosystem approach to the management of marine ecosystems as earlier sketched by SGEAM with reference to integrated comprehensive assessments (ICES CM 2000/E:09). SGEAM also noted the major concerns and issues and the scoring of these from the draft "Reporting Table" as produced by the BTT in 2000. The scoring concerning environmental and socioeconomic aspects for "System 1" in the Baltic Sea indicated some preliminary proposals for the 22 issues associated with the five major concerns (see Annex 3). Although SGEAM has not taken a specific view as to the actual validity and details of these preliminary criteria and scorings, it believes that the general approach used by GIWA in this manner should be considered by the ICES entities that may be eventually charged with developing the indices for the comprehensive integrated assessments of geographic "regions", such as the periodic assessments of OSPAR and HELCOM. Similarly, SGEAM noted that the table of "Environmental and Socioeconomic Impacts of Water Related Major Concerns and Principal Issues", together with their "Potential Transboundary Consequence", could successfully be applied in such regional assessments, e.g., the Baltic region.

In conclusion, SGEAM believes that the general GIWA concept is encouraging and necessary, but notes that even in regions which have been well studied and where a long history of scientific advise has been provided, a significant challenge remains in moving from conservative quantitative sciences, organized in a sectorial manner towards a multidisciplinary integration of results as needed by "comprehensive assessments". Thus, although valuing the goals of GIWA, the group has significant reservations as to the practical ability of the project to tackle all the more demanding aspects (e.g., full socio-economic costing). This particularly applies to regions with countries in political and economic transition. Accordingly, SGEAM underlines that ICES should determine the extent to which it can contribute to a GIWA related assessment in all sciences areas.

The group also considered the developments occurring in several other fora (e.g., EEA and OECD) to develop indicators for ecosystem quality assessment. The principal aim of these indicators is to provide simple yet understandable and communicable measures for the wider public to be kept informed of ecosystem status and change. SGEAM emphasizes the importance of such indicators for communicating the scientific information and advice arising from ICES, and proposes that ICES give increased priority to the identification and extraction of relevant indicators concerning the status of important components of the ecosystem.

4.2 GEF/Baltic Sea Regional Project

SGEAM noted the development and current status of the Global Environment Facility/"Baltic Sea Regional Project' (GEF/BSRP) and the establishment of a GEF/BSRP Office headed by a Chair/Coordinator at ICES Headquarters. In particular, specific aspects of the project were considered, as discussed below.

Background

Continued degradation of the Baltic Sea ecosystem has affected the water quality, modified the biodiversity of the ecosystem, and impacted regional fisheries. The Baltic Sea is now an ecosystem under extreme stress. In response to this situation, the coastal countries initiated a Joint Comprehensive Environmental Action Plan (JCP) for the Baltic Sea region. It provides an environmental management framework for long-term restoration of the ecological balance of the Baltic Sea ecosystem through a series of preventive and curative actions in the region to be undertaken in a phased manner. Within this framework, the Governments of the recipient countries requested GEF assistance through UNDP and the World Bank for a regional project to support the objectives of the JCP.

The project

The objective of the GEF BSRP is to introduce ecosystem-based assessments to strengthen the management of the Baltic Sea coastal and marine environments through regional cooperation and targeted, transboundary marine and watershed activities. This will reduce impacts from non-point sources of pollution and increase sustainable biological production in the region. The proposed project supports the JCP and provides linkages with country activities. It is consistent with GEF global environment policy to contribute significantly to "reducing stress to [the] international waters environment" by integrating land and water resource management strategies that promote sustainable development. The project's long-term goal is for the two international regulatory commissions (HELCOM, Helsinki Commission; International Baltic Sea Fishery Commission, IBSFC) and ICES to utilize project-developed management tools for sustainable ecosystem management, and to contribute to the improvements in the social and economic benefits provided by coastal fishing and farming communities in the recipient countries.

Project components

The project has four major components and all will be implemented as an integrated activity coordinated by HELCOM as the principal executing agency:

1) The Baltic Sea Large Marine Ecosystem (BSLME) activities are managed by ICES. This component aims to enable the following activities: ecosystem-based assessments and management for the Baltic Sea; coordination and integration of the regional monitoring and assessment capacity; improved management practices to increase and sustain fishery yields and biological productivity of the BSLME; in the long term, improvement of the Baltic marine environment as well as the economic benefits and standard of living of the fishing and coastal communities.
2) The "Land and Coastal Management Activities" component is managed by HELCOM in conjunction with the Swedish University of Agricultural Sciences (SLU), and aims to: increase awareness of environmental issues related to agriculture among farmers and communities; invest in and implement environmentally responsible farm management practices; undertake demonstration projects in priority areas linked with the activities for agriculture; in the long term, improve the economic welfare and standard of living within the farming and coastal communities while reducing non-point source agricultural discharges.
3) "Institutional Strengthening and Capacity Building" is managed by HELCOM in cooperation with ICES and IBSFC and aims to: improve the "valuation of ecosystem goods and services"; strengthen local and regional decision-making and management capacity; and achieve a more integrated approach to ecosystem-based management of the BSLME.
4) "Project Management" is managed by HELCOM in cooperation with ICES and IBSFC and aims to: successfully implement the BSRP to achieve the stated development objective; provide support for the project management; fulfill accounting, auditing and reporting requirements; and perform project monitoring and evaluation for reporting to the World Bank

Strengthened regional management and technical capability will provide a series of beneficial outcomes, not only at the regional level, but also at the national and local levels, and will contribute to sustainable management of the Baltic Sea ecosystem. In March 2001, the GEF approved the project and its financial support of USD 18 million and additional funding sources should raise the budget to USD 40 million for the period 2001–2006.

4.3 Report on the Status of Fisheries and Related Environment of Northern Seas

In 1999, ICES was invited by the Nordic Council of Ministers (NCM) to contribute towards a feasibility project to develop an "information programme with the aim of providing consumers, as well as the public in general, with reliable information on fisheries, to enhance knowledge and public awareness including a report by ICES on Northeast Atlantic fish stocks." The area to be covered was the Baltic Sea, the North Sea and the Northeast Atlantic, and the areas of the Arctic without permanent ice cover (e.g., the Barents Sea). The NCM also included the West Greenland areas to the project. The report, published in February 2000 (Nord 2000:10), contains information on the effect of fisheries on the fish stocks and on the marine ecosystems. The impact of environmental conditions on the fish stocks is also considered, along with concentrations of contaminants in several species of fish and shellfish, and the occurrence of diseases in fish and shellfish.

SGEAM reviewed the report and concluded that it provides a very good basis of knowledge within the issues focused on, and has a good balance between style and layout as well as scientific substance. As such, the report can be considered as providing a significant step towards arriving at an integrated assessment involving fish, fisheries and relevant environmental factors. Using the current format, the report could be kept up-to-date by new data points, etc., on

an annual basis without substantial additional work as the information becomes available from the ICES Working Group system. Further, SGEAM noted that the NCM is considering contracting ICES to do this, in a move from a feasibility project to regular reporting of operational activities and their assessment. Part of the reason for this is that the current ACFM reports and its extracts are presented in a manner that is beyond the reach and understanding of the educated layperson, including politicians. Thus, SGEAM believes that there is a very important role for similar "assessments" that are clearly related to discernible and corroborated facts. The group firmly considers that there is an important place for timely and frequent "assessments" of this type, that can be provided in the electronic media on websites, at shorter time schedules (e.g., 12 months) than the full scale periodic assessments such as the QSRs and the HELCOM periodic assessments which are undertaken every 4–5 years.

5 PRESENTATION OF SOME RESULTS FROM THE SGEAM 2000 DISCUSSION OF THE SCIENTIFIC FRAMEWORK FOR AN ECOSYSTEM APPROACH FOR SUSTAINABLE USE AND PROTECTION OF THE MARINE ENVIRONMENT

5.1 Presentation of the work conducted in SGEAM and WGECO.

This agenda point was presented at the joint session between SGEAM and WGECO.

One of the main objectives addressed in the SGEAM 2000 report was the presentation of agreed definitions of "key" terms commonly used in ecosystem management texts. Without a common understanding and clear definitions it is very likely that misunderstandings will occur. SGEAM 2000 outlined a framework for an ecosystem approach to the management of the marine environment, and the intention of the SGEAM 2001 meeting was to follow up the previously developed concept. This was also undertaken to ensure that there was no overlap with the work of WGECO.

The Chair of WGECO, Jake Rice, presented the work the group had done in their meeting, which was running in parallel to the SGEAM meeting. With regard to SGEAM ToR c, this strongly overlapped with a ToR for WGECO on the setting of appropriate EcoQ/EcoQO indices for marine mammals and seabirds. Since these issues have been addressed also by other parties (WGSE and WGMMPH), WGECO approached its task by comparing the results produced by WGSE and WGMMPH with a more general EcoQO framework developed at the meeting. An important common property of the EcoQOs suggested was that they were all single-species metrics. WGECO was unable to suggest community or ecosystem properties that would be of any use as reference points for management.

As WGSE, WGMMPH, and WGECO have undertaken in-depth analyses towards the setting of EcoQs and EcoQOs, SGEAM therefore felt it was inappropriate to contribute at this level. Rather SGEAM concentrated on analyses of possible governance structures (which may effectively implement such limits) and which allow an increased number of stakeholders to participate in an adaptive management process (see Section 5.2). EcoQs and EcoQOs for birds and marine mammals are likely to receive attention from a very wide range of stakeholders, which will prove to be a difficult test for any management system.

5.2 Further development of a framework for integrated ecosystem assessment and management and implementation of EcoQOs

5.2.1 Recommendation from SGEAM 2000

The SGEAM 2000 report presented "a simplified framework for an ecosystem approach to the management of marine ecosystems in order to achieve sustainable use of ecosystem goods and services and the conservation of ecosystem integrity". Based on discussions about ecosystem management and the implementation of EcoQOs, the group recommended that Regional Ecosystem Groups (REGs) should be established within ICES. This also recognised the development of various classification schemes for coastal and transitional waters under European Directives. SGEAM 2000 recommended that the work in the REGs should focus on the following tasks:

1) Consider the general issue of integration of pertinent assessment information on the changing states of large marine ecosystems in the region, based on regional expertise;

2) Prepare periodic assessments of the status and trends in fish stocks and environmental conditions of the LMEs in the region with the emphasis on:

   a) climatic/physical driving forces, and

   b) biological (e.g., multispecies) interactions;

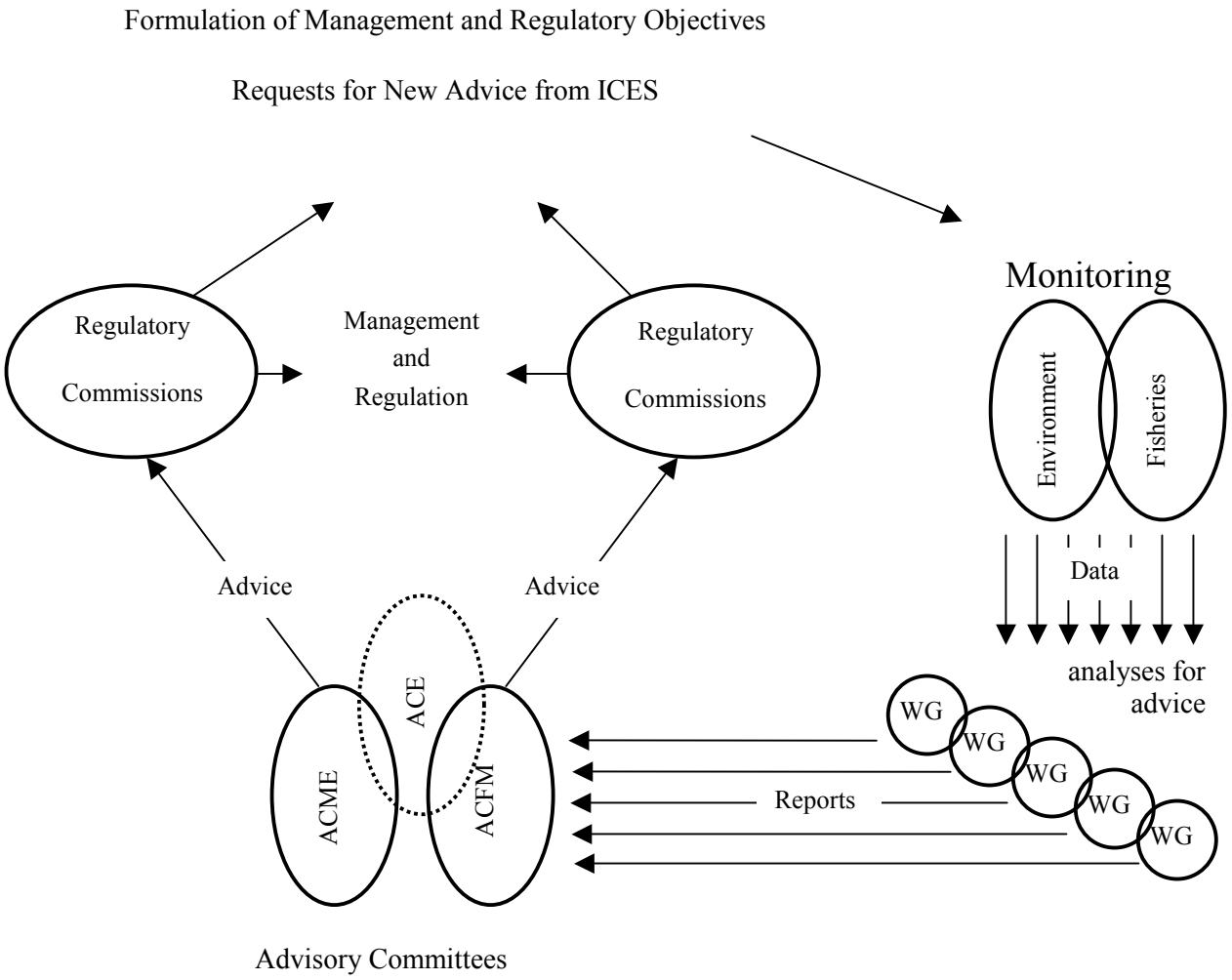
3) Contribute to environmental assessments and preparation of Quality Status Reports (QSRs) in cooperation with stakeholders, academic institutions, the public, and other organisations (e.g., EEA, OSPAR, AMAP, HELCOM).

5.2.2 Framework for monitoring, assessment, advice and management

In the 2000 SGEAM report a simplified framework was presented for an ecosystem approach to the management of marine ecosystems to achieve sustainable use of ecosystem goods and services and conservation of ecosystem integrity. At the 2001 SGEAM meeting, the group further considered elaborating more specific aspects of the framework of particular relevance to the further development of ICES.

ICES has been involved in a framework for the provision of scientific information and advice for many decades together with various stakeholders operating within the areas of fisheries and environment via the advisory committees (e.g., Advisory Committee on Fishery Management, ACFM and Advisory Committee on the Marine Environment, ACME) and their subsidiary entities. With a few exceptions—these being requests for advice between these areas—the process has been primarily separate for fisheries and for environment, as illustrated in Figure 5.2.2.1. At the end of 2000, the Council of ICES established an additional advisory committee, the Advisory Committee on Ecosystems (ACE), to handle the provision of ecosystem-related advice as described in the new Rules of Procedure (Rule 26). In essence, the new system recognizes the ongoing commitment to the long-standing types of requests from environmental and fisheries commissions via ACME and ACFM, respectively, whilst also developing a more integrated approach to cross-cutting issues via the new ACE.

Figure 5.2.2.1. Present ICES advisory structure.

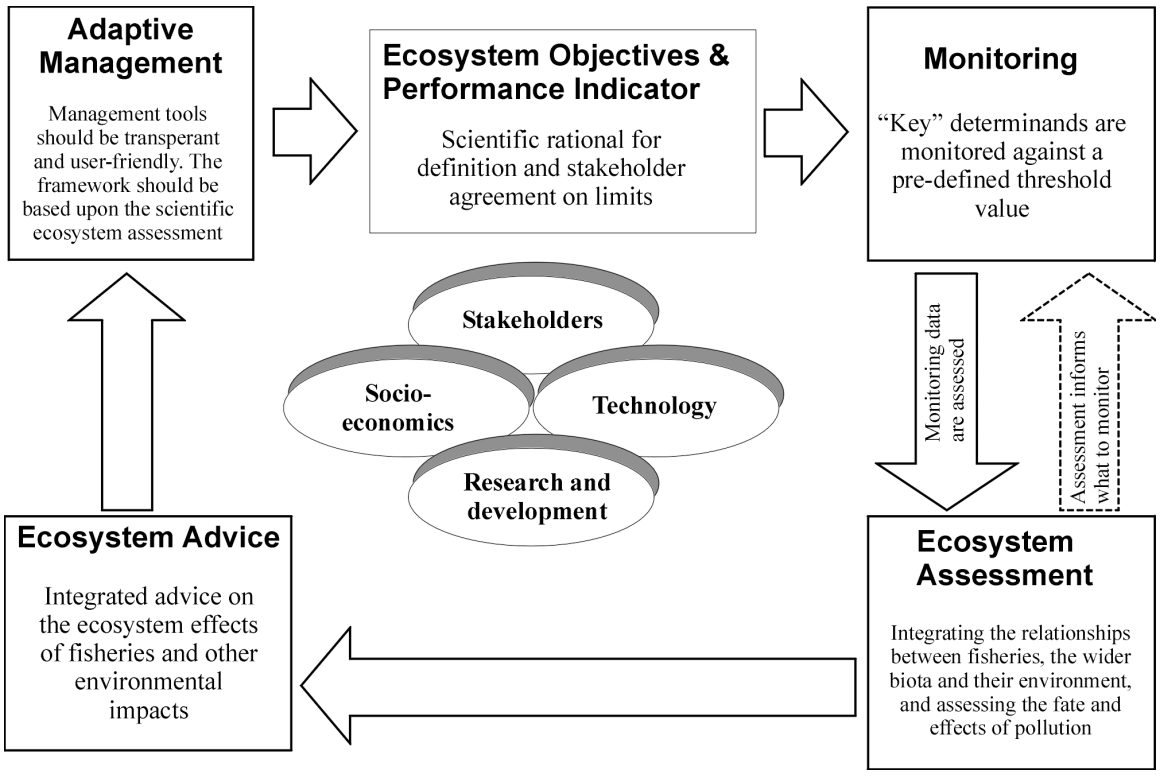


Up to the end of 200, the need for integrated advice was either dealt with by integration "bottom up" via the novel WGECO approach with multidisciplinary experts involved in a single Working Group with peer-review by one or more of the existing advisory committees, or by tasking several individuals working on a sectorial basis and applying the integration of information and knowledge submitted via the advisory committees themselves. There is a belief based on experience that it is very difficult to achieve successful integrated advice if this is not already happening at the assessment stage.

As of May 2001, ACE has not yet held its first meeting and has few working groups for which it is the parent committee. ACE can be expected to, *inter alia*, embark on a process of establishing a portfolio of working groups and a relevant quality assurance framework for ecosystem-related assessments. It is pertinent to note that ACE does not have an immediate externally driven client basis although it is expected that this will increase over the medium to long term. The question is raised as to what legitimate tasks ACE will address from the ICES viewpoint. Further, for the shorter term, ecosystem-based advice will still be requested by the existing regulatory commissions and the Member Countries, e.g., delivery of products to sectorial commissions, etc.

The SGEAM 2000 report and its framework figure recognises that managing the marine environment covers a wide variety of issues. The integrated management of these issues requires a coherent and transparent approach, and as a step towards delivering this within ICES Member Countries there are plans (for example, at a national level within the UK) to consider the integration of various monitoring and assessment programmes. An example of an overarching framework to implement such an approach was described in SGEAM 2000 and this is schematically shown in Figure 5.2.2.2. This describes a number of "key" thematic areas at a national level which, when linked (via the production of reports, consultation and the development of computer-based management tools), provides a transparent and auditable account of the scientific and regulatory decision-making process required to sustain marine ecosystem stakeholder values.

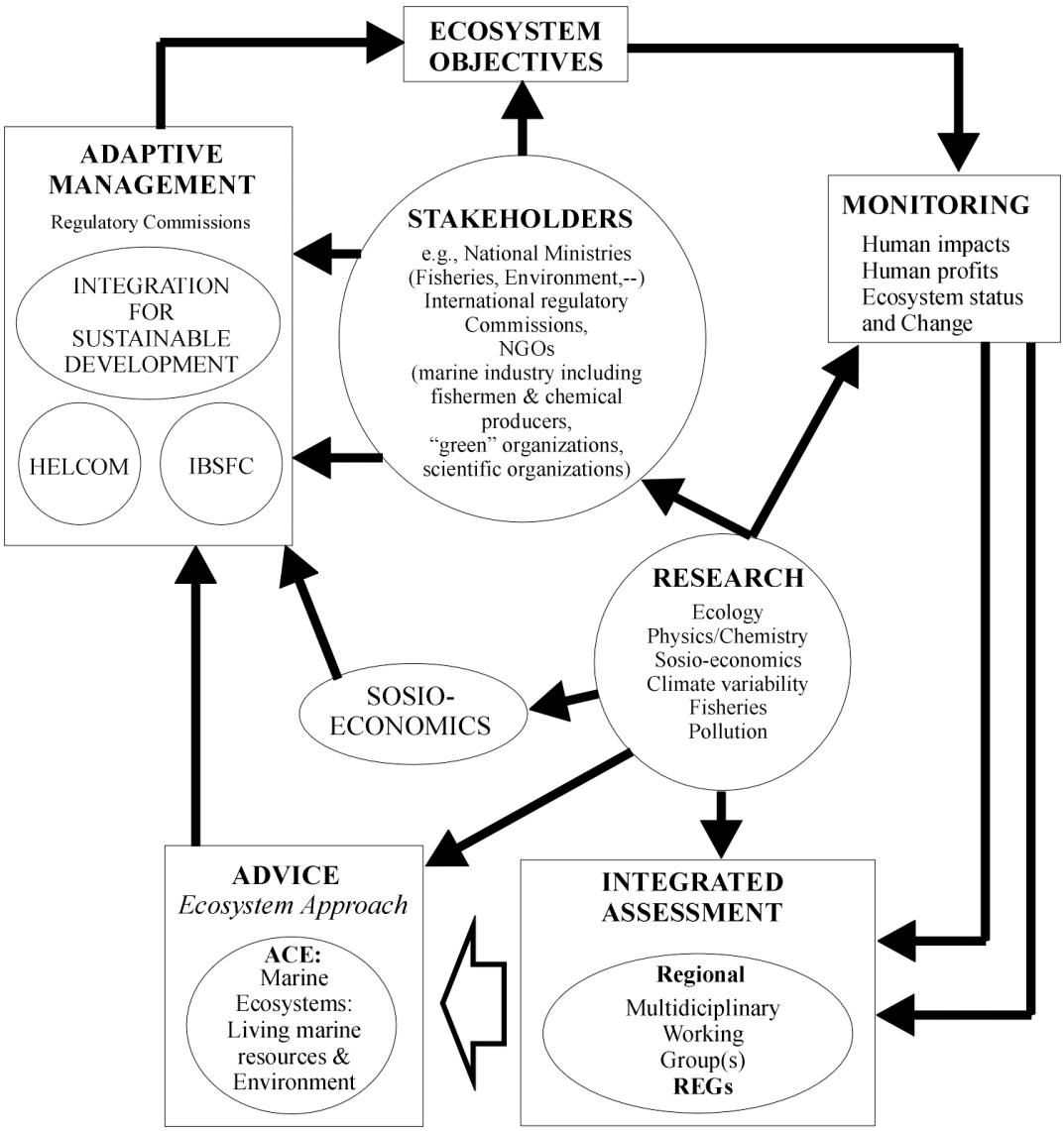
Figure 5.2.2.2. The flow of information required in an adaptive integrated management system to conserve the marine environment on a sectorial basis, e.g., within national assessment and monitoring programmes. The figure is based on the framework figure (Figure 5.2.4.1) presented in the SGEAM 2000 report.



The main operational development task for ACE appears to be to supervise the exploration and establishment of ecosystem assessment methods at an appropriate regional scale, which in the medium and longer term can support an ecosystem advisory role.

Taking the Baltic Sea as an example, a key benefit of establishing a multidisciplinary regional working group approach is the provision of integrated assessments, as sketched in Figure 5.2.2.3.

Figure 5.2.2.3. An example of an ecosystem based management framework for the Baltic Sea, where ICES is making a substantial contribution through ACE and a proposed Regional Ecosystem Group (REG).



The assessments should be underpinned by appropriate monitoring of ecosystem status and change, involving human impacts and human profits (economics); this requires full access to the necessary knowledge and information base. Connected with this is the need to develop and enhance the research basis of scientific disciplines in line with a number of the "outreach" arguments of the ICES Strategic Plan; this can only be facilitated by broader-based stakeholder participation in the overall framework.

ACE will also be expected to provide particular advice connected with parts of the wider "ecosystem status" assessment(s). This is the practical operational product outside of ICES. However, although integration of the advisory product can be achieved, the question arises as to what mechanisms can be brought about at the current sectorial management levels that are represented via regulatory commissions for fisheries and for the environment in the form of HELCOM and IBSFC. The Baltic Sea has been highlighted by the GEF for the establishment and substantial funding of the BSRP as outlined earlier in this report, where a key aspect is the great potential for socio-economic benefits resulting from applying a Large Marine Ecosystem approach to science, advice and management. An important element

in this is institutional strengthening and capacity building for valuing ecosystem goods and services as well as the capacity for local and regional integrated management. This also implies improved adaptive management for achieving sustainable development that integrates the environmental and living marine resources (e.g., fisheries and aquaculture) sectors. In order to achieve acceptance for the eventual outcome of the advisory and management process, a wider representation of stakeholders within ICES for building consensus is needed.

6 REVIEW OF THE EXTENT TO WHICH HOLISTIC ENVIRONMENTAL ASSESSMENTS ARE SUPPORTED BY RESULTS FROM MONITORING PROGRAMMES

Term of Reference a): continue, and complete, the review of the extent to which holistic environmental assessments (e.g., OSPAR QSR 2000, HELCOM Fourth Periodic Assessment) are supported by results from monitoring programmes.

6.1 OSPAR QSR 2000 and HELCOM Fourth Periodic Assessment

OSPAR

The QSR 2000 status report represents the first publication since the introduction of the new OSPAR strategies. The introduction of the strategy which deals with "marine biodiversity and ecosystems" represents a major shift in emphasis for OSPAR, which has traditionally focused on aquatic pollution assessment. It is therefore to be expected that some "teething troubles" will be encountered in putting in place the mechanisms to report at the integrated ecosystem level. This demanding task has also highlighted the need to put in place better data handling and reporting facilities in order to ensure comprehensive access to available national data sets.

Integrated reporting and assessment needs to be underpinned by integrated monitoring. This not only applies within a single monitoring programme, where more than one determinand is being measured, but integration is also required between different sectorial monitoring programmes. For example, surveys undertaken to observe ocean processes (GOOS), nature conservation (Natura 2000), fisheries and contaminants (JAMP) should be integrated wherever possible. The group believes that the lack of integrated monitoring is largely the reason why a large amount of monitoring data (outside of NSTF and JAMP) have not been assessed in the context of the QSR 2000 reports, but that these data are very important in assessing ecosystem health.

HELCOM

The full report of HELCOM was not available for review by SGEAM. However, a popular version of the HELCOM Fourth Periodic Assessment of the State of the Environment of the Baltic Sea Area (HELCOM Baltic Sea Environment Proceedings No. 82A) was made available at the meeting. On the basis of this version, SGEAM was not able to assess whether the Fourth Periodic Assessment is sufficiently supported by results of the HELCOM Monitoring Programme.

6.2 Examples of Practical Ecosystem Management Use of Monitoring

An integrated ecosystem approach to the assessment and management of the marine environment necessitates that we understand how the ecosystem works in order to identify what attributes need to be monitored and why. For example, whilst biological measures at the lower end of the food chain may allow precise causality of response to be monitored, at higher trophic levels causality of change is often difficult to ascertain. Such difficulty requires an understanding of how many parameters interact at all levels within the ecosystem. SGEAM recognises that, in order to evaluate the consequences of various management scenarios, realistic ecosystem models coupled to useable management tools need to be developed.

Simulation-based ecosystem modelling may be defined (at a deterministic level) as the numerical linkage of two or more cause/consequence models that describe the behaviour of the physical, chemical and biological environment.

The challenge of such ecosystem modelling is how to handle (numerically) the links between all the defined (separately modelled) cause/consequence processes. One area of ecosystem modelling that attempts this, and is growing in popularity and interest, is that of "complex adaptive system" modelling. This method aims to simulate, in a game theoretical way, the dynamics of a group of individual objects (for example, animals or sediment particles) which over time give rise to a pattern in the spatial density of the population. This is achieved by assigning a set of conditions (or rules) to each object as to how they should interact with each other under varying environmental conditions. A few specialist research institutes, such as the Santa Fe Institute in New Mexico, have established such modelling techniques

using powerful supercomputers and are at the forefront of research in this area. However, the advent of powerful desktop computers has resulted in these techniques being used more widely.

Whichever modelling approach is adopted, the end result should be the same, namely that an adaptive ecosystem management tool is developed that has real practical value. An example of this, from Sweden, is given below in the context of sewage effluent discharges and how the aquatic receiving ecosystem can be regulated accordingly. Another example, from Canada, shows how an ecosystem approach can be used to develop a plan for monitoring.

Example from Sweden

South of Stockholm, Sweden, a modern sewage treatment plant has been built to serve approximately 250,000 inhabitants in the southern greater Stockholm area. The plant is located in the inner (northern) part of a Baltic Sea bay named Himmerfjärden. The sewage treatment plant was originally designed to be particularly efficient in removing phosphorus from the waste water, but an understanding of the importance of the N/P ratio in maintaining ecosystem health led to the plant being developed to control also the amount of nitrogen being discharged. This is achieved via the process of denitrification. By adding proper quantities of a carbon source (often in the form of alcohol), the efficiency of the denitrification can be very high (~90 %).

When introducing the denitrification, involved parties were well aware of the possibility that reduced nitrogen discharges could increase the densities of cyanobacteria (blue-green nitrogen-fixing algae) in the area. This could cause both aesthetical and environmental problems (possible toxicity and fixation of N_2, counteracting the measures taken in the sewage treatment plant). To minimize the risk of such problems, an adaptive management approach was taken.

Water quality measured in terms of nutrient and chlorophyll *a* concentrations is sampled at 9 stations once per month during winter, every week during the spring bloom, and every second week throughout the rest of the year. Nutrient concentrations and water flow are also monitored in streams entering the bay. The results from these measurements are used to guide the operation of the sewage treatment plant. One objective for this is to keep the N/P ratio in the recipient area at such a level that the risk of cyanobacteria blooms is low.

As shown by the graphs below, the denitrification has reduced nitrogen concentrations in the water column, resulting in reductions in the N/P ratio and in phytoplankton biomass (expressed as chlorophyll *a*).

Figure 6.2.1. Monthly mean concentrations of nitrate and nitrate in Himmerfjärden at 0–10 m and 20–30 m depths in 2000 (points) and from 1978–1998 (box and whiskers).

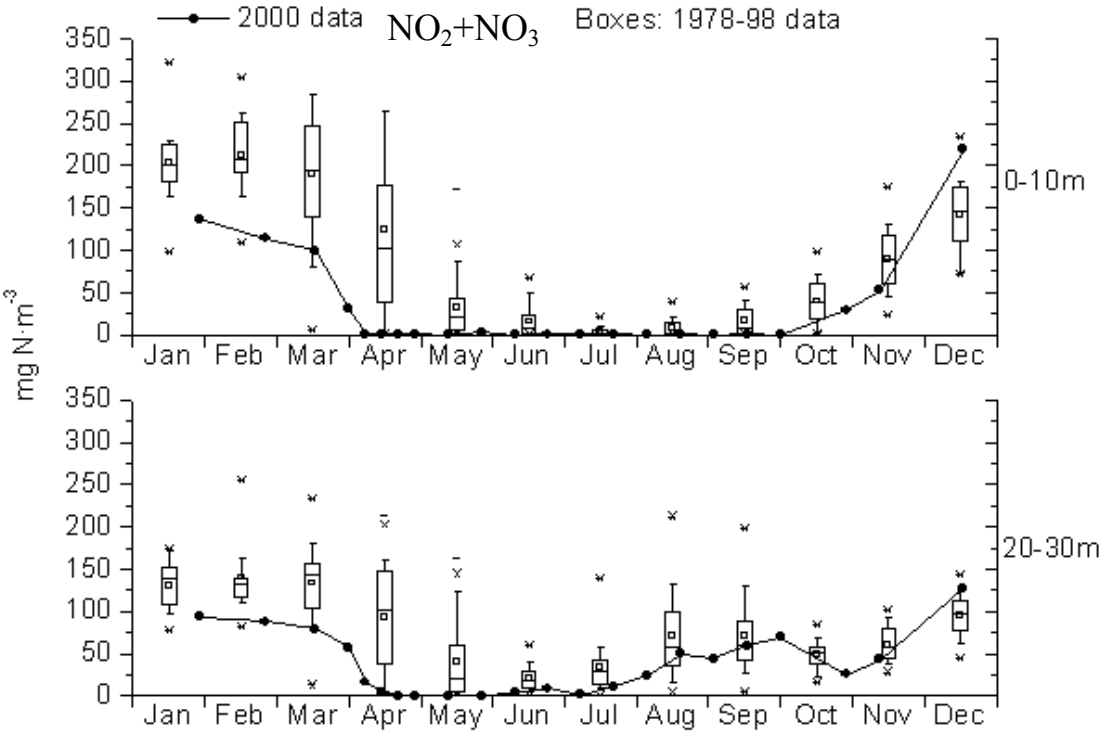


Figure 6.2.2 Monthly mean N/P rations in Himmerfjärden at 0–10 m and 20–30 m depths in 2000 (points) and from 1978–1998 (box and whiskers).

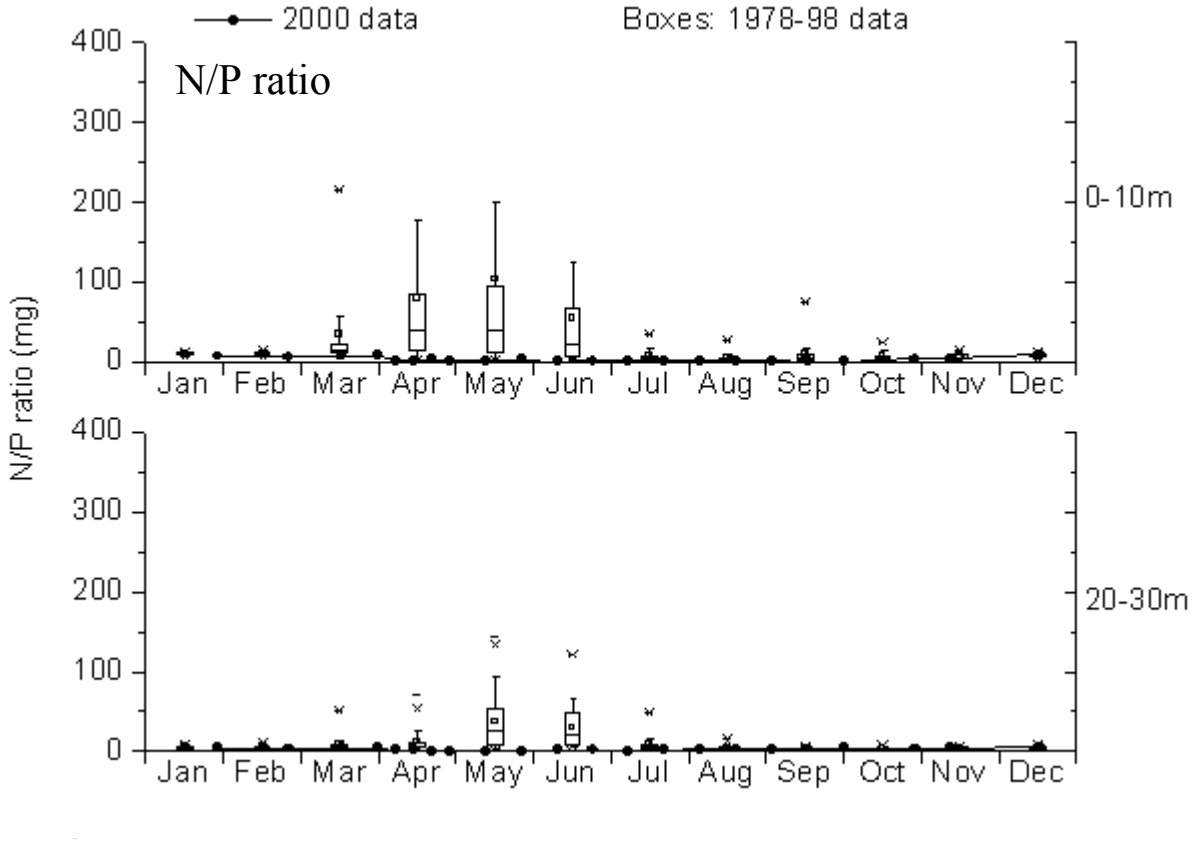
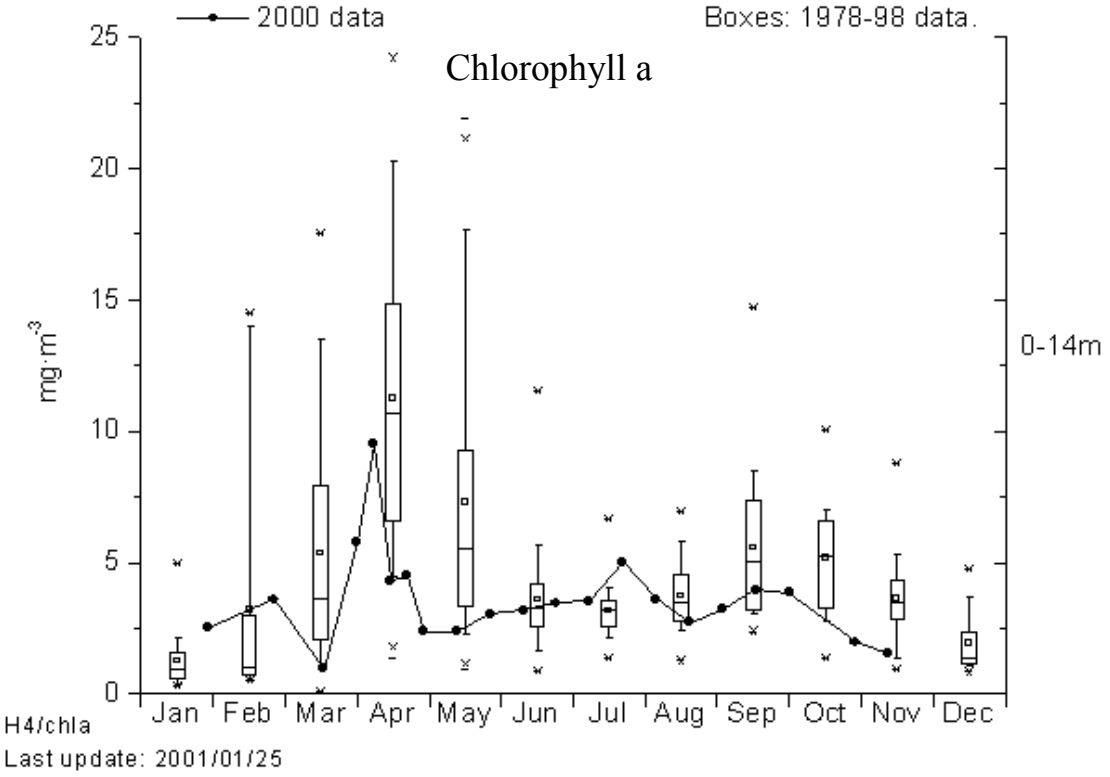


Figure 6.2.3 Monthly mean concentrations of chlorophyll *a* in Himmerfjärden at 0–14 m depth in 2000 (points) and from 1978–1998 (box and whiskers).



Further information on the environmental monitoring of the Himmerfjärden sewage treatment plant is found at http://www.ecology.su.se/dbhfj/hfjsmall.htm.

Example from Canada

At the Maurice-Lamontagne Institute in Canada, an ecosystem approach has been developed for producing monitoring plans at the level of coastal communities as described in the following. The coastal areas of the estuary and Gulf of St. Lawrence are among the areas that experience increasing pressure and are in need of management measures. One of the means for improving the conditions is the Oceans Act that went into effect in 1997 and in which the Marine Environmental Quality (MEQ) programme is included. The MEQ program carries the establishment of marine environmental quality guidelines, objectives and criteria, including the development of methods for marine quality assessment. The programme is meant to support the management of Marine Protected Areas (MPAs) and Integrated Management (IM) zones, programmes that are also included in the Oceans Act. One of the major challenges in the management of coastal areas is to find a balance between the needs of various groups that have interests in the area, as well as the conservation of the habitats. This is a primary objective of the MPAs and IMs.

Within the MEQ framework, the following figure illustrates an approach developed to evaluate the state of biological communities and to select indicators of ecosystem health in the coastal zone of the estuary and Gulf of St. Lawrence. The approach is applied to one of the relevant coastal zone communities, namely the *Mya-Macoma* community. Referring to Figure 6.2.4, the major issues are first identified at the management and scientific levels. Each major issue, in this case the clam fishery in the *Mya-Macoma* community, is then explored to extract its driving human and natural factors. Among the natural factors only the ones that are likely to interfere or covary with the identified human factors are retained: these are called confounding natural factors. The potential impact of each factor on the characteristic properties of every organisational level of the ecosystem is then assessed. Thus, although the focus is on the community level, this approach is an ecosystem approach where potential impacts are identified throughout the system. At each ecosystem level, key properties that are normally used to describe the structure and function of that level, are examined to determine those which would be affected by the major issue. The next step is the search for indicators of these key properties. Depending on the priority given to each selected property, criteria are set as to the level of accuracy, detail, economy, etc., that are to be met by the indicator(s) of that property. In Figure 6.2.4 shown below, the process is applied to the *Mya-Macoma* community. One can follow the expected impacts of the digging-piling part of the fishery activity, that are especially intense on the physical, chemical and population levels of the ecosystem and some potential indicators.

For indicators to be useful and effective, one also needs reference levels. Different approaches can be taken: comparison with historical data, with comparable but pristine areas, and with known gradient or successional trends. In setting reference levels, one avenue explored will be to use succession as a reference model that can be groundtruthed through succession experiments. General successional trends along spatial gradients and through time have already been demonstrated at the community level (Pearson and Rosenberg, 1978). At the ecosystem level, a number of trends equivalent to ecosystem regression are expected in stressed ecosystems (Odum, 1985). Succession trends are characterised by distinct peaks regarding abundance, biomass and trophic diversity corresponding to distinct succession stages. This should allow for the setting of objectives, critical and reference levels within the range of values of the indicators on the succession pattern.

In conclusion, this ecosystem approach applies to communities to find relevant indicators of ecosystem health. The approach prioritises issues, ecosystem levels and properties, the objective being to obtain the smallest possible set of representative indicators covering the major issues and their possible effects. Objectives and comparison levels, set with reference to verified successional trend, are applicable throughout an ecological zone. This approach lends itself to hypothesis-driven monitoring (Underwood, 1995), allowing quantified judgment over the attainment or not of the objectives.

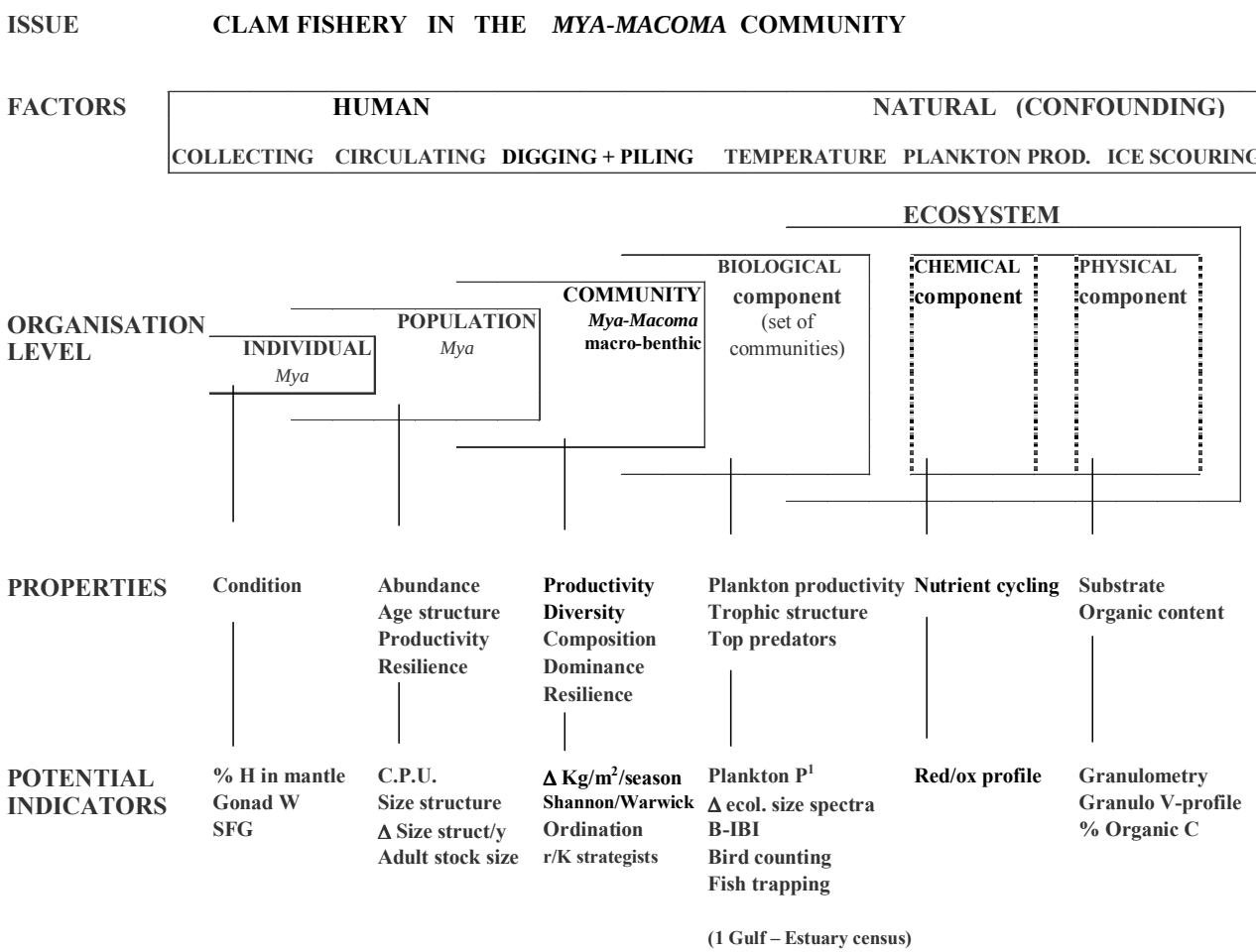
References

Odum, E.P. 1985. Trends expected in stressed ecosystems. BioScience, 35(7): 419–422.

Pearson, T.H., and Rosenberg, R. 1978. Macrobenthic succession in relation to organic enrichment and pollution of the marine environment. Oceanography and Marine Biology Annual Review, 16: 229–311.

Underwood, A. J. 1996. Detection, interpretation, prediction and management of environmental disturbances: some roles for experimental marine ecology. Journal of Experimental Marine Biology and Ecology, 200: 1–27.

Table 6.2.4 Clam fishery in the *Mya-Macoma* community.



7 REVIEW THE ENVIRONMENTAL ASSESSMENTS CONDUCTED BY OSPAR, HELCOM, AND EEA

Term of reference b): review the environmental assessments conducted by OSPAR, HELCOM and EEA.

7.1 OSPAR QSR 2000

The regional assessment QSR 2000 reports (e.g., Region II, Greater North Sea) provide a great deal of useful monitoring and assessment data, although specific references to the source of the data are lacking in most cases. We also conclude that the regional reports suffer from the same inconsistency as the summary assessment reports, as detailed below:

In the QSR 2000 (overall assessment report) there is in general an inconsistency in the level of detail reported under each of the identified "issues". For example, it is stated that a priority issue to be addressed is the impact of fisheries on the ecosystem. However, there is a clear mismatch in the level of detail provided between this issue and the issue on hazardous substances. This is most evident in the text (under each issue) which deals with the "*limitations in knowledge*" and "*priority areas for action*", arguably the most important sections.

Specifically, the fisheries issue admits that current management measures to regulate fish stocks are not working: "*although effective in some fisheries, overall these measures have had limited effectiveness, given the existing over capacity of some European fishing fleets*". Accepting this conclusion, it is remarkable that the priority areas identified to fill gaps in knowledge are largely based on doing more of the same thing—this is a reactive approach rather than a proactive one.

Several of the sections describing the effectiveness of current measures simply refer the reader to the OSPAR strategy on "*marine biodiversity and ecosystems*"; this is not an effective means of communicating a clear message of action. If specific management actions are presently being developed based upon a better integration of scientific understanding , then it should say so in a clear and unambiguous way.

At best, the text leaves the reader feeling somewhat confused as to what the take home message is. For example, within the section dealing with the mineral extraction issue, it is not true to say that "*there is limited information on short-term impacts*". Such impacts have been studied extensively and reported to ICES, (WGEXT and the recent *ICES Cooperative Research Report*). An example where the QSR 2000 gives insufficient information is about the large and increasing amount of produced water discharged from the offshore oil and gas industry. The produced water contains a multitude of dissolved components of which only some are mentioned in the status reports. The discharges are continuous and create a chronic influence. The magnitude of the discharges can be illustrated by the discharge of carboxylic acids, which represents a major part of the dissolved components in produced water. A conservative estimate gives an annual discharge to the North Sea of above 170 000 tonnes of carboxylic acids. ACME addressed the issue of the increasing discharges of produced water and its possible impact on marine ecosystems in its 1998 report.

Overall the present emphasis and progress being made within many ICES scientific working groups on ecosystem level processes has not come through in the "key" sections of the QSR 2000 and in particular the recommendations for future R&D.

7.2 HELCOM Fourth Periodic Assessment

The full report of HELCOM was not available for review by SGEAM. However, a "short", popular version of the HELCOM Fourth Periodic Assessment of the State of the Environment of the Baltic Sea Area (HELCOM BSEP No. 82A) was made available at the meeting. This popular version of the Assessment is a well-illustrated, clearly structured leaflet. It has informative statements as subtitles and short descriptions of environmental problems.

SGEAM notes some very positive developments in the HELCOM Periodic Assessments in terms of their contents, from the physico-chemical descriptions of the environment in the First Periodic Assessment towards ecological descriptions of biotopes and Baltic Sea nature; from descriptions of the status of the open sea, towards environmental assessment of the whole Baltic marine system being under the strong influence of its catchment area. It has also developed in terms of the integrity of information and cross-disciplinary approaches to environmental problems. However, SGEAM notes that some important issues are still lacking such as: biological effects of harmful substances in lower parts of the food chain, coastal fish and biodiversity issues.

In spite of these positive developments of the Fourth Periodic Assessment, some shortcomings should be pointed out. For example, an enhanced activity of detoxifying enzymes is reported, the reason for which is unknown. This is certainly notable and deserves explanation. However, to explain this generally by "increased concentrations of unknown contaminants", hardly falls within the realm of science. This is particularly true because the report also describes substantial changes in the food web, with fundamental changes in its very base (phytoplankton) and hence also potential changes in the production of different organic substances.

For the Baltic Sea salmon, HELCOM neglects discussing today's commercial offshore fishery. This activity is one of the key causes for the critical situation of the species, as it indiscriminately targets both wild and stocked fish. Even if all stocked fish were marked, this fishery would seriously endanger wild salmon, as drift net caught salmon seldom would survive if released. Because of this, and the dwindling population of wild salmon, the offshore salmon fishery is unsustainable. This fishery may also contribute to the serious situation of the harbour porpoise population.

With regard to mariculture, the report concludes, "its impact on the Baltic marine environment is considered to be negligible". This sweeping statement is surprising, since several studies report that nutrients from fish farms have eutrophied areas in the Finnish archipelago: "Fish farming in the middle archipelago zone exerts a remarkable influence on water quality there" (Hänninen *et al.,* 2000, see also, e.g., Bonsdorff *et al.,* 1997).

References

Hänninen, J., Vuorinen, I., Helminen, H., Kirkkala, T., and Lehtila, K. 2000. Trends and gradients in nutrient concentrations and loading in the Archipelago Sea, northern Baltic, in 1970–1997. Estuarine Coastal and Shelf Science, 50: 153–171.

Bonsdorff, E., Blomqvist, E.M., Mattila, J., and Norkko, A. 1997. Coastal eutrophication: Causes, consequences and perspectives in the Archipelago areas of the northern Baltic Sea. Estuarine Coastal and Shelf Science, 44: 63–72.

7.3 EEA Assessment

Two documents prepared by the European Environment Agency (EEA) on environmental assessment of European seas were made available to the group at the end of the meeting. The two documents cover OSPAR and HELCOM sub-regions:

- Draft Technical Report "Testing of Indicators for the Marine and Coastal Environment in Europe, Part 1 Eutrophication and Coastal Zone Management", November 2000, by J.T. van Buuren, T. Smit, G.J.M. Poot, A. van Elteren, B. OpdenKamp;
- Hazardous substances in marine waters. Environmental Signals 2001.

Due to lack of time, SGEAM did not review the two documents, but noted that EEA develops a Driving force-Pressure-State-Impact-Response framework, DPSIR, of indicators to assess environmental status of the European seas. Results of the EEA assessment efforts will depend to a great extent on further development of socio-economic and environmental indicators and the availability of data. This is one more reason why ICES should urge Member Countries to provide environmental data to the ICES Data Bank.

An interesting approach of EEA is to include the information on the progress of Integrated Coastal Zone Management in the EU countries and Norway. This issue, which has so much to do with environmental quality of the coastal environments, may well be a part of future integrated assessments.

8 DISCUSSION AND CONTRIBUTION TO THE FURTHER DEVELOPMENT AND IMPLEMENTATION OF ECOLOGICAL QUALITY OBJECTIVES IN GENERAL, AND IN PARTICULAR FOR MARINE MAMMALS AND SEABIRDS

Term of reference c), contribute to the further development and implementation of Ecological Quality Objectives (EcoQO) in general, and in particular for marine mammals and seabirds [OSPAR 2001/2.2 and 2.3].

Seabird and marine mammal EcoQOs have been considered by the Working Group on Seabird Ecology (WGSE) and the Working Group on Marine Mammal Population Dynamics and Habitats (WGMMPH). Only drafts of their reports were available to SGEAM. Because the Working Group on Ecosystem Effects of Fishing Activities (WGECO), which held its meeting in parallel to SGEAM, was tasked with reporting on these issues, it was the opinion that SGEAM

should not deal with these issues. For information, a draft of Section 6 "Seabirds and Marine Mammals in an EcoQO-framework" of the WGECO report was made available for SGEAM.

The development of EcoQOs is seen as a necessary component of an Ecosystem Approach and is being developed jointly within OSPAR and the North Sea Ministerial Conference framework with special reference to the North Sea.

Within the OSPAR framework for EcoQOs for the North Sea, a set of ten issues has been identified:

1) reference points for commercial fish species;
2) threatened or declining species;
3) sea mammals;
4) seabirds;
5) fish communities;
6) benthic communities;
7) plankton communities;
8) habitats;
9) nutrient budgets and production;
10) oxygen consumption.

SGEAM noted that ICES was contributing to the development of EcoQOs for Sea Mammals and Seabirds through WGMMPH and WGSE, respectively. Proposals for reference points for commercial fish species, threatened and declining species, fish communities, benthic communities, and habitats are being developed under the direction of Norway and the Netherlands as lead countries via the "North Sea Network" of collaborating scientists.

Canada has held its own ecosystem-based management and EcoQOs Workshop (February 2001) that resulted in a process for setting Ecosystem-Based Management (EBM) objectives, indicators, and reference points. Benthic Communities, Nutrient Budgets and Production, and Oxygen Consumption are being developed under the direction of OSPAR (EUC). The anticipated time schedule for promoting the evolving EcoQOs is focused in the first instance at the March 2002 Fifth Ministerial Conference on the North Sea.

SGEAM recognises the undoubted importance of EcoQOs and supports their further development as part of the "tool box" for identifying ecosystem change and implementing management goals. Further, SGEAM noted that substantial efforts had been made by WGMMPH and WGSE in addressing the EcoQOs issue and that significant progress has taken place on this front. The development of EcoQOs in most cases will probably take significant additional time and effort to bring them to the appropriate level of completion required for adoption and implementation by management bodies. SGEAM emphasizes that it neither had the time nor an appropriate composition of the scientific experts necessary to evaluate the specific validity of the EcoQOs originating from WGMMPH and WGSE. As with its positive views regarding the need to develop appropriate indicators for ecosystem assessments, SGEAM recommends that ICES give a high priority to this type of work within its Core Science Programme.

9 ANY OTHER BUSINESS

Eugeniusz Andrulewicz presented a working paper "Developing indicators for ecosystem quality assessment", where he gave examples for a practical approach to the use of indicators. SGEAM noted the value of the presentation for the further work within ICES on the development and use of indicators. It was decided to include the paper as Annex 4 to the SGEAM 2001 report.

10 CONSIDERATION AND APPROVAL OF RECOMMENDATIONS

The following recommendations were considered and approved:

I The Global International Waters Assessment (GIWA)

Item 4.1:

SGEAM recommends that ICES determine the extent to which it can contribute to a GIWA-related assessment in all of its science areas.

II Report on the Status of Fisheries and Related Environment of Northern Seas

Item 4.3:

SGEAM recommends that ICES follow up the work put down in the assessment report to the Nordic Council of Ministers and consider a way that such informative assessments could be given by ICES on a regular basis.

III To the further development of a framework for integrated ecosystem assessment and management and implementation of EcoQOs

Recommendations from SGEAM 2000.
Item 5.2.1:

SGEAM 2000 recommended that the work in the Regional Ecosystem Groups (REGs) should focus on the following tasks:

a) consider the general issue of integration of pertinent assessment information on the changing states of large marine ecosystems in the region, based on regional expertise;

b) prepare periodic assessments of the status and trends in fish stocks and environmental conditions of the LMEs in the region with the emphasis on:

   i) climatic/physical driving forces, and

   ii) biological (e.g., multispecies) interactions;

c) contribute to environmental assessments and preparation of Quality Status Reports (QSRs) in cooperation with stakeholders, academic institutions, the public, and other organisations (e.g., EEA, OSPAR, AMAP, HELCOM).

IV Framework for monitoring, assessment, advice and management

Item 5.2.2:

SGEAM recommends that, in order to achieve acceptance for the eventual outcome of the advisory and management process, a wider representation of stakeholders within ICES is needed for building consensus.

SGEAM recommends that ACE should supervise the exploration and establishment of ecosystem assessment methods at an appropriate regional scale, which in the medium and longer term can support an ecosystem advisory role. To do this, emphasis should be given to the Baltic Sea for reasons given above, and to establishing a regional multidisciplinary working group for conducting the assessments.

SGEAM recommends that, as a first step towards implementing the overarching management framework, a strategic integration of national monitoring programmes is required. This also has implications for the way in which data are managed and reported for integrated appraisal and assessment. To facilitate this:

SGEAM recommends that a GIS approach be developed to enable the flexible interrogation of data held in the ICES database.

V OSPAR QSR 2000 and HELCOM Fourth Periodic Assessment

Item 6.1:

SGEAM recommends that ICES is best placed to coordinate via ACE reports on ecosystem assessment to OSPAR.

VI Examples of practical ecosystem management use of monitoring

Item 6.2:

SGEAM recommends that, in order to evaluate the consequences of various management scenarios, realistic ecosystem models coupled to useable management tools need to be developed.

VII Discussion and contribution to the further development and implementation of Ecological Quality Objectives in general, and in particular for marine mammals and seabirds

Item 8:

SGEAM recommends that ICES give increased priority to the identification and extraction of relevant indicators concerning the status of important components of the ecosystem.

11 PROPOSAL FOR A FURTHER MEETING

SGEAM proposed that the next meeting of the Study Group should take place at ICES Headquarters from 29 April–3 May 2002.

12 CONSIDERATION AND APPROVAL OF THE MEETING REPORT

The draft report prepared at the meeting was approved and it was agreed that a full draft report was to be sent by the Chair at the beginning of Week 19 for corrections and eventual amendments. All corrections and amendments have to be returned not later than 14 May and the final draft report will be sent to the participants and ICES not later than 16 May.

13 CLOSURE OF THE MEETING

The Chair thanked the participants for their contribution to the meeting and for a most interesting meeting. He pointed to the fact that the issues discussed needed some time for "warming up" before the whole concept of ecosystem assessment could be freely discussed with a common understanding. He felt that the result of the SGEAM 2001 meeting as presented in this report clearly demonstrates that the open-minded discussions had brought us an important step further in developing practical tools for implementing integrated ecosystem management.

On behalf of SGEAM, the Chair thanked the staff of ICES for friendly help and hospitality, and closed the meeting at 20.15 hrs Thursday 3 May 2001.

ANNEX 1: LIST OF PARTICIPANTS

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ANNEX 2: AGENDA

Study Group on Ecosystem Assessment and Monitoring (SGEAM)

ICES Headquarters, 30 April–3 May 2001

1) Opening of the meeting.
2) Adoption of the agenda.
3) Arrangement for the preparation of the report.
4) Reports of activities in other fora of interest to the meeting.
5) Presentation of some of the results from the SGEAM 2000 discussion of the scientific framework for an ecosystem approach for sustainable use and protection of the marine environment.
6) Review of the extent to which holistic environmental assessments are supported by results from monitoring programmes.
7) Review the environmental assessments conducted by OSPAR, HELCOM and EEA.
8) Discussion and contribution to the further development and implementation of Ecological Quality Objectives in general, and in particular for marine mammals and seabirds.
9) Any other business.
10) Consideration and approval of recommendations.
11) Proposals for a further meeting.
12) Consideration and approval of the meeting report.
13) Closure of the meeting.

ANNEX 3: APPLICATION OF ENVIRONMENTAL INDICATORS FOR GLOBAL INTERNATIONAL WATERS ASSESSMENT (GIWA)

(Selected items from GIWA working papers)

Contents

1) The GIWA Project in General (selected from Annex 1, pages 1–5, GIWA Terms of Reference)

2) Criteria for scoring environmental impacts (selected issues from GIWA Scoping Methodology: eutrophication, chemical pollution and exploitation of living resources from GIWA Methodology, Chapter 2)

3) Impacts Table (Selected from GIWA 2nd BTT Report)

1 The GIWA Project in General (selected from Annex 1, pages 1–5, GIWA Terms of Reference)

Rationale

Lack of an international waters assessment, similar to those adopted by other global monitoring bodies such as the International Panel on Climate Change, the Global Biodiversity Assessment and the Stratospheric Ozone Assessment, is a serious impediment to the implementation of the International Waters (IW) component of the Global Environment Facility (GEF) because, at present, there is no basis for the identification of areas of global priority that require intervention by the GEF. As a consequence, there is a need for a globally coherent investigation of transboundary water issues that incorporate and expand on the many existing but narrowly focused studies that have been conducted at national, regional and global levels. The GEF, through GIWA, is in a unique position to facilitate such an investigation by developing a suite of consistent methodologies that can be implemented by groups of specialists assembled in each region to assess the ecological status of international waters and identify the potential causes of degradation of those water bodies. The implementation of such a coherent system of assessments conducted at regional and sub-regional scales will provide a global picture of the quality of international waters that will facilitate the identification of areas that should be prioritised by the GEF for intervention.

Objective

The primary objective of GIWA is to develop a comprehensive suite of methods for assessing the quality of international waters that will be implemented by a strategic network of specialists to identify priority areas for remedial and preventative action in international waters that will produce significant environmental improvements at national, regional and global levels.

Expected Outcomes

It is anticipated that GIWA will yield strategic information that can be used by the GEF to:

1. Identify regional and global international waters that should be prioritised by the GEF and its partners for intervention;

2. Make decisions concerning appropriate management interventions, including identification of more sustainable approaches to the use of water and its associated resources;

3. Prepare protocols for the implementation of incremental cost analyses, causal chain analyses and trans-boundary diagnostic analyses in GEF-IW projects;

4. Increase leveraged co-financing.

The GIWA Network in General

GIWA is being executed by UNEP in collaboration with the University of Kalmar, Sweden. GIWA is coordinated by a UNEP-appointed Core Team located in Kalmar, which consists of four to six professionals and the Project Manager. The main task of the Core Team is to initiate, coordinate, facilitate and evaluate the sub-regional assessments. The Core Team will be advised by and report to the Steering Group which consists of senior scientists and representatives from the major co-sponsoring organisations of GIWA. The assessments will be conducted in each of the 66 sub-regions that

are the basic units of GIWA. In each sub-region, a focal point will be identified who is responsible for the implementation of the GIWA Assessment Protocol in that particular sub-region. The 66 sub-regions are grouped into nine mega-regions. In each mega-region, a mega-regional task team will be appointed that will be comprised of the focal points from each sub-region in the mega-region and, if necessary, additional experts who will assist and support the sub-regional assessments. The mega-regional task team will be linked to and supported by a mega-regional host organisation.

The GIWA Methodology (Assessment Protocol) in General

The analytical phase of the GIWA Assessment (Phase 2) will involve assembling data and information from existing sources where possible. The analytical phase will require comparable, validated information from each sub-region regarding:

- the current status of the aquatic environment and its associated resources;
- the magnitude and extent of major water-related concerns and principal issues;
- the social and economic driving forces resulting in the degradation of the aquatic environment;
- the current institutional policy and legal framework applicable in the region;
- historical trends associated with any of the above.

In a few selected cases it will be necessary to gather additional information or generate estimates in order to fill gaps in our knowledge. Such estimates will be based upon existing, internationally acceptable rapid assessment methodologies.

In order to complete the analytical phase of GIWA successfully, all data and information collected in each sub-region must be comparable between sub-regions. Therefore, it is essential that the GIWA Assessment Protocol provides comprehensive guidance and explains to the sub-regional focal points and the mega-regional task teams precisely the nature of the data and information that must be assembled and the appropriate spatial and temporal scales from which it should be obtained.

The GIWA Assessment Protocol will include, but not be limited to:

- agreed quantifiable indicators for each of the major concerns, principal issues, environmental and socio-economic impacts identified in the GIWA Project Document;
- an electronic pro-forma that encompasses all elements of the analytical phase of the assessment which should be completed by the sub-regional focal points;
- guidance to potential sources of appropriate meta-data and information at regional and global scales;
- links to internet sites holding internationally acceptable rapid assessment methods that are recommended for use in GIWA sub-regions where data or information are scarce or absent;
- specific worked examples of causal chain analyses of selected issues and problems in areas that encompass the entire range of GIWA concerns and issues.

The final version of the GIWA Assessment Protocol that will be used in the 66 sub-regional assessments will be posted on the GIWA web site. The GIWA Assessment Protocol can also be obtained on CD-ROM or as a hard copy by request to the GIWA Core Team.

Phase 3 of GIWA, the predictive, policy and option phase, will be executed on the mega-regional level with input from the sub-regional task teams. The Consultant, the Sub-regional focal point, shall be available for the Mega-regional host for this phase of the project and participate in and give input to the predictive policy and option task force as required. The detailed guidance and work plans for Phase 3 is expected to be ready in October 2001.

2 GIWA Scoping Methodology - (selected issues from GIWA Scoping Methodology: eutrophication, chemical pollution and exploitation of living resources from GIWA Methodology, Chapter 2)

GIWA SCOPING METHODOLOGY, CRITERIA FOR SCORING ENVIRONMENTAL IMPACTS

Issue 5: Eutrophication

Eutrophication[1] including harmful algal blooms refers to artificially enhanced primary productivity in receiving water basins related to the increased availability or supply of nutrients.

Score 0 = No known Impact

No known impact is determined when the following criteria are met:

- No visible effects on the abundance and distributions of natural living resource distributions in the area;
- No increased frequency of hypoxic conditions[2] and/or fish mortality events and/or harmful algal blooms associated with enhanced primary production;
- No evidence of periodically reduced dissolved oxygen or fish and zoobenthos mortality;
- No evident abnormality in the frequency of harmful algal blooms.

Score 1 = Slight Impact

"Slight" impact is determined when one or more of the following criteria are met or exceeded:

- Increased abundance of epiphytic algae;

  or

- A statistically significant trend in decreased water transparency associated with algal production as compared with long-term (>20 year) data sets;

  or

- Measurable shallowing of the depth range of macrophytes.

Score 2 = Moderate Impact

"Moderate" impact is determined when one or more of the following criteria are met or exceeded:

- Increased filamentous algal production resulting in algal mats;

  and/or

- Medium frequency (< once per year) of large-scale hypoxia and/or fish and zoobenthos mortality events and/or harmful algal blooms.

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[1] Eutrophication includes cultural eutrophication in lakes

[2] hypoxia begins at 2.0 ml/l and extends to the point of anoxia (0.0 ml/l) (Diaz, R.J. & R. Rosenberg, 1995. Marine benthic hypoxia: a review of its ecological effects and the behavioural responses of benthic macrofauna. Oceanographic Marine Biology Annual Review, 33: 245–303

Score 3 = Severe Impact

"Severe" impact is determined when one or more of the following criteria are met or exceeded:

- High frequency (> 1 event per year), or intensity, or large areas of periodic hypoxic conditions, or high frequencies of fish and zoobenthos mortality events or harmful algal blooms.
- Significant changes in the littoral community.
- Presence of hydrogen sulphide in historically well oxygenated areas.

GIWA SCOPING METHODOLOGY, CRITERIA FOR SCORING ENVIRONMENTAL IMPACTS

Issue 6: Chemical pollution

Chemical pollution refers to the adverse effects of chemical contaminants[3] released to standing or marine water bodies as a result of human activities. Chemical contaminants are here defined as compounds that are toxic and/or persistent and/or bioaccumulating

Score 0 = No known Impact

No known impact is determined when the following criteria are met:

No known or historical levels of chemical contaminants except background levels of naturally occurring substances

- No fisheries closures or advisories due to chemical pollution;
- No incidence of fisheries product tainting;
- No unusual fish mortality events.

If there is no available data use the following criteria

- No use of pesticides;
- No sources of PCDD/PCDF;
- No regional use of PCBs;
- No Bleached Kraft Pulp Mills using chlorine bleaching;
- No use or sources of contaminants listed in footnote 6.

Score 1 = Slight Impact

"Slight" impact is determined when one or more of the following criteria are met or exceeded:

- Chemical contaminants are below threshold limits defined for the country or region (e.g., by a regional or national Commission).

- Restricted area advisories regarding chemical contamination of fisheries products.

If there is no available data use the following criteria:

- Some use of pesticides in small areas

  or

- Presence of small sources of PCDD/PCDF (e.g., incineration plants or small Bleached Kraft Pulp Mills using chlorine;

  or

- Some previous and existing use of PCBs and limited amounts of PCB-containing wastes but not in amounts invoking local concerns.

  or

- Presence of other contaminants described in the UNEP Global Plan of Action for the Protection of the Marine Environment from Land Based Activities[4]

Score 2 = Moderate Impact

"Moderate" impact is determined when one or more of the following criteria are met or exceeded:

- Chemical contaminants are above threshold limits defined for the country or region (e.g., by a regional or national Commission).
- Large area advisories by public health authorities concerning fisheries product contamination but without associated catch restrictions or closures;

  or

- High mortalities of aquatic species near outfalls.

If there is no available data use the following criteria:

- Large-scale use of pesticides in agriculture and forestry;

  or

- Presence of major sources of PCDD/PCDF such as large municipal or industrial incinerators or large Bleached Kraft Pulp Mills using chlorine as a bleaching agent;

  or

- Considerable quantities of waste PCBs in the area with inadequate regulation and some public concerns.

  or

- Presence of considerable quantities of other contaminants described in the UNEP Global Plan of Action for the Protection of the Marine Environment from Land Based Activities[7]

Score 3 = Severe Impact

[4] The list can be obtained from the UNEP Global Plan of Action for the Protection of the Marine Environment from Land Based Activities website at www.gpa.unep.org

"Severe" impact is determined when one or more of the following criteria are met or exceeded:

- Chemical contaminants are above threshold limits defined for the country or region (e.g., by a regional or national Commission).
- Public health and public awareness of fisheries contamination problems with associated reductions in the marketability of such products either through the imposition of limited advisories or by small-area closures of fisheries;

  or

- Large-scale mortalities of aquatic species.

If there is no available data use the following criteria:

- Indications of health effects resulting from use of pesticides;

  and/or

- Known emissions of PCDD/PCDF from either incinerators or chlorine bleaching of pulp with attendant advisories on mollusc or crustacean consumption or large-area fisheries closures;

  and/or

- Known contamination of the environment or foodstuffs as a result of poor waste management of PCB-containing wastes.

  and/or

- Known contamination of the environment or foodstuffs as a result of poor waste management of other contaminants described in the UNEP Global Plan of Action for the Protection of the Marine Environment from Land Based Activities[7].

GIWA SCOPING METHODOLOGY, CRITERIA FOR SCORING ENVIRONMENTAL IMPACTS

Issue 14: Over-exploitation

Over-exploitation refers to the capture of fish, shellfish or marine invertebrates at a level that exceeds the maximum sustainable yield of the stock.

Score 0 = no known impact

- No harvesting exists catching fish (with commercial gear for sale or subsistence)

Score 1 = slight

"Slight" impact is determined when one or more of the following criteria are met or exceeded:

- Commercial harvesting exists but there is no evidence of over-exploitation

Score 2 = moderate

"Moderate" impact is determined when one or more of the following criteria are met or exceeded:

- One stock is exploited beyond MSY (maximum sustainable yield) or is outside safe biological limits

Score 3 = severe

"Severe" impact is determined when one or more of the following criteria are met or exceeded:

- More than one stock is exploited beyond MSY or is outside safe biological limits.

GIWA SCOPING METHODOLOGY, CRITERIA FOR SCORING ENVIRONMENTAL IMPACTS

Issue 15: Excessive bycatch and discards

Bycatch refers to the incidental capture of fish or other animals that are not the target of the fisheries. Discards refer to dead fish or other animals that are returned to the sea.

Score 0 = no known impact

- Current harvesting practices show no evidence of excessive bycatch and/or discards.

Score 1 = slight

"Slight" impact is determined when one or more of the following criteria are met or exceeded:

- 10–30 % of the fisheries yield (by weight) consists of bycatch and/or discards.

Score 2 = moderate

"Moderate" impact is determined when one or more of the following criteria are met or exceeded:

- 30–60 % of the fisheries yield consists of bycatch and/or discards

Score 3 = severe

"Severe" impact is determined when one or more of the following criteria are met or exceeded:

- Over 60 % of the fisheries yield is bycatch and/or discards.
- Noticeable incidence of capture of endangered species

GIWA SCOPING METHODOLOGY, CRITERIA FOR SCORING ENVIRONMENTAL IMPACTS

Issue 16: Destructive fishing practices

Destructive fishing practices are those that are deemed to produce significant harm to marine, lacustrine or coastal habitats and communities.

Score 0 = no known impact

- No evidence of habitat destruction due to fisheries practices.

Score 1 = slight

"Slight" impact is determined when one or more of the following criteria are met or exceeded:

- Habitat destruction resulting in changes in distribution of fish or shellfish stocks.
- Trawling of any one area of the seabed is occurring less than once per year.

Score 2 = moderate

"Moderate" impact is determined when one or more of the following criteria are met or exceeded:

- Habitat destruction resulting in moderate reduction of stocks or moderate changes of the environment
- Trawling of any one area of the seabed is occurring 1–10 times per year.
- Incidental use of explosives or pesticides for fishing.

Score 3 = severe

"Severe" impact is determined when one or more of the following criteria are met or exceeded:

- Habitat destruction resulting in complete collapse of a stock or far reaching changes in the environment.
- Trawling of any one area of the seabed is occurring more than 10 times per year.
- Widespread use of explosives or pesticides for fishing.

GIWA SCOPING METHODOLOGY, CRITERIA FOR SCORING ENVIRONMENTAL IMPACTS

Issue 17: Decreased viability of stocks through contamination and disease

This refers to contamination of feral (wild) stocks of fish or invertebrates as a result of human-induced contamination or of diseases that are a direct or indirect consequence of human action.

Score 0 = no known impact

- No evidence of increased incidence of fish or shellfish diseases

Score 1 = slight

"Slight" impact is determined when one or more of the following criteria are met or exceeded:

- Increased reports of diseases without major impacts on the stock

Score 2 = moderate

"Moderate" impact is determined when one or more of the following criteria are met or exceeded:

- Declining populations of one or more species as a result of diseases or contamination.

Score 3 = severe

"Severe" impact is determined when one or more of the following criteria are met or exceeded:

- Collapse of stocks as a result of diseases or contamination.

Figure A5.1. Impacts Table (selected from GIWA 2nd BTT Report)

Reporting Table Impacts Scoping Exercises and Perception of Change (Complete from the 1st BTT Meeting)

IMPACTS TABLE	Sub-Region: Baltic Region		Date: December 2000		Group leaders: William Hogland & Marcia Marques	
Major concern	**Issue**	**System 1: Baltic Sea**				
		Scores 0 - 3		**Total for issue**	**Max score for Major concern**	**Scores* −4 to 4**	**Max score for Major concern**
		(a) Environ-mental	**(b) Socio-economic**	**(a+b) max=6**	**0 - 6**	**Perceived future changes**	**−4 to 4**
I Freshwater shortage	1. Reduction in stream flow	1	0	1	4	0	+1
	2. Pollution of existing supplies	2	2	4		+1	
	3. Lowering of water table	1	0	1		0	
II Pollution	4. Microbiological	0	2	2	5	−3	+3
	5. Eutrophication (harmful algal blooms)	3	1	4		+3	
	6. Chemical	1	2	3		+1	
	7. Suspended solids	1	1	2		0	
	8. Solid wastes	1	1	2		0	
	9. Thermal	1	1	2		−1	
	10. Radionuclide	1	1	2		0	
	11. Spills	3	2	5		+3	
III Habitat and community modification	12. Loss of ecosystems or ecotones*	3	1	4	4	+3	+3
	13. Modification of ecosystems or ecotones, including community structure and/or species composition	2	1	3		+3	

IMPACTS TABLE	Sub-Region: Baltic Region	Date: December 2000	Group leaders: William Hogland & Marcia Marques

Major concern	Issue	System 1: Baltic Sea					
		Scores 0 - 3		Total for issue	Max score for Major concern	Scores* −4 to 4	Max score for Major concern
		(a) Environ-mental	(b) Socio-economic	(a+b) max=6	0 - 6	Perceived future changes	−4 to 4
IV Unsustainable exploitation of fisheries & other living resources	14. Over-exploitation	3	1	4	4	−2	+3
	15. Excessive bycatch and discards	3	1	4		0	
	16. Destructive fishing practices	2	1	3		0	
	17. Decreased viability of stock through pollution and disease	1	1	2		+2	
	18. Impact on biological and genetic diversity	2	1	3		+3	
V Global change	19. Changes in hydrological cycle	0	-	-	-	+1	+1
	20. Sea level change	1	-	-		0	
	21. Increased UV-b radiation as a result of ozone depletion	0	-	-		0	
	22. Changes in ocean co_2 source/sink function	0	-	-		+1	

* From –4 to –2: Improvement with decreasing degree of confidence; From −1 to +1: No change with decreasing degree of confidence; From +2 to +4: deterioration with increasing degree of confidence.

ANNEX II

ENVIRONMENTAL AND SOCIO-ECONOMIC IMPACTS OF WATER RELATED MAJOR CONCERNS AND PRINCIPLE ISSUES, TOGETHER WITH THEIR POTENTIAL TRANSBOUNDARY CONSEQUENCES

MAJOR CONCERN 1: FRESHWATER SHORTAGE

ISSUES	ENVIRONMENTAL IMPACTS	SOCIO-ECONOMIC IMPACTS	POTENTIAL TRANSBOUNDARY CONSEQUENCES
REDUCTION IN STREAM FLOW	1. Modification of riparian habitats 2. Depletion of fish stocks and species diversity 3. Water quality change 4. Decreased wetland areas 5. Reduced capacity to transport sediments, siltation 6. Reduced groundwater recharge 7. Saltwater intrusion 8. Changes in biological diversity and food webs 9. Changes in sediment budgets	1. Loss of agricultural uses (crops, livestock, aquaculture, mariculture) 2. Loss of human drinking water supplies 3. Loss of recreational use 4. Loss of hydro-electric power production 5. Loss of aesthetic values 6. Loss of coastal harbours and inland transport 7. Loss of industrial uses 8. Increased potential for upstream/downstream conflicts 9. Reduced availability of fish as food 10. Loss of waste assimilative capacity 11. Increased costs of alternative water supplies 12. Compromise of future use optional	- Shifts in freshwater/saltwater front - Changes in riparian communities - Changes in withdrawal uses - Potential for conflict over shared water - Potential for induced migration - Reduced groundwater recharge
POLLUTION OF EXISTING SUPPLIES	1. Modification of riparian habitat 2. Depletion of fish stocks and species diversity 3. Changes in terrestrial and aquatic biological diversity and food webs 4. Potential for impacts on migratory species such as water birds	1. Human health impacts 2. Reduced agriculture productivity (crops, livestock, aquaculture mariculture) 3. Loss of recreation possibilities 4. Loss of aesthetic values 5. Increased intake treatment cost 6. Increased damage to water-related equipment 7. Increased potential for upstream-downstream conflicts 8. Increased costs of alternative water supplies 9. Compromise of future use options	- Reduction in water use options - Human health impacts - Upstream/downstream conflicts
LOWERING OF WATER TABLE	1. Reduction in stream flows 2. Land subsidence 3. Reduced aquifer capacity 4. Reduced vegetation cover 5. Greater potential for saltwater intrusion 6. Water quality changes 7. Increased soil erosion 8. Increased penetration of contaminants into deep aquifers	1. Loss of aesthetic value 2. Damage to infrastructure 3. Increased costs of deepening wells and pumping 4. Population migration 5. Transboundary implications 6. Compromise of future use options 7. Increased costs of alternative water supplies 8. Increased vulnerability to sea level rise	- Transboundary groundwater supply conflicts - Contamination of transboundary aquifers - Potential for reduced transboundary streamflow

ANNEX II. Cont.

MAJOR CONCERN II: POLLUTION

ISSUES	ENVIRONMENTAL IMPACT	SOCIO-ECONOMIC IMPACT	POTENTIAL TRANSBOUNDARY CONSEQUENCES
MICROBIOLOGICAL (bacteriological, viral and other microbial)	1. Aquatic organism infections and diseases	1. Increased risks to human health 2. Increased costs of human health protection 3. Loss of potable water supplies 4. Increased costs of water treatment 5. Costs of preventative medicine 6. Costs of medical treatment 7. Loss of tourism/recreational values 8. Costs of increased fisheries product processing	The sub-group on pollution examined the entries under the various categories of pollutant for "environmental impact" and "socio-economic impact" with a view to determining the potential for these impacts to be transboundary. It was concluded that all such pollutants have the potential for transboundary impacts. Accordingly, rather than simply assigning each and every impact as "potentially
EUTROPHICATION	1. Redox changes [extreme Anoxia] 2. Increased algal blooms 3. Changes in algal community structure 4. Changes in macrophyte community structure 5. Loss of habitat (e.g. coral reefs) [Sedimentary composition changes] 6. Change in composition of feral fisheries and loss in case of anoxia	1. Loss of tourism/recreation 2. Loss of water supplies 3. Costs of water treatment 4. Change in fisheries value 5. Compromise of options for aquaculture development opportunities 6. Loss of property values 7. Loss of aesthetic value 8. Costs of weed control 9. Loss of wildlife sanctuaries 10. Costs of increased navigational clearance 11. Increased costs of human health protection 12. Increased costs of fish surveillance/processing in the case of toxin incidence 13. Costs of reduced fish marketability due to aesthetic perceptions	transboundary " it was decided that a text should be prepared to provide some qualitative discrimination to the likely magnitude of such transboundary impacts for each class of contaminants. The reason that <u>all</u> contaminant classes have the potential for transboundary impacts is due to the high probability both in riparian rivers and coastal margins that the introduction of substances will result in transport and effects beyond national boundaries. Nevertheless, the relative potential for these and other transboundary effects depends on both the conservatism and persistence of the contaminants. Thus,
CHEMICAL	1. Reproductive disfunction in aquatic organisms 2. Behavioral disfunction in aquatic organisms 3. Modified community structure 4. Increased mortality of aquatic organisms	1. Loss in fisheries 2. Loss of protected areas 3. Increased cost of human health protection measures 4. Increased cost of navigational dredging activities 5. Increased cost of fish processing activities 6. Reduced options for aquaculture development 7. Increased costs of water treatment 8. Loss of tourism/recreational opportunities 9. Compromise of other uses of freshwater (reduction in options) 10. Potential for international conflicts	lowest on the scale of potential for transboundary impacts are microbiological agents, solid wastes and thermal discharges. Next highest in probability are suspended solids and nutrients (as proxy for eutrophication). Of similar scales of impact and, therefore similar probability of transboundary consequences, are substances introduced by accidental spillage. The highest likelihood of transboundary impacts are posed by chemicals and radionuclides which, because many of them behave conservatively, can be transported great distances and pose increased risks of damage in remote areas.

ANNEX II. Cont.

SUSPENDED SOLIDS	1. Habitat modification 2. Changes in biological community composition 3. Changes in the growth/survival/reproduction of species 4. Reduced productivity 5. Enhanced erosion of coasts and river channels 6. Increased sediment deposition and siltation 7. Destruction (blanketing) of benthic communities 8. Changes in sediment redox conditions (organics)	1. Increased costs of navigational survey and dredging 2. Loss of reservoir storage capacity 3. Damage to equipment (particle impacts) 4. Reduced tourism/recreational amenities/opportunities 5. Increased water treatment costs 6. Increased costs of coastal protection from waves/storm surges/erosion 7. Costs of cleaning intakes	
SOLID WASTES (Bulk)	1. Habitat loss 2. Hydraulic modification 3. Entanglement/Suffocation of marine organisms 4. Beach and sediment compositional changes	1. Loss of aesthetic values/amenities 2. Endangerment of species 3. Increased costs of animal protection (esp endangered species) 4. Increased costs of human health protection 5. Increased costs of clean-up 6. Increased costs of navigational protection (survey & dredging)	
THERMAL	1. Population/community changes 2. Barriers to migration 3. Displacement of organisms 4. Changes to physical environment	1. Compromise of options for aquaculture development 2. Displacement of valued species 3. Increased risk to aquaculture (if improper siting)	
RADIONUCLIDE (from anthropogenic sources only)	1. Proximal and stochastic risks to animal life	1. Avoidance of amenities and products due to perceptions of effects of contamination 2. Costs of public reassurance 3. Risks to human health 4. Maintenance of monitoring and radiological protection activities for public reassurance purposes	
SPILLS (accidental episodic releases/introductions of substances to the aquatic environment)	1. Increased avian mortality 2. Increased mortality of aquatic life 3. Habitat damage 4. Long-term contamination of sediments and beaches with associated ecological changes	1. Costs of clean-up 2 Costs of preventive measures (e.g. tanker design/construction) 3. Costs of contingency measures 4. Real or perceived damage to feral and cultured fisheries 5. Loss of tourism and recreational amenities (temporary or permanent) 6. Costs of litigation 7. Costs of insurance 8. Loss of sanctuary and protected areas and associated wildlife 9. Costs of disruption to shipping, marine reserve and marine scientific activities during survey and clean-up	

ANNEX II. Cont.

MAJOR CONCERN III: HABITAT AND COMMUNITY MODIFICATION

ISSUES	ENVIRONMENTAL IMPACT	SOCIO-ECONOMIC IMPACT	POTENTIAL TRANSBOUNDARY CONSEQUENCES
LOSS OF ECOSYSTEMS OR ECOTONES	1. Loss of natural productivity 2. Loss of biodiversity 3. Loss of natural storm barriers 4. Loss of natural protection from erosion 5. Loss of carbon sinks and release of carbon to the atmosphere 6. Loss of migratory species using the habitat and altered migratory patterns 7. Impacts of estuarine system changes on adjacent coastal marine ecosystems	1. Reduced capacity to meet basic human needs (food, fuel) for local pop'ns 2. Changes in employment opportunities for local populations and associated changes in social structures 3. Loss of aesthetic value/recreation for local populations 4. Loss of existing income and foreign exchange from fisheries, tourism, etc. 5. Loss of opportunity for investment income and foreign exchange from former ecosystem and possible new opportunities (e.g. loss of materials for potential pharmaceutical products) 6. Loss of cultural heritage 7. Human conflicts, nat'l & Int'l 8. Loss of education and scientific value 9. Increased risks to human population and capital investment; loss of land due to loss of physical protection 10. Costs of responding to risks 11. Intergenerational inequity, possibly	- Damage to transboundary ecosystems, including loss (or change) in productivity, biodiversity, or loss of stability in shared ecosystem, change in community structure, both plant and animal (regional) - Damage to endangered, threatened or endemic species (global) - Loss of stability in national or transboundary systems due to species introductions (global) - Spread of disease or exotic species to neighbouring countries (regional) - Reduced natural protection from storms or erosion in countries sharing ecosystems (regional) - Impacts of freshwater or estuarine system changes on international coastal marine ecosystems (regional) - Impacts of physical changes in beach dynamics on adjacent countries, erosion deposition (regional) - Damage to migratory species and their habitat changing patterns of migration (interregional and global) - Loss of carbon sinks and increased release of carbon to the atmosphere (global)
MODIFICATION OF ECOSYSTEMS OR ECOTONES, INCLUDING COMMUNITY STRUCTURE AND/OR SPECIES COMPOSITION (threatened/endangered species)	1. Modification of natural productivity 2. Modification of biodiversity including loss of species and genetic diversity 3. Changes in ecosystem stability 4. Changes in community structure both plant and animal 5. Susceptibility to disease 6. Changes in migratory species populations and migratory patterns 7. Modification in natural storm barriers and reduced protection from erosion 8. Increased vulnerability to opportunistic invaders	1-5 as above 6. Modification or loss of cultural heritage 7-11 as above 12. Costs of controlling invasive species 13. Costs of restoration of modified ecosystems	- Loss/damage of anadramous/catadramous stocks and their habitat shared by riparian fishing States (regional and interregional) - Reduced means of meeting basic needs (food and fuel) for pop'ns in countries sharing systems (regional) - Loss of existing and potential income from fishing, tourism, potential future resources (regional and global) - Loss of existing potential foreign exchange and investment in countries sharing damaged systems (regional) - Effects on movement of foreign investment, world prices (regional and global) - Costs of restoration to countries sharing damaged systems (regional) - Costs of controlling introduced species to shared marine systems (regional) - Costs of emergency response and rebuilding to shared systems for storm or erosion damage (regional) - Damage to shared cultural heritage (regional) - Reduced aesthetic recreational value in shared system (regional) and for international tourism (global) - Damage to educational and scientific value to shared systems (regional) and loss of potential knowledge (global) - Costs of dealing with human migration and possible international conflict (regional and global)

ANNEX II. Cont.

MAJOR CONCERN IV: UNSUSTAINABLE EXPLOITATION OF FISHERIES & OTHER LIVING RESOURCES.

ISSUES	ENVIRONMENTAL IMPACT	SOCIO-ECONOMIC IMPACT	POTENTIAL TRANSBOUNDARY ISSUES
INAPPROPRIATE HARVESTING PRACTICES Over-exploitation Destructive fishing practices	a. Changes in biological community structure due to overexploitation/depletion of one or more key species b. Changes in food webs favouring scavengers by Wastage of bycatch discards c. Increasing vulnerability of protected species populations d. Changes to habitat and community structure resulting from destructive fishing practices.	1. reduced economic returns 2. loss of employment 3. Conflict between user groups for shared 4. resources including space 5. (+): potential new source of employment 6. (-): loss of proteing for human or animal consumption 7. (-): Juveniles entering other fisheries destroyed, thus reducing earnings 8. Loss of protected species 9. Lost opportunities inter-generational equity issues	- For shared/straddling stocks - problem of sharing resources/management mechanisms by fishery commission. - Wastage of juveniles in one jurisdiction may affect earnings in other (through migration - International tensions due to conflicting claims - Pressure on States through international press (media)/NGOs
RESOURCE/HABITAT CHANGES	a. Changes in community structure by food chain manipulation b. Changes in community structure through restocking and habitat manipulation	1. Improved catch/earnings 2. Improved catch/earnings	- Assumes agreement of owners in other jurisdictions, for transboundary resources
HABITAT DESTRUCTION	a. Ecosystem degradation	1. Loss of employment/earnings	- Uncertain (see Habitat)
DECREASED VIABILITY OF STOCK THRO' CONTAMINATION & DISEASE	a. Possible physiological and ecological impacts on animal populations through chronic contamination	1. Possible Human Health impacts 2. Reduced commercial value resulting from tainting	- Effects in other jurisdictions of imported fishery products
MAN-INDUCED CHANGES IN THE PHYSICAL ENVIRONMENT	a. Potentially severe impacts on ecosystem	1. Loss of food sources and livelihood	
BIODIVERSITY IMPACTS	a. Long-term changes in population genome & gene frequencies b. Changes in biological communities thro' deliberate and accidental introductions	1. Possible effects on fishery (uncertainty) 2. Increased risks of predation, competition and/or disease for commercially valuable species	- Relevant to transboundary seas and waterbodies and shared resources

ANNEX II. Cont.

MAJOR CONCERN V: GLOBAL CHANGE

ISSUES	ENVIRONMENTAL IMPACT	SOCIO-ECONOMIC IMPACT	POTENTIAL TRANSBOUNDARY ISSUES
CHANGES IN HYDROLOGICAL CYCLE	1. Land cover change 2. Habitat/Biodiversity 3. Shifts in Boundaries between sea and fresh waters 4. Feedback to global climate change 5. Changes in thermohaline circulation 6. Extreme events (frequency and intensity) 7. Changes in precipitation, evaporation and snow accumulation and melting	1. Freshwater availability 2. Food security 3. Employment security 4. Changes in productivity of agriculture, fisheries and forestry 5. Changes in resources distribution and political jurisdiction over them 6. Human migration 7. Damage to human life and property 8. Response costs for extreme events 9. Costs for avoiding navigation hazards	N.B. Climate Change is by its very nature a Transboudary cause of environmental and socio-economic issues, many of the impacts of which are themselves transboundary.
SEA LEVEL CHANGE	1. Intrusion of sea water to fresh water 2. Modification of aquatic habitats 3. Loss of land, damage to coastal zones including productive land	1. Increased cost of coast protection and emergency response/forecast 2. Loss of income and employment 3. Loss of property & capital assets 4. Human migration	
INCREASED UV-B RADIATION AS A RESULT OF OZONE DEPLETION	1. Damage to flora and fauna at the water surface and sub-surface 2. Decrease of productivity	1. Loss of incomes and foreign exchange from fisheries 2. Loss of opportunity for investments (both domestic and foreign) 3. Increased costs of human health care	
CHANGES IN OCEAN CO_2 SOURCE/SINK FUNCTION	1. Feedback to global climate change		

ANNEX III
PRINCIPAL SOCIO-ECONOMIC ROOT CAUSES OF THE IDENTIFIED WATER RELATED MAJOR CONCERNS AND PRINCIPAL ISSUES

I. Policy and Legal Failures (Economic policy failures, see III below)

1. Policy and Legal failures including inadequate regulation and best practices, guidelines, etc.
2. Inadequate law and policy harmonization among international instruments
3. Property and user rights
4. Unethical transfer of goods, wastes and technology between countries

II Institutional Failures

1. Lack of capacity, budget, or will to implement policies and decisions
2. Lack of capacity, budget, or will to enforce policies and decisions
3. Lack of clearly defined responsibilities and poor coordination among national government agencies responsible for different sectors
4. Inadequate coordination between local and national levels of government and inadequate delegation responsibility
5. Deficiencies in stakeholder participation (a matter of law and policy in most cases)
6. Failure of institutions to utilize effectively current information in decision-making processes, including selecting inappropriate technology
7. Corrupt practices which subvert the effective implementation of policies and programmes

III Economic (Market) failures (many of these issues originate in Law and Policy)

1. Pricing issues, domestic and international
2. Subsidies
3. Investment policies
4. Valuation of environmental goods and services
5. User fees

IV Information failures in scientific, technical and economic aspects

1. Inadequate scientific understanding and uncertainty and related data
2. Inadequate economic analysis and related data
3. Inadequate or unreliable data collected through routine national data programmes
4. Inadequate knowledge of technological and technical response options

5a. Methodological failures in pre-operational prediction, such as prior comparative analysis of options, prior risk assessments, prior impact assessments

5b. Methodological failures in post operational or environmental analysis, such as environmental auditing, environmental accounting, cause effect analysis, source distribution analysis

6. Ineffective data interpretation for management purposes
7. Inappropriate expert advice and technology
8. Inadequate access to scientific information at the international level by governments and access to data collecting at the national level for international purposes
9. Poor public education and awareness regarding scientific and economic values and technical options

ANNEX IV

INTERACTIONS BETWEEN THE MAJOR CONCERNS AND PRINCIPAL ISSUES

1 = Low; 2 = Intermediate; 3 = High

			A			B		C							D						E		
			1	2	3	1	2	1	2	3	4	5	6	7	1	2	3	4	5	6	1	2	3
A WATER SCARCITY	A1	Pollution	*			3	3	3	3	2	2	1		1				2	3	2			
	A2	Lowering of water table		*	3	2	2												2	1	2		
	A3	Reduction in streamflow		3	*	3	3	3	3	3	3	2		2					3	2	2		
B HABITAT	B1	Loss of ecosystem/ecotones	3	2	3	*											2	2	3	3			
	B2	Modification of ecosystems/ecotones	3	2	3		*	3	3	3	2	1		2	2	2	2	2	2	2	3	3	2
C POLLUTION	C1	Microbiological	3		3		3	*										2	1	1			2
	C2	Eutrophication	3		3		3		*						1				2	2			
	C3	Chemical	2		3		3			*								3	3	2			
	C4	Suspended solids	2		3		2				*							2	2	2			
	C5	Solids	1		2		1					*						1	1	1			
	C6	Radionuclides											*					3	2	1			
	C7	Spills	1		2		2							*						2			
D FISHERIES	D1	Overexploitation					2		1						*	2	3	2	3	3			
	D2	Excessive by-catch					2								2	*	3		1	2			
	D3	Destructive fishing				2	2								3	3	*	2	1	1			
	D4	Disease/Pollution	2			2	2	2		3	2	1	3		2		2	*	2	2		2	
	D5	Biogenetic Diversity	3	2	3	3	2	1	2	3	2	1	2		3	1	1	2	*	2	2	1	2
		Fisheries biomass	2	1	2	3	2	1	2	2	2	1	1	2	3	2	1	2	2	*	2	1	1
E GLOBAL CHANGE	E1	Hydrological Cycle		2	2		3												2	2	*		
	E2	Sea-level rise					3											2	1	1		*	
	E3	UVB					2	2											2	1			*

ANNEX V

CAUSAL CHAIN ANALYSIS FOR IDENTIFIED WATER RELATED MAJOR CONCERNS AND PRINCIPAL ISSUES

MAJOR CONCERN I: FRESHWATER SHORTAGE

ISSUES	CAUSAL CHAIN				UNCERTAINTIES
	IMMEDIATE	SECONDARY	TERTIARY	QUATERNARY	
POLLUTION OF EXISTING SUPPLIES	a. Municipal waste water discharges b. Industrial waste water discharges c. Irrigation return flows d. Urban storm runoff e. agricultural storm runoff f. Evaporation induced concentration g. Atmospheric deposition	1. Inadequate waste water treatment (a,b) 2. Excessive use of fertilizers and other chemicals (c,e) 3. Excessive irrigation (c) 4. Lack of storm water controls and treatment (d,e) 5. Impoundments (f) 6. Poor air quality (g)	1. High cost of treatment (a,b,g) 2. Inadequate regulation and enforcement (a,b,g) 3. Poor operation of treatment plants (a,b) 4. Difficulty in monitoring (a-e,g) 5. Lack of knowledge of pollution impacts (a-e,g)	I 1 II 1, 2, 7 II 2 II 2 IV 4 IV 1, 9	- Effects of pollution - Ambient conditions - Future development patterns
LOWERING OF WATER TABLE	a. Excessive pumping b. Reduced recharge c. Reduced peak flow d. Vegetative cover including phreatophytes	1. Increased water demand from: Population growth; Life style; Industrialization; Food production; Urbanization (a,b) 2. Urban drainage and impermeability (b) 3. Lack of protection of recharge zones (b) 4. Climate change (b,d) 5. Rural land use patterns (b,d) 6. Impoundments (c)	1. Agricultural subsidies (a) 2. Lack of groundwater property rights (a) 3. Lack of regulation and enforcement (a,b) 4. Lack of basin-wide management (a-d) 5. Lack of conjunctive use management (a,b,c) 6. Inappropriate reservoir operation (b,c)	I 1 III 2 I 1 II 1, 2, 7 II 3, 4 IV 1-4	- Future land use and development patterns - Future demographic patterns - Effects of land-use change on hydrology - Regional effects of climate change - Effectiveness of regulations - Future technological changes - Future institutional changes
REDUCTION IN STREAMFLOW	a. Increased diversion for: domestic, industrial, public, irrigation, and recreational uses b. Decreased inputs from: changed rainfall-runoff relationships, and decreased groundwater inflow, c. Return flows d. Increased evaporation e. Reduced peak flows	1. Population growth (a) 2. Life style changes (a) 3. Industrialization (a) 4. Over pumping (a,b) 5. Urbanization (a,b) 6. Food production (a,f) 7. Inappropriate land-use practice (b,c) 8. Reduced recharge (b,c) 9. Irrigation practice (b,c) 10. Changes in channel (b,c) 11. Increased temperature (b,d) 12. Increased water surface, including impoundments (d) 13. Increased vegetative cover	1. Inappropriate investment policies and subsidies (a) 2. Inappropriate water pricing (a) 3. Lack of regulation and enforcement (a) 4. Absence of demand-side management (a,b) 5. Lack of water property rights (a,b) 6. Lack of basin-wide management (a-c) 7. Climate change (a,e)	III 2, 3 I 1 II 1, 2, 7 I 1, 3 II 3, 4 IV 1-4 IV 1	- Future land use and development patterns - Future demographic patterns - Effects of land-use change on hydrology - Regional effects of climate change - Effectiveness of regulations - Future technological changes - Future institutional changes

ANNEX V. Cont.

MAJOR CONCERN II: POLLUTION

ISSUES	CAUSAL CHAIN				UNCERTAINTIES
	IMMEDIATE	SECONDARY	TERTIARY	QUATERNARY	
EUTROPHICATION	a. Enhanced Nutrient Inputs (given appropriate turbidity, incident light and temperature conditions) b. Increased recycling/mobilization c. Trapping of nutrients (e.g. in river impoundments)	1. Use of fertilizers in crop production (a) 2. Use of animal wastes in agriculture (a) 3. Wastes from animal production (a) 4. Combustion of fossil fuel (a) 5. Forestry/Agricultural practices (a,b) 6. Phosphate detergents (a) 7. Sewage discharges (a) 8. Aquaculture (a) 9. Draining of wetlands (a,b) 10. Wildlife preservation e.g. accumulation of guano from sanctuaries for migratory birds (a) 11. Soil loss (a) 12. [Transport of micro-nutrients to the pelagic environment] 13. Water system impoundment (b,c) 14. Soil and sediment erosion, remobilization, leaching (a,b)	1. Enhanced food production via use of fertilizers (a) 2. Intensification of animal production (a) 3. Enhanced energy demand (a,c) 4. Urbanization (a) 5. Enhanced aquacultural production (a) 6. Land-use changes (a,b) 7. Enhancement of navigation, dredging of watersways and harbours (b) 8. Enhancement of water supplies (b,c) 9. Hydrolelectric power development (b,c)	1. Lack of internalization of costs of environmental degradation 2. Inadequate development and/or enforcement of regulations I 1, 2 II 1-7 III 1 - 5 IV 1 - 9	- Relative importance of given sources in a given situation (temporal & spatial variance) - Levels/input rates of nutrients that give rise to algal blooms (exceptional) - Limitations of information on the incidence and bio-availability of forms of nutrients (N & P) - Uncertainties in the precision of comparisons among options or, - Uncertainties in the predictions of the outcome of management intervention
[HARMFUL ALGAL BLOOMS] (Including shifts in phytoplankton community structure, e.g. diatoms to dinoflaggelate)	a.Alterations to the relative rates of input of nutrients (P & N) - Phosphate limitation (Enhancements of nitrogen supply/inputs, reduction in phosphorus inputs, abnormal mixing/upwelling (M) b.Alterations to the relative rates of input of nutrients (Si, P & N) (Increased N inputs, reduced Si inputs, reduced P inputs)	1.Reduction of Phosphorus containing detergents (a) 2.ncreased nitrogen emissions from agriculture especially animal husbandry (a) 3.Increased N emissions from agriculture (b) 4.River impoundment (b)	1. Intensification of agriculture (a) 2. Intensification of agriculture (b) 3. Runoff control/modification (b)	I 1, 2 II 1-7 III 1-5 IV 1-9	- Lack of understanding of phytoplankton metabolism in response to changes in availability of nutrients - Consequence on higher trophic structure of shifts in phytoplankton community structure

ANNEX V. **Cont**

MICROBIOLOGICAL (Bacteriological, viral, and other microbiological agents)	a.Discharge of: sewage, animal wastes, contaminated solids, urban (runoff), inadequately treated hospital wastes, through point and diffuse sources	1.Inadequate regulation of waste management activities and/or 2.lack of enforcement	1. Governance and/or institutional failures 2. Lack of internalization of costs of environmental degradation 4. Lack of education 5. Deficiencies in sectoral management approaches	I 1, 2 II 1-7 III 1-5 IV 2, 3, 5a, 5b, 6, 7, 9	
CHEMICAL	a.Industrial and urban waste discharges b.Agricultural runoff c.Leachates from solid waste landfill d.Chemical releases from aquaculture e.Acid mine drainage f.Weed and pest control activities g.Disease vector control activities h.Emissions from fossil fuel combustion (electrical and vehicle) i.Increased combustion of natural vegetation	1.Road safety improvement (a) 2.Enhanced manufacture and use of chemicals in domestic applications (a, b) 3.Mineral extraction and refining (a, b, c) 4.Land clearance (and combustion) (a, b, c, i) 5.Human health protection (a, b, g) 6.Intensification of agriculture (b, f, i) 7.Aquaculture development (d) 8.Increased use of antifoulants (d) 9.Intensified forest management (f) 10.Intensified fossil fuel combustion (h)	1. Population growth (a, b) 2. Enhancements in standards of living (a, b) 3. Increased industrial development (a, b, e, h) 4. Increased urbanization (a, b, h) 5. Increased demand for food/proteins (a, d, f, i) 6. Reduction of risks to human health and safety (g) 7. Increased use of vehicles (h) 8. Continued reliance on fossil fuels (h)	1. Lack of internalization of costs of environmental degradation 2. Failure to limit population growth and migration 3. Poor development and/or enforcement of regulations pertaining to environmental impacts of social and industrial development. 4. Limitations in the international transport of hazardous substances 5. Deficiencies in sectoral management approaches I 1-4 II 1-7 III 1-5 IV 1-9	- Effects on the environment, Man and aquatic organisms imprecise (both deterministic and stochastic effects regimes) - Dose/response relationships uncertain - Difficulties in quantifying relative magnitudes of sources - Lack of information on production rates and use of chemicals and their locations
SUSPENDED SOLIDS	a.Soil erosion (aeolian and runoff transport) b.Land development/ excavation/earthmoving c.Dredging d.Aggregate recovery e.Mine waste discharges f.Placer mining g.Sewage (& sewage sludge) discharges, dumping h.Release of drilling muds and particulate additives i.Hydraulic mining j.Urban waste discharges (including plastic scrubbers in domestic and industrial cleaners)	1.Deforestation (a) 2.Agricultural activities (a) 3.Mineral mining, extraction and separation (a, b, d, e, h, i) 4.Reservoir maintenance (b, c) 5.Harbour development, maintenance (b, c, d) 6.Navigational improvements (c, d) 7.Inadequate treatment of urban wastes (g, j)	1. Urbanization (a, b, d, g, j) 2. Infrastructural improvement (a, b, c, d, g, j) 3. Industrial development (a, b, c, d, e, f, h, i) 4. Residential development (a, b, d, g) 5. Marine and riverine transport (c, d)	1. Population growth 2. Improvement in standards of living 3 Failure to internalize costs of environmental degradation 4 Deficiencies on the development and/or enforcements of regulations (unregulated activities) 5. Failures of sectoral management approaches I 1, 2 II 1-7 III 1-5 IV 1, 2, 3,, 5a, 5b, 6, 7, 9	

ANNEX V. Cont.

SOLIDS (Bulky wastes)	a.Deliberate dumping of objects b.Casual discard of buoyant and non-buoyant waste objects by individuals	1.Increased use of packaging 2.Misplaced reliance on public good behaviour 3.Thoughtlessness 4.Deficiencies in recycling programmes	1. Excessive/unnecessary use of packaging 2. Limitations in waste disposal options 3. Excessive pace of enhancements to standards of living without commcomitant development of recycling and disposal facilities	1. Deficiencies in the development and/or enforcement of regulations 2. Failure to internalize the costs of environmental degradation 3. Inadequate education 4. Deficiencies in the control of public behaviour 5. Deficiencies of sectoral (non-holistic) management approaches I 1, 2, 3, 4 II 1, 2, 3, 4, 5,7 III 1, 5 IV 2, 3, 5a, 5b, 6, 7, 9	
RADIONUCLIDES	a.Incidents at sea b.Spills from treatment facilities c.Discharges/emissions from nuclear power plants d.Discharges/emissions from nuclear fuel reprocessing plants e.Deliberate waste disposal at sea f.Accidents with nuclear weapons g.Accidents at nuclear power installations h.Accidents involving nuclear-powered vessels i.Fallout from nuclear weapons tests j.Contamination from underwater/underground nuclear tests (military and peaceful)	1.Deliberate use of the marine environment for waste assimilation and disposal 2.Use of nuclear power as an electrical generation source and for powering military and civilian vessels 3.Military activities	1. Peaceful applications of nuclear power 2. Military applications of nuclear power and nuclear weapons 3. Peaceful application of nuclear explosives	1. No global problems 2. Perceptions represent concerns only 3. Except for limited fail-safe provisions for release from nuclear weapons	
ACCIDENTAL SPILLS	a.Inadequate accident minimization measures b.Inadequate contingency, response measures c.Human error d.Force majeure	1.Lack of development or implementation of preventative and/or remedial measures	1. Failures in policy development 2. Failures in policy implementation	I 1, 2(f), 3, 4 II 1-7 III 3, 5 IV 1, 2, 4(f), 5a, 5b, 6, 7, 9 I 1, 2(f), 3, 4 II 1, 2, 3, 4, 5a, 5b, 6, 7 III 3, 5 IV 1, 2, 4(f), 5a,5b, 6, 7, 9	

ANNEX V. Cont.

MAJOR CONCERN III: HABITAT AND COMMUNITY MODIFICATION

ISSUES [1]	CAUSAL CHAIN				UNCERTAINTIES
	IMMEDIATE	SECONDARY	TERTIARY	POLICY MANAGEMENT FAILURES	
LOSS OF MANGROVE ECOSYSTEM	a. Conversion to aquaculture	1. High economic returns at individual and group level	1. Export drive & world market price of shrimp	1. Undervaluation of mangrove ecosystem 2. Government foreign trade & investment policies I-1, 2, 3; II-all; III-1, 3, 4; IV-1-7, 9	- Method of economic valuation and valuation of mangrove ecosystems
	b. Conversion to Agriculture for: (i) Subsistance requirements (ii) Intensive, commercial production	1. Subsistance requirements & food security eg rice 2. Economic returns from cash crops e.g. oil palm	2. High population pressures 3. Export drive and world prices of agricultural commodities	1. Undervaluation of mangrove ecosystem 2. Government foreign trade & investment policies I-1, 2, 3; II-all; III-1-4; IV-all	- Determination of carrying capacity
	c. Conversion to ports, airports and other public infrastructure d. Conversion to Tourism Infrastructure	1. National Development needs 2. High economic returns		1. Undervaluation of ecosystem 2. National policies on land-use 3. Coordination among sectoral agencies of government I-1, 3; II-all; III-3, 4; IV-all 4. Government policies on foreign investment I-1, 3; II-all; III-2, 3, 4; IV-all	- Determination of carrying capacity

[1] The examples specified are not meant to be comprehensive. Similar causal chains could be developed for coral reefs, seagrass beds, and many other tropical and temperate systems

ANNEX V. cont.

MODIFICATION TO MANGROVE ECOSYSTEM	a. Subsistance wood harvest b. Commercial timber harvest (forestry ("sustainable") c. Selection of particular species resulting in monoculture d. Woodchip harvest for Rayon Production, based on clear-felled coups	1. Subsistance/Survival needs 2. Better economic returns 3. Commercial exploitation for export	1. Poverty, lack of employment, economic opportunities 2. Population growth and migration 3. High economic return to foreign investor but negligible return to country when resources is exploited	1. Government policies on foreign investment 2. Monopoly in world woodchips market; government policies on foreign investment; undervaluation of mangrove ecosystem I-1, 2, 3; II-all; III-1, 3, 4; IV-all	- Valuation of mangrove ecosystem - Lack of ecological understanding of ecosystem structure and function - Recovery time after extensive harvest - Extent of ecological damage after harvest
	a. Partial conversion to aquaculture b. Diminished freshwater & sediment supply due to dams, diversion c. Sedimentation from offshore mining d. Movement into mangroves	1. High economic returns 2. Comparative value of placer minerals such as tin 3. Population pressure		I-1, 2, 3; II-all; III-1, 3, 4; IV-1-7, 9 1. Inadequate consideration of downstream impacts and lack of coordination among different government Ministries in water allocation I-1, 2; II-all; III-1, 2, 4, 5; IV all I-1; II-all; III-3, 4; IV-1-7, 9 I-3; II-2, 3-5, 7; III-4; IV-9	- Scientific basis for buffer zone and protected areas - Scientific information on nutrient fluxes
MODIFICATION OF TEMPERATE ESTUARY Modification in biodiversity and system function, migratory species and patterns of migration, nursery and fishery productivity, recreational value	a. Sedimentation due to: Forestry, road and other construction; Dams, diversion; Cattle raising/riparian erosion b. Introduction of exotic species through aquaculture c. Disease from reintroduction of species for aquaculture d. Loss of habitat due to conversion to airports, marinas, housing, etc.	1. Food supply and cash crop 2. Food supply and cash crop 3. Relative valuation	1. Inadequate forest and watershed management practices 2. Inadequate consideration of downstream impacts and lack of coordination among different government Ministries in water allocation 3. Inadequate management practices to control erosion	I-1, 2; II-all; III-1, 2, 4, 5; IV all	- Agreed methods and economic valuation of system and system function - Change in flushing rates in some estuaries

ANNEX V. cont.

MAJOR CONCERN V: OVEREXPLOITATION OF FISHERIES & OTHER LIVING MARINE RESOURCES

ISSUES	CAUSAL CHAIN				UNCERTAINTIES
	IMMEDIATE	SECONDARY	TERTIARY	QUATERNARY	
OVER-EXPLOITATION	a. Excessive effort (too many boats, fishermen, etc.)	1. Possibility of individual/collective profits 2. Need for food for subsistence drives poor into fishery as "employment of last resort"	1. High prices, demand driven, international trade in fish 2. Migration to the coast 3. Lack of employment opportunities, poverty 4. Lack of other food options	1. Free access to resources 2. Human population growth and lack of land tenure in agriculture I 3 III 4 IV 1, 2, 3,5a,6, 7,9	- Inadequate information on resources and on socio-economic aspects; - Market uncertainties - Employment uncertainties - Impact of climate variability on resources (e.g. El Nino)
EXCESSIVE BYCATCH AND DISCARDS	a. Low economic value of discards	1. Poor Fishing Gear Selectivity 2. Perishability and/or lack of storage facilities and/or poor acceptance as food	1. Lack of research on fishing technology 2. Lack of research on product development	III 1, 4, 5 IV 1 IV 4	- Uncertainty of priority between reducing bycatch and utilising it
DESTRUCTIVE FISHING PRACTICES	a. Inappropriate technology and poor harvest procedure	1. Lack of "environmentally friendly" fishing gear 2. Lack of ecological ethics in harvesters/users	1. Lack of research on fishing technology 2. Lack of consideration of intergenerational equity issue	1. Lack of education of fishery I 1 II 1, 2, 5 III 4 IV 1	- Direct and indirect impacts of fishing difficult to distinguish
DECREASED VIABILITY OF STOCK THROUGH POLLUTION/ DISEASE	a. Unsuitable environment for survival or completion of life cycles	1. Anoxia 2. Contaminants 3. Loss of habitat 4. Disease-causing organisms	1. Pollution (See pollution and Habitat)		
IMPACT ON BIOLOGICAL AND GENETIC DIVERSITY	a. Increase in exotic species interferes with commercial species, competitors, predators) b. Reduction of the gene pool of wild stocks	1. Accidental introductions by shipping (ballast water), aquaculture 2. Intentional release of animals of a single genotype stock 3. Loss of diversity in breeding areas/ecosystems	1. Failure of regulations regarding ballast water treatment/quarantine of imported species 2. High returns from aquaculture and recreational fisheries investments	1. Lack of scientific research IV_1 II_2 2. Poor planning (lack of consideration of intergenerational equity) when making investments	Inadequacy of controls Questionable enforcement capacity

ANNEX VI

MARINE GEOGRAPHICAL AREAS AND FRESHWATER BASINS

The following tabulation is a preliminary and far from complete geographic framework under which a GIWA Assessment might be organised. The Major Regions correspond to the 9 regional organisational Units. Columns one and two represent the major marine divisions, and columns 4 and 5 represent the major freshwater units, around which the regional assessments could be structured. Column 3 includes smaller marine sub-units for a number of areas where it is known that specialised assessment activities are already underway or have been completed in the past.

The following points should be noted:
- The columns headed Coastal and Riparian States & Relevant Institutions, Organisations and Programmes, are provided for guidance only and are NOT intended to be taken as an exhaustive listing;
- in a number of instances the inland or land-locked countries sharing freshwater basins have not been listed (e.g. the Nile)
- not all the world's rivers have been listed and in a number of instances where none are named, numerous smaller rivers drain into the coastal seas designated in columns 2 & 3; and,
- the geographic scope of each unit includes the entire area of the catchment basins draining to the designated marine area.
- nomenclature follows the Times Atlas of the Oceans
- A global map of Large Marine Ecosystems (LMEs) is included in Annex V of this report and individual LMEs are identified under each of the large regional units in the following tabulation.

ANNEX VI. Cont.

REGION I: ARCTIC & MAJOR FRESHWATER CATCHMENT BASINS

Marine Area Level 1*	Marine Sub-area, Level 2*	Marine Sub-area, Level 3*	Freshwater catchment(s) Level 1	Freshwater catchment(s) Level 2	Coastal/ Riparian States	Relevant Institutions, Organizations & Programmes
Arctic Basin (I)[2]					Denmark, Norway, USA	AMAP; IASC; AOSB;
			MacKenzie		Canada	MIZEX; SHEBA; AII
			N. Dvina		Russia	
			Pechora			
			Ob			
			Enisey	Baykal Lake		
			Lena			
			Kolyma			

[2] Roman numerals in parantheses (e.g.I) correspond to the columns in Annex ##

ANNEX VI. Cont.

REGION II: NORTH ATLANTIC & MAJOR FRESHWATER CATCHMENT BASINS[3]

Marine Area Level 1*	Marine Sub-area, Level 2*	Marine Sub-area, Level 3*	Freshwater catchment(s) Level 1	Freshwater catchment(s) Level 2	Coastal/ Riparian States	Relevant Institutions, Organizations & Programmes
Wider Caribbean	Gulf of Mexico (2) (LME)		Mississippi		USA Mexico	IOCARIBE; UNEP (CEP); Gulf of Mexico Program; Gulf of Mexico Fisheries Management Council; River Basin Commissions; National Estuary Programs; Watershed Councils; Universities; EPA; NOAA; USGS; National Water Quality Monitoring Council
			Rio Grande			
			Brazos			
			Grijalva			
			Colorado			
	Caribbean Sea (3) (LME)		Magdalena		Belize, Guatemala, Honduras, Nicaragua, Costa Rica, Panama, Colombia, Venezuela	IOCARIBE, COSDLC, UNDP, FAO, CARICOMP, OAS MEXICO, UNEP, PNUMA.
		Caribbean Islands (4)			Aruba, Cuba, Haiti, Dominican Republic, Jamaica, Puerto Rico, Bahamas, US Virgin Islands, Antigua & Barbuda, Barbados, Bermuda, St.Kitts/Nevis, Dominica, St.Lucia, St.Vincent & the Grenadines, Grenada, Trinidad & Tobago, British Dependent Territories, The Netherlands Antillies, French Islands	UNDP; FAO; UNCHS; CRMI(OECS/NRMU); CCA; ECLAC; CARICAD; CEPPOL; COSALC; CFRAMP; CARICOMP; WIDECAST; IRF; CEHI; IMA; CMI; METEO-France; CARMABI; CANARI; Univ. of West Indies; MAREMP; CMS; UWICED.

[3] NB. The designations employed and the presentation of the material in this document do not imply the expression of any opinion whatsoever on the part of UNE the legal status of any State, Territory, City or area, or of its authorities, or concerning the delimitation of its frontiers or boundaries. This document cor acting in their individual capacities, and may not necessarily correspond with the views of the sponsoring organisations.

ANNEX VI. Cont.

REGION II: NORTH ATLANTIC & MAJOR FRESHWATER CATCHMENT BASINS[4], Continued.

Marine Area Level 1*	Marine Sub-area, Level 2*	Marine Sub-area, Level 3*	Freshwater catchment(s) Level 1	Freshwater catchment(s) Level 2	Coastal/ Riparian States	Relevant Institutions, Organizations & Programmes
Western North Atlantic	Southeast Shelf (5) (LME)	Pamlico Sound	Pamlico		USA	NAFO; ICES;
			Neuse			
	Northeast Shelf (6) (LME)	Gulf of Maine	Androscoggin		USA	National Estuary Programs;
			Penobscot			
		Bay of Fundy	St. John			National Water Quality Monitoring Council
		Long Island Sound	Connecticut			
			Hudson			
		Delaware Bay	Delaware			
		Chesapeake Bay	Susquehanna			Chesapeake Bay Programme
			Potomac			
			James			
		Albermarle Sd.				
	Scotian Shelf (7) (LME)		St. John		Canada	
	Gulf St. Lawrence (8)		St. Lawrence	Great Lakes	USA, Canada	International Joint Commission;
	Newfoundland Shelf (9) (LME)				Canada	Fisheries Management
	Baffin Bay, Labrador Sea, Canadian Archipelago (10)					Councils States/Tribes;
	East Greenland (15) (LME)				Greenland	
	West Greenland (16) (LME)					
	Iceland Shelf (14) (LME)				Iceland	

[4] NB. The designations employed and the presentation of the material in this document do not imply the expression of any opinion whatsoever on the part of UNE the legal status of any State, Territory, City or area, or of its authorities, or concerning the delimitation of its frontiers or boundaries. This document cor acting in their individual capacities, and may not necessarily correspond with the views of the sponsoring organisations.

REGION II: NORTH ATLANTIC & MAJOR FRESHWATER CATCHMENT BASINS[5], Continued.

Marine Area Level 1*	Marine Sub-area, Level 2*	Marine Sub-area, Level 3*	Freshwater catchment(s) Level 1	Freshwater catchment(s) Level 2	Coastal/ Riparian States	Relevant Institutions, Organizations & Programmes
Eastern North Atlantic	Barents Sea (11) (LME)		Tuloma		Russia, Norway, Faroes	ICES: UNDP Barents Sea Oslo & Paris Commission
	Norwegian Sea (12) (LME)		Namsen			
	Faroe Plateau (13) (LME)					
	Baltic Sea (17) (LME)				Sweden, Finland, Estonia, Latvia, Lithuania, Denmark	HELCOM; ICES; EU (Phare/Tacis, MAST); NSP; SKAGEX; Baltic Agenda 21, BALTEX
			Oder		Germany	
			Vistula	Bug	Poland, Belarus, Ukraine	
			Neva	Ladoga Lake	Russia	
			Dalelven		Sweden, Norway, Denmark	Oslo & Paris Commission
	North Sea (18)		Rhine		Switzerland, France Netherlands	Int. Rhine Comm.
			Shelde			
			Elbe		Germany	Int Elbe Comm.
			Weser			
			Humber		UK	
			Tyne			
			Thames			
	Celtic-Biscay Shelf (19) (LME)		Avon		UK,	Oslo & Paris Commission
			Loire		France,	
			Shannon		Ireland,	
	Iberian Coastal (20)(LME)		Douro, Tejo		Spain,	Oslo & Paris Commission
			Tambre		Portugal	
	Mediterranean Sea (21) (LME)	Western			Malta, Morocco , Algeria, Monaco	UNEP/MAP; EU; WB/UNDP/EIB-METAP WB
		Mediterranean	Ebro		Spain	
			Rhone		France Switzerland	
		Eastern	Po		Italy. Slovenia, Croatia, Greece	

[5]NB. The designations employed and the presentation of the material in this document do not imply the expression of any opinion whatsoever on the part of UNEP the legal status of any State, Territory, City or area, or of its authorities, or concerning the delimitation of its frontiers or boundaries. This document co acting in their individual capacities, and may not necessarily correspond with the views of the sponsoring organisations.

Marine Area Level 1*	Marine Sub-area, Level 2*	Marine Sub-area, Level 3*	Freshwater catchment(s) Level 1	Freshwater catchment(s) Level 2	Coastal/ Riparian States	Relevant Institutions, Organizations & Programmes
		Mediterranean	Nile[6]		Egypt. Albania, Turkey, Cyprus Syria, Lebanon, Israel, Tunisia, F. Yugoslavia, Bosnia-Herzegovina, Libya	

[6] The countries of the Nile Basin are not listed in the Right Hand Column

ANNEX VI. Cont.

REGION II: NORTH ATLANTIC & MAJOR FRESHWATER CATCHMENT BASINS[7], Continued.

Marine Area Level 1*	Marine Sub-area, Level 2*	Marine Sub-area, Level 3*	Freshwater catchment(s) Level 1	Freshwater catchment(s) Level 2	Coastal/ Riparian States	Relevant Institutions, Organizations & Programmes
	Black Sea (22) (LME)				Bulgaria Georgia Romania Russia Turkey Ukraine	BSEP- UNDP/UNEP/WB /EU; TU-Black Sea - NATO; EROS-2000 - EU; COMSBlack - IOC IOC Reg. Programme.
			Danube		Austria, Bulgaria, Romania, Germany, Slovakia, Slovenia, Moldova, Hungary, Croatia, Czech Republic, Bosnia, F.Yugoslavia	Danube River Basin - EU/GEF Sub-regional: Danube Delta GEF (PDF)
			Dnipro		Belarus, Russia, Ukraine	Dnipro GEF (PDF)
			Dniestr		Moldova	
			Chorokh		Georgia, Turkey	
		(Azov Sea)	Don		Russia, Ukraine	Azov Sea DSS - Netherlands; Lower Don (WB)
	Caspian Sea (23)	North Caspian			Turkmenistan, Iran	WB/EU
			Volga		Russia	
			Ural		Kazakhstan	
		South Caspian	Kura		Turkey, Georgia, Armenia, Azerbaidjan	
			Aral Sea (24)	Amudariya	Kirgistan, Turkmenistan Kazakhstan, Uzbekistan	

[7] NB. The designations employed and the presentation of the material in this document do not imply the expression of any opinion whatsoever on the part of UNE the legal status of any State, Territory, City or area, or of its authorities, or concerning the delimitation of its frontiers or boundaries. This document coı acting in their individual capacities, and may not necessarily correspond with the views of the sponsoring organisations.

ANNEX VI. REGION III: NORTH PACIFIC & MAJOR FRESHWATER CATCHMENT BASINS[8], Continued.

Marine Area Level 1*	Marine Sub-area, Level 2*	Marine Sub-area, Level 3*	Freshwater catchment(s) Level 1	Freshwater catchment Level 2	Coastal & Riparian States	Relevant Institutions, Organizations & Programmes
North Pacific	California current (26) (LME)		Columbia		Canada	CALCOFI; GLOBEC;
			Sacramento		USA	COOP; WOCE
	Gulf of California (27) (LME)		Colorado		Mexico	
			Fuerte			
	Gulf of Alaska (25) (		Columbia		USA	INPOC; WOCE; GLOBEC; COOP
			Susitna			
			Matanuska			
			Copper			
			Fraser		Canada	
			Skeena			
	Bering Sea	E. Bering Sea (28) (LME)	Yukon		USA, Canada,	BERPAC
		W. Bering Sea (29) (LME)	Anadyr		Russia	
	Sea of Okhotsk (30) (LME)				Russia, Japan	
	Oyashio Current (31) (LME)				Japan	NOWPAP
	Kuroshio Current (32) (LME)				Japan, China	NOWPAP
	Sea of Japan[9] (33) (LME)		Amur		Russia, Japan, S.Korea, N.Korea, China	NOWPAP
			Tumen			
	Yellow Sea (34)	Bohai Sea (35	Hai		Japan, N. Korea, S.Korea	NOWPAP
			Liao			
			Yellow		China	
	East-China Sea (36) (LME)		Yangtse		China, Japan, S. Korea	EASAP
			Huai			
Central Pacific	Hawaiian Archipelago (37) (LME)				USA & International Water	UNCLOS

[8] NB. The designations employed and the presentation of the material in this document do not imply the expression of any opinion whatsoever on the part of UNE the legal status of any State, Territory, City or area, or of its authorities, or concerning the delimitation of its frontiers or boundaries. This document co acting in their individual capacities, and may not necessarily correspond with the views of the sponsoring organisations.

[9] Also known as the East Sea

ANNEX VI. Cont.

REGION IV: EASTERN SOUTH AMERICA & MAJOR FRESHWATER CATCHMENT BASINS[10]

Marine Area Level 1*	Marine Sub-area, Level 2*	Marine Sub-area, Level 3*	Freshwater catchment(s) Level 1	Freshwater catchment(s) Level 2	Coastal/ Riparian States	Relevant Institutions, Organizations & Programmes
Southeast Atlantic	Patagonian Shelf (38) (LME)		La Plata/Parana	Paraguay	Chile, UK Brazil, Paraguay,	La Plata Treaty
				Bermejo	Argentina, Bolivia	GEF Project
				Uruguay	Uruguay, Brazil	
				Parana	Paraguay, Argentina, Brazil	Itaipu Agreement
	Brazil Current (39) (LME)		Paraibe do Sul Guanabara Bay Sao Francisco		Brazil	Brazilian Government PDBG
			Patos Lagoon		Uruguay	CEIVAP
	Northeast Brazil Shelf (40) (LME)		Tocantins,	Araguia	Brazil	Brazilian Government
				Xingu		CEVASF
			Amazon (33b)		Peru, Colombia, Venezuela, Brazil, Equador	Amazon Treaty

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ANNEX VI. REGION V: SUB-SAHARAN AFRICA & MAJOR FRESHWATER CATCHMENT BASINS[11]

Marine Area Level 1*	Marine Sub-area, Level 2* (description)	Marine Sub-area, Level 3* (description)	Freshwater catchment(s) Level 1	Associated catchment Level 2	Coastal/ Riparian States	Relevant Institutions, Organizations & Programmes
West & Central Africa	Canary Current (41) (LME) Senegal/Cape Verde Island				Guinea Bissau	ORSTOM, ECOWAS, CECAF
			Senegal		Senegal, Mauritania, Mali	Senegal River Commission
			Gambia		Gambia, Senegal, Guinea	
			Lake Chad (43)		Nigeria, Chad, Sudan, Cameroon, Niger	Lake Chad River Basin
	Gulf of Guinea (42) (LME)				Sierra Leone, Liberia, Cote d'Ivoire, Sao Tome & Principe, Equatorial Guinea, Gabon	ECOWAS, Central Africa Economic Community, CECAF, GEF
			Volta		Ghana, Benin, Burkino Faso, Togo	Volta River Authority, CEB
			Niger/Benue		Niger, Guinea, Nigeria, Benin, Cameroon, Chad, Mali	Niger River Authority
			Congo		Congo Brazzaville, Congo Kinshasa, Angola	Economic Community of Central Africa
	Benguela Current (44) (LME)		Cunene		Angola	BENEFIT, SADC
			Oranje		Namibia, South Africa	SADC,
			Okavango (internal)		Namibia, Botswana, Angola	SADC, OKACOM
East Africa - Western Indian Ocean	Agulhas Current (45) (LME)		Great Ruaha		Tanzania, Comoros, Madagascar	SADC, COMESA, IOCIMCWO
			Mangoky			
			Limpopo		Botswana, Zimbabwe	
			Zambezi		Mozambique, Zambia, Malawi, Namibia, South Africa	
	Somali Coastal Current (46) (LME)		Tana		Kenya	IGAD; EAS; IOCINWIO
			Ruyuma		Tanzania, Mozambique	
			Juba		Somalia, Ethiopia, Kenya	

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Marine Area Level 1*	Marine Sub-area, Level 2* (description)	Marine Sub-area, Level 3* (description)	Freshwater catchment(s) Level 1	Associated catchment Level 2	Coastal/ Riparian States	Relevant Institutions, Organizations & Programmes
			East African Rift Valley Lakes (47)		Kenya, Tanzania, Uganda, Ruanda, Burundi, Congo-Kinshasa, Ethiopia, Zambia, Zimbabwe, Mozambique	GEF

ANNEX VI. Cont.

REGION VI:INDIAN OCEAN & MAJOR FRESHWATER CATCHMENT BASINS[12]

Marine Area Level 1*	Marine Sub-area, Level 2* (description)	Marine Sub-area, Level 3* (description)	Freshwater catchment(s) Level 1	Associated catchment Level 2	Coastal/ Riparian States	Relevant Institutions, Organizations & Programmes
Arabian Sea	Gulf of Aden (48)				Yemen, Djibouti, Somalia	PERSGA
	Red Sea (49) (LME)				Eritrea, Sudan, Egypt, Palestine, Israel, Syria, Jordan, Saudi Arabi	PERSGA
			Jordan (land-locked river) (51)		Izrael, Syria, Jordan, Palestine, Lebanon	EU Database Project
	Persian Gulf (50)		Tigris-Euphrates		Turkey, Syria, Iraq, Iran, Saudi Arabia, Kuwait, Bahrain, Qatar, United Arab Emirates	ROPME
South Asia Seas	Arabian Sea (52) (LME)		Narmada		India Oman, Somalia, Yemen, Pakistan, Maldives, Iran.	SACEP, ICIMOD, SAARC, IOMAC, START - SEACOM, ESCAP JGOFS, PERSGA, WOCE
			Indus		Afganistan, Pakistan, India	Indian/Pakistan Agreement
	Bay of Bengal (53) (LME)				Sri Lanka, Thailand	GEF
			Ganges		Bangladesh, India, Bhutan, Nepal	ICIMOD, Indo/Bangladesh Agreement, India/Nepal Agreement
			Brahmaputra			
			Irriwaddy		Myanmar	

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ANNEX VI. REGION VII: SE ASIA AND THE SOUTH PACIFIC & MAJOR FRESHWATER CATCHMENT BASINS[13]

Marine Area Level 1*	Marine Sub-area, Level 2*	Marine Sub-area, Level 3*	Freshwater catchment(s) Level 1	Freshwater catchment(s) Level 2	Coastal/ Riparian States	Relevant Institutions, Organizations & Programmes
South-East Asia (incl. North Australia)	South China Sea (54) (LME)				Malaysia, Philippines, Indonesia	START - SARCS; ASEAN; COBSEA
			Pearl River		China	
			Red River		Vietnam,	
			Black River			
			Mekong (55)		Laos, Cambodia,	Mekong Commission
		Gulf of Thailand	Chaophria		Thailand	
	Sulu-Celebes Sea (56) (LME)				Indonesia	
	Indonesian Seas (57) (LME)				Indonesia	
	Northern Australian Shelf (58) (LME)				Australia Indonesia	
South Pacific	Coral Sea Basin (59)				Australia New Zealand	
	Great Barrier Reef (60) (LME)				Australia	GBRMPA
	Great Australian Bight (61)		Murray-Darling		Australia	Murray-Darling Commission
	Small Islands (62)				Cook Islands; Fiji; Kiribati; Niue, Marshall islands; Federated States of Micronesia; Papua New Guinea; Tonga; Tuvalu; Vanuatu; Western Samoa; Nauru; Solomon Islands; Territories & Dependencies of UK & USA; France	SPREP, ESCAP, University of South Pacific, SPC, SPEC, South Pacific Forum, Forum Fisheries Agency, SOPAC, Tourism Council of the South Pacific
	Tasman Sea (63)	New Zealand Shelf (LME)			New Zealand	

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ANNEX VI. Cont.

REGION VIII: SOUTH-EAST PACIFIC & MAJOR FRESHWATER CATCHMENT BASINS[14]

Marine Area Level 1*	Marine Sub-area, Level 2* (description)	Marine Sub-area, Level 3* (description)	Freshwater catchment(s) Level 1	Associated catchment Level 2	Coastal/ Riparian States	Relevant Institutions, Organizations & Programmes
Southeast Pacific	Humboldt Current (64) (LME)				Colombia, Panama	CPPS
			Bravo		Chile, Peru, Equador	
			Lake Titicaca (landlocked)		Peru, Bolivia	
			Chilean Southern Lakes			
Eastern Equatorial Pacific (65)					Guatemala, Nicaragua, El Salvador, Costa Rica, Honduras	

REGION IX: ANTARCTIC[15]

Marine Area Level 1*	Marine Sub-area, Level 2* (description)	Marine Sub-area, Level 3* (description)	Freshwater catchment(s) Level 1	Associated catchment Level 2	Coastal/ Riparian States	Relevant Institutions, Organizations & Programmes
Antarctic (66) (LME)	Southern Ocean				Antarctic Treaty Countries	Scientific Committee on Antarctic Research CCAMLR
		Weddell Sea				

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ANNEX VII

PRELIMINARY CONSIDERATION OF THE REGIONAL IMPORTANCE OF THE MAJOR WATER-RELATED CONCERNS AND PRINCIPAL ISSUES

The following tabulation provides an initial expert opinion concerning the relative importance of the identified major concerns and principal issues on a regional basis. It was constructed as a means of scoping the full assessment and does not constitute, in itself, an assessment of the relative importance of the major concerns and principal issues.

During the preparation of these tables and the subsequent plenary discussion it was clearly recognised that:

- the contents of this Annex provide a guide to the scope and nature of the final assessment and should not be taken as a quantitative statement concerning the importance of the concerns in each region;
- the highlighted concerns (shaded cells) represent an opinion by members of the Group concerning the comparative importance of each issue in a regional and global context;
- Individual regional assignments should not be taken out of the context of the entire table; and,
- participants in the exercise noted that in many cases, either information was lacking, or the collective knowledge of the Expert Group was insufficient for a well-qualified judgement regarding the degree of concern, such cases are indicated by ii = insufficient information.

In some cases the designated regions could be further subdivided on the basis of available information and expert knowledge, hence the final page of this annex provides a more detailed geographic breakdown for the Mediterranean, Black and Caspian Seas.

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ANNEX VII. Cont.

		REGION I ARCTIC	REGION II - NORTH ATLANTIC																					
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
A FRESHWATER	A1 Pollution		ii	ii																ii					
SHORTAGE	A2 Changes in Water Table		ii	ii																ii					
	A3 Reduction in streamflow		ii	ii	ii															ii					
B HABITAT	B1 Loss of ecosystems/ecotones			ii																ii		ii			
MODIFICATION	B2 Modification of ecosystems ecotones																			ii					
C POLLUTION	C1 Microbiological																								
	C2 Eutrophication																								
	C3 Chemical			ii																					
	C4 Suspended solids		ii	ii																					
	C5 Solids																			ii					
	C6 Radionuclides																								
	C7 Spills																								
D FISHERIES	D1 Overexploitation																								
OVEREXPLOITATION	D2 Excessive by-catch																								
	D3 Destructive Fishing		ii	ii																					
	D4 Diseases/Pollution		ii	ii																		ii			
	D5 Biogenetic diversity		ii	ii	ii																				
	D6 Fisheries biomass																								
E GLOBAL CHANGE	E1 Hydrological cycle		ii	ii																					
	E2 Sea level change		ii	ii																ii					
	E3 UVB		ii	ii	ii															ii		ii	ii	ii	ii

REGION I ARCTIC

1. Arctic

REGION II - NORTH ATLANTIC

2. Gulf of Mexico LME
3. Caribbean Sea LME
4. Caribbean Islands
5. South East Shelf LME
6. Northeast Shelf LME
7. Scotian Shelf LME
8. Gulf of St. Lawrence
9. Newfoundland Shelf LME
10. Baffin Bay, Labrador Sea, Canadian Archipelago
11. Barents Sea LME
12. Norwegian Sea LME
13. Faroe Plateau
14. Iceland Shelf LME
15. East Greenland Shelf LME
16. West Greenland Shelf LME
17. Baltic LME
18. North Sea LME
19. Celtic-Biscay Shelf
20. Iberan Coastal LME
21. Mediterranean Sea LME
22. Black Sea LME
23. Caspian Sea
24. Aral Sea

ANNEX VII. Cont.

		REGION III - NORTH PACIFIC													REGION IV - EASTERN SOUTH AMERICA				REGION V - SUB-SAHARAN AFRICA						
		25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40a	40b	41	42	43	44	45	46	47
A FRESHWATER	A1 Pollution				ii		ii															ii			
SHORTAGE	A2 Changes in Water Table				ii		ii																		
	A3 Reduction in streamflow				ii		ii															ii			
B HABITAT	B1 Loss of ecosystems/ecotones				ii		ii																		
MODIFICATION	B2 Modification of ecosystems ecotones				ii		ii															ii			
C POLLUTION	C1 Microbiological				ii		ii																		
	C2 Eutrophication				ii		ii						ii												
	C3 Chemical				ii		ii																		
	C4 Suspended solids				ii		ii																		
	C5 Solids				ii		ii																		
	C6 Radionuclides				ii		ii																		
	C7 Spills						ii																		
D FISHERIES	D1 Overexploitation				ii								ii												
OVEREXPLOITATION	D2 Excessive by-catch				ii																				
	D3 Destructive Fishing				ii		ii																		
	D4 Diseases/Pollution				ii		ii													ii			ii		
	D5 Biogenetic diversity				ii		ii								ii	ii				ii			ii		
	D6 Fisheries biomass				ii		ii																		
E GLOBAL CHANGE	E1 Hydrological cycle				ii		ii															ii	ii		
	E2 Sea level change				ii		ii														ii	ii	ii		
	E3 UVB				ii		ii														ii	ii	ii		

SAHARAN

REGION III NORTH PACIFIC

25. Gulf of Alaska, LME
26. California Current LME
27. Gulf of California LME
28. West Bering Sea LME
29. East Bering Sea LME
30. Sea of Okhotsk LME
31. Oyashio Current LME
32. Kuroshio Current LME
33. Sea of Japan LME
34. Yellow Sea LME
35. Bohai Sea
36. East China Sea LME
37. Hawaiian Archipelago LME

REGION IV

EASTERN SOUTH AMERICA

38. Patagonian Shelf LME
39. Brazil Current LME
40. Northeast Brazil Shelf LME
    40a. Brazilian Northeast
    40b. Amazon

REGION V SUB-

AFRICA

41. Canary Current, LME
42. Gulf of Guinea, LME
43. Lake Chad
44. Benguela Current, LME
45. Agulhas Current, LME
46. Somali Coastal Current, LME
47. East African Rift Valley Lakes

ANNEX VII. Cont.

		REGION VI - INDIAN OCEAN						REGION VII - SOUTHEAST ASIA AND THE SOUTH PACIFIC									REGION VIII SOUTHEAST PACIFIC		REGION IX ANTARCTIC
		48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63		
A FRESHWATER SHORTAGE	A1 Pollution									ii	ii	ii	ii		ii		ii		
	A2 Changes in Water Table									ii	ii	ii	ii		ii		ii		
	A3 Reduction in streamflow									ii	ii	ii	ii		ii		ii		
B HABITAT MODIFICATION	B1 Loss of ecosystems/ecotones	ii		ii		ii	ii					ii	ii		ii		ii		
	B2 Modification of ecosystems ecotones			ii		ii	ii			ii		ii	ii		ii		ii		
C POLLUTION	C1 Microbiological	ii								ii	ii	ii	ii		ii		ii		
	C2 Eutrophication	ii	ii			ii				ii	ii	ii	ii		ii		ii		
	C3 Chemical									ii	ii	ii	ii		ii		ii		
	C4 Suspended solids		ii		ii	ii				ii	ii	ii	ii		ii		ii		
	C5 Solids				ii	ii	ii			ii	ii	ii	ii		ii		ii		
	C6 Radionuclides			ii						ii	ii	ii	ii		ii		iii		
	C7 Spills									ii	ii	ii	ii		ii		ii		
D FISHERIES	D1 Overexploitation									ii	ii		ii		ii				
OVEREXPLOITATION	D2 Excessive by-catch			ii						ii	ii		ii		ii				
	D3 Destructive Fishing					ii				ii	ii	ii	ii		ii		ii		
	D4 Diseases/Pollution		ii		ii	ii	ii	ii		ii	ii		ii		ii		ii		
	D5 Biogenetic diversity	ii	ii	ii	ii	ii		ii		ii	ii		ii		ii		ii		
	D6 Fisheries biomass		ii	ii	ii	ii		ii		ii	ii		ii		ii		ii		
E GLOBAL CHANGE	E1 Hydrological cycle									ii	ii		ii		ii		ii		ii
	E2 Sea level change									ii	ii		ii		ii		ii		ii
	E3 UVB									ii	ii		ii		ii		ii		

REGION VI INDIAN OCEAN

48. Gulf of Aden
49. Red Sea LME
50. Persian Gulf
51. Jordan(Land-locked River system)
52. Arabian Sea, LME
53. Bay of Bengal

REGION VII SOUTHEAST ASIA & THE SOUTH PACIFIC

54. South China Sea LME
55. Mekong River
56. Sulu-Celebes Sea, LME
57. Indonesian Seas, LME
58. North Australian Shelf, LME
59. Coral Sea Basin
60. Great Barrier Reef, LME
61. Great Australian Bight
62. Small island States
63. New Zealand Shelf, LME

REGION VIII SOUTHEAST PACIFIC

64. Humboldt Current LME
65. Eastern Equatorial Pacific

REGION IX ANTARCTIC

66. Antarctic LME

ANNEX VII. Cont.

		REGION II NORTH ATLANTIC																
		SUB-REGION 21 MEDITERRANEAN							SUB-REGION 22 BLACK SEA							SUB-REGION 23 CASPIAN SEA		
		21	A	B	C	D	E	F	22	G	H	I	J	K	L	23	M	N
A FRESHWATER	A1 Pollution																	
SHORTAGE	A2 Changes in Water Table																	
	A3 Reduction in streamflow																	
B HABITAT	B1 Loss of ecosystems/ecotones	ii	ii	ii	ii	ii												
MODIFICATION	B2 Modification of ecosystems ecotones																	
C POLLUTION	C1 Microbiological																	
	C2 Eutrophication																	
	C3 Chemical																	
	C4 Suspended solids																	
	C5 Solids																	
	C6 Radionuclides																	
	C7 Spills																	
D FISHERIES	D1 Overexploitation																	
OVEREXPLOITATION	D2 Excessive by-catch																	
	D3 Destructive Fishing																	
	D4 Diseases/Pollution	ii	ii	ii														
	D5 Biogenetic diversity																	
	D6 Fisheries biomass																	
E GLOBAL CHANGE	E1 Hydrological cycle																	
	E2 Sea level change																	
	E3 UVB	ii	ii	ii	ii	ii	ii	ii	ii	ii	ii	ii	ii	ii	ii	ii	ii	ii

SUB-REGION 21

SUB-REGION 22
MEDITERRANEAN

A. Western Mediterranean
B. Eastern Mediterranean
C. Ebro
D. Rhone J.
E. Po
F. Nile

SUB-REGION 23
BLACK SEA

G. Azov Sea
H. Danube
I. Dnipro
Dniestr
K. Chorokh
L. Do

CASPIAN SEA

M. Volga
N. Kura

ANNEX IX

LOGFRAME MATRIX

Project Structure	Indicators of Achievement	Means of Verification	Assumptions/Risks
Goal To contribute to improving the effectiveness of national, regional, and global level actions designed to achieve environmental benefits in the area of international waters.	Adoption of the framework by the GEF at programmatic level. Adoption of the Framework by other donors and organisations in the selection of future international waters projects	Selection by the GEF and other donors of projects which address the priority areas identified by the GIWA	It is assumed that selection of future priority areas for interventions in International Waters will be based on rational decision making. An associated risk is that decision making is distorted by other sectorial interests or external influences
Purpose (Immediate Objectives) To develop a comprehensive and strategic framework for the identification of priorities for remedial and mitigatory actions in international waters, designed to achieve significant environmental benefits, at national, regional and global levels	Production of a detailed scheme for determining priorities between and among transboundary water-related issues and areas	Use of the GIWA framework by the GEF and the participating Governments in prioritising and selecting future IW projects Use of the GIWA framework by the GEF's partner organisations, UNCSD, ACC Sub-committees on Ocean and Water Resources, in the design of future programmes Use of the framework by other donors in project identification and appraisal	The governments will support the process of the development of GIWA and will actively contribute to it. Governments and donors will accept the results of the assessment.
Outputs Strategic information for GEF use at a programmatic level in the IW focal area	A global overview of the relative importance of the various major concerns and principal issues by region A global analysis of the societal causes of identified water-related, major concerns and principal issues	Policy statements related to the International Waters, promoting the results of GIWA. Periodic Reviews by the Steering Group and, the Thematic and Regional Task Teams;	It is assumed that sub-regional reviews will be produced in an orderly and timely manner to permit their aggregation to a global scale It is assumed that sub-regional reviews and analyses will be of comparable quality permitting regional and global aggregation
Identified regional and global priority areas for action in the area of International Waters	66 sub-regional reviews of the transboundary ecological status (including analyses of environmental degradation)	Peer review and acceptance Review and acceptance by various intergovernmental fora;	
Identified approaches for more sustainable use of water and its associated resources	9 regional and 66 sub-regional scenarios of the future state of international waters		It is assumed that socio-economic data are available and suitable for the development of the sub-regional scenarios. An associated risk is a failure to release data by the data holders/owners
GIWA Assessment Protocol including agreed methods for conducting causal chain analyses to examine societal root causes of water related environmental problems, and transboundary diagnostic analyses	Completion and publication of methods/guidelines for the conduct of causal chain and transboundary diagnostic analyses	Adoption of the guidelines by the GEF Implementing Agencies , collaborating organisations/agencies and other donors. Application of the methodology in future transboundary diagnostic and causal chain analyses	
Detailed approaches to the application of Incremental Cost Analyses in IW projects	Provision of approaches to incremental cost analysis to the GEF family	Improved Incremental Cost Analyses in future GEF projects	

The activities leading to the above outputs and the means to achieve them are laid out in detail in section 4 of the project brief.

ANNEX X

INCREMENTAL COSTS AND BENEFITS OF GIWA

Background

The GEF Incremental Costs analysis requires a consideration of baseline and incremental costs associated with achieving 'domestic' and global environmental benefits. The global scope of GIWA presents methodological difficulties in assessing the baseline and incremental costs of the project which are normally calculated in a national context. This results in part from the fact that the benefits resulting from the execution of the project are seen as being primarily accruing at the global and regional scales, and in part from the fact that the GIWA project is dependent on the information and data assembled as a result of past activities undertaken at national, regional and global scales. Consequently the entire costs of the GIWA Project may be considered incremental since no other organisation will undertake such an assessment in the immediate future.

The GIWA project is global in scope and complementary to existing national, regional and global activities related to the assessment of water-related environmental issues and concerns. In addition no other international organisation or body is at present contemplating undertaking such an assessment and hence the entire costs of GIWA may be considered 'incremental'. Nevertheless some global thematic assessments are ongoing or planned for the immediate future and these may be considered as the existing baseline for GIWA. By developing strong synergistic links with such global efforts GIWA will build upon this existing base of activities.

At the regional and sub-regional level various assessment activities including those contemplated through the execution of the GPA/LBA and UNEP's Regional Seas Programme may be seen as contributing directly to the achievement of GIWA goals and objectives. These have not been included in the baseline. The costs of such assessments at sub-regional and regional levels are considered as analogous to the costs of achieving 'domestic' environmental benefits in nationally executed GEF projects.

Whilst the entire project costs may be considered incremental, it should be noted however, that not all costs are eligible for GEF funding. To ensure a global scope the assessment requires the participation of donor countries in conducting assessments for those sub-regions outside the GEF eligible areas of the Globe. Present indications are that the support required and detailed in the budget table of the project brief will be forthcoming.

Baseline - past activities providing the information and data upon which GIWA will be based

GIWA is based upon the evaluation and analysis of information which, in most though not all cases, has already been gathered or is being gathered by existing country-based or international programmes. **It adds value** to these sets of information by facilitating a truly interdisciplinary analysis which: **examines societal driving forces or causes of environmental degradation; generates regional and global scenarios for policy consideration; and recommends priority areas for developing and funding international waters projects**.

GIWA as a global project with broad scope, encompassing the analysis of environmental and societal factors in a global context will focus on - and support financially - activities that are not, covered by existing programmes or undertaken by individual countries acting unilaterally. GIWA is therefore clearly focused on undertaking and supporting incremental activities, leading to the identification of priority actions yielding maximal global benefits.

An illustration of the **baseline costs of GIWA** can be made by examining the approximate costs of some regional, and global assessment programmes as provided by the relevant co-ordinating bodies:

- **Mediterranean:** The Mediterranean countries have been conducting a pollution assessment programme, MEDPOL, within the framework of UNEP's Mediterranean Action Plan (MAP) since 1976. The estimated cost of this assessment to the Mediterranean Trust Fund and the cooperating UN Agencies is US $ 35 million. This cost does not include the contribution of the countries for implementing national monitoring programmes and research projects. The full cost of MEDPOL, including national and individual contributions, is **estimated as US $ 180 million**[1]**.** A socio-economic study, designated **the Blue Plan**, has also been conducted within the framework of MAP and the Barcelona Convention. The estimated cost to the Mediterranean Trust Fund and the Government of France is US $ 9 million for the 1978-1996 period. The corresponding costs of developing national scenarios elevate this figure to some **US $ 20 millions**, which does not include the costs of socio-economic assessments conducted in the framework of the coastal area management plans and other activities of the Priority Areas Programme of the MAP.

- **Black Sea:** The recently completed three-year GEF study for formulating the Black Sea Transboundary Diagnostic Analysis cost a total of approximately US $ 3 million in GEF funding and US $ 3 million in funding from other donors, notably the European Union. An additional US $ 10 million was spent on capacity building for a total cost of **US $ 16 million**.

- **Arctic:** The Arctic Marine Assessment Programme (AMAP) cost about US $ 4.5 million in specialist time and data analysis (some 30 person-years). The published assessment itself cost some US $ 0.5 million, for a total cost of **US $ 5 million**.

- **Comprehensive Freshwater Assessment:** The CFA, which focused on problems of freshwater availability, was funded in a complex manner through support to the eight Agencies involved and the total funding involved is difficult to evaluate at this stage. Funding for the Secretariat (the Stockholm Environment Institute) consisted of about US $ 1 million from the Swedish government plus US $ 0.2 million for publication, adding the other agency costs, gives an estimated total of **US $ 3.2 million.**

- **GESAMP - State of the Marine Environment:** GESAMP's 1985-1989 State of the Marine Environment (which did not include socio-economic studies) cost about US $ 2.5 millions. This sum does not include the cost of eleven regional studies on which the global study was based. The costs associated with the preparation of these studies is estimated as between US $ 3 and 4 million for a total cost of around **US $ 6 million**.

- **GEMS - Water** The Global Environment Monitoring System compilations of River discharge and freshwater quality have cost **approximately US $ 5 million** over the last 4-5 years.

- **Independent World Commission on the Oceans (IWCO):** For the preparation of a report for the Year of the Oceans the Commission's operating budget for the period 1996-1998 is approximately US $ 4.7 million, mainly provided by governments and private foundations. This figure does not include the in kind contributions of several governments, foundations and individuals, estimated as an additional US $ 1.4 million, for a total of **US $ 6.3 million**

- **GEF Regional TDA's & SAP preparation:** During the last three years GEF has funded a number of regional TDA assessments at an average cost of **around US $ 350,000.**

The above are examples of the costs of different regional and thematic assessments of varying scope and this is by no means a comprehensive listing of the past assessments, the information and data from which will contribute to the execution of GIWA. On the basis of these examples however, it is apparent that **the costs of the information on which GIWA is to be based will be considerable**. A conservative estimate for the 'past' baseline costs of the GIWA would be of the order of **US $ 200 million.**

[1] This figure includes equipment and training for developing country scientists; field sampling measurements and observations, laboratory analyses and experiments not figure cannot be considered in total as a baseline contribution.

Baseline - ongoing and planned global activities contributing to the GIWA

Planned or ongoing global assessment activities that will contribute to the execution of the GIWA include: the GESAMP assessment of the State of the Marine Environment (1997-2002), the World Water Council's 'Vision for the Future', and the GEMS/Water activities, amongst others. A conservative estimate of the costs of such activities would be approximately **US $ 12.5 million** over the life of the GIWA Project.

Based on the above figures a conservative estimate of the ongoing annual investment worldwide in water-related assessment activities undertaken at a regional scale (such as those outlined above and those undertaken in the context of UNEP's Regional Seas Programme) that will provide on-going support to GIWA during its execution would be of the order of **50 million US $** ***per annum***. Such activities may be considered as an analogue of the 'domestic' benefits for GEF projects conducted within a single country. The national level assessment activities that contribute to regional assessment activities such as those outlined above, may be as much as two orders of magnitude greater than this figure.

Benefits of the GIWA

GIWA adds value to international programmes, since it will **provide inter-regional comparisons** of the findings of individual assessments of ecological status and root causes of degradation. GIWA will, to the extent possible, incorporate the findings of past programmes related to international waters or, in the case of on-going programmes, work in close partnership with them in order to avoid duplication and optimize the overall benefit.

The incremental benefits of GIWA are harder to quantify at this stage. GIWA should **reduce the scoping study costs** for the GEF, partner agencies and many donors, enabling more of their funds to be applied to direct action. By focusing action on priority areas where environmental benefits may be achieved the effectiveness of limited funding will be improved.

The global and regional benefits of the GIWA project are clearly recognised by the extent of commitment to co-financing and collaboration secured during the preparatory phase (see Annex IV)

ANNEX XII

Table 1 Timetable for the Execution of GIWA

ACTIVITIES	PDF PHASE				Appraisal Phase				DURATION OF PROJECT 48 MONTHS															
	3	6	9	12	3	6	9	12	3	6	9	12	15	18	21	24	27	30	33	36	39	42	45	48
1. Pre-Project preparatory phase PDF																								
Steering Group mtgs	x	x	x																					
2 expert group meetings, & Management mtg.	x	x	x		3																			
Prelim. Biblio. & metadata catalogue																								
Finalisation of project brief																								
Finalisation of UNEP prodoc																								
2. Establishment of the network & development of Assessment Protocol																								
2.1 Select Core Team; id Focal Pts; regional organisations; form. Regional Task Teams (RTT)																								
2.2 Steering Group (SG) Mtg.										x														
2.3 Draft assessment protocol include: TDA & causal chain methods; approaches to incremental costs analysis.																								
2.4 Mtgs of 9 Regional Task Teams																								
Prep. of meta-data catalogue & website inputs																on-going updating of the website see 5.4 below								
2.5 Review of assessment protocol & mtgs. of Thematic Task Teams																								
3. Analytical phase																								
3.1 Annual Core Team Rpt & 1999 workplan, SG Mtg													x											
3.3 Regional Task Team mtgs. 2 x 9																								
Preparation of regional reviews, TDA analysis																								
Preparation of regional causal chain analysis																								
3.4 3 Mtgs of Economics Task Team, methods for scenario analysis													x	x		x								
3.5 3 Mtgs of Thematic Task Teams													x	x	x									
Preparation of draft thematic global reviews																								
3.6 Finalisation of GEF TDA guidelines																								
4. Predictive/policy options phase																								
4.1 Annual Core Team Rpt & 2000 workplan, SG Mtg.																x								
4.2 Combined mtg. Economics & RTT																x								
4.3 Regional & sub-regional scenario development																								
4.4 Stakeholders meeting																				x				
4.5 Preparation of the global overview																								
5. Dissemination of GIWA products																								
5.1 Annual Core Team Rp & 2001 workplan, SG Mtg																	x				x			
5.2 Appt. of Public Information expert																								
5.3 Mtgs of Regional & Thematic TT																								
5.4 Expansion of website information, CD ROMs																								
5.5 Global & Regional Information products																								

ANNEX XII Cont.

TABLE 2 WORKPLAN: SUMMARY OF GIWA ACTIVITIES, MILESTONES AND PRODUCTS

Activity	Time Period	Implementation	Products (major products in bold)
1. Pre-project preparatory phase (completed)			
1.1 Establishment & meetings of Steering, Management and Expert Groups .	April - Sept. 1997	UNEP	Two Steering, Two Expert Group & Management Meeting reportds. Preliminary analysis of thematic and geographical scope of GIWA.
1.2 Preparation of preliminary bibliography	May - Sept. 1997	UNEP	Preliminary bibliography of water related assessments
1.3 Analysis of expert meeting results & design of the project Brief	July - Sept. 1997	UNEP	• **Project Brief**
1.4 Approval of the Project brief	November 1997	GEF Council	• Approved Project Brief
1.5 Appraisal and finalisation of the UNEP Internal project Document including Host Country Agreement, MoU for Institutional support and co-financing agreements	December 1997 - November 1998	UNEP	• **UNEP Project Document**
1.6 Final clearance	December 1998	CEO & GEF Council	• **Final clearance by the GEF Council**
2. The establishment of the GIWA network and development of the GIWA Assessment Protocol			
2.1 Appointment of Core Team staff of specialists: Scientific Director (D2), 4 Programme Officers (P4/P5) and identification of regional collaborators & focal points.	Nov./Dec. 1998	UNEP	Recommendations to the Steering Group (SG) on: identification of existing programmes and institutions in each region, and sub-region; selection of regional, collaborating bodies; identification of sub-regional focal points and formation of regional task teams, where justified, or the use of existing teams where present.
2.2 Steering Group meeting	April, 1999	UNEP	Approval of GIWA Management Plan & final GIWA UNEO Project Document. Recommendation to UNEP on appointment of Core Team
2.3 Completion of draft GIWA Assessment protocol; TDA & causal chains methods; approaches to incremental cost analysis	Jan - Sept. 1999	Core Team	Draft documents, see under 2.5
2.4 Meetings of all 9 Regional Task Teams	April - Dec. 1999	Core Team	Reports on the establishment of the regional GIWA task teams; analysis of existing/completed projects in the regions; full discussion of the proposed methodology; identified information gaps.
2.5 Peer review and meeting of Thematic Task Teams to complete the GIWA methodology	April - September, 1999	Core Team	• **a meta-data catalogue of existing/completed projects in all regions;** • **GIWA methodology for causal chain analysis of water-related environmental issues and their societal causes;** • **methodology for conducting regional TDA; and,** • **detailed approaches to incremental cost analyses.**
3. Analytical phase of GIWA			
3.1 Meeting of the GIWA Steering Group	November, 1999	UNEP	Review of 1998 project implementation & results, approval of 1999 annual workplan
3.2 Coordination of implementation	October 1999 - September 2000	Core Team	Report demonstrating the implementation of workplan and development of specific products
3.3 Two meetings of each regional task team and implementation of regional programmes	October 1999 - September 2000	Core Team/ Donors/ regional bodies	• **Sub-regional & regional reviews of transboundary issues & their societal causes.** • **Meta database & bibliography on CD ROM.** • **Creation and updating of a GIWA Web page**

ANNEX XII Cont.

Activity	Time Period	Implementation	Products (major products in bold)
3.4 Three meetings of economic task team in support of regional case studies & to identify & fill gaps in regional/global database.	October 1999 - September 2000	Core Team in close cooperation with the World Bank	Draft methodology for the scenario and policy options analysis phase, based upon the availability of regional data and information from case studies.
3.5 Meetings of *ad-hoc* thematic task teams, as necessary	December 1999 - July 2000	Core Team. in close cooperation with technical partners.	• **Preparation of draft global thematic reviews**
3.6 Methodology development for GEF Transboundary Diagnostic Analyses (TDA)	April - July 2000	Core Team	• **Methodology for GEF TDA (including inputs from the Regional TTs)**
4 Predictive/ policy options analysis phase			
4.1 Meeting of the GIWA Steering Group	October, 2000	UNEP	Review of 1999 project implementation & results, approval of 2000 annual workplan
4.2 Meeting of economic task team & key members of regional TTs to review data gathered in Phase 4 & to explain the methodology for regional scenario development & policy options analysis.	October, 2000	Core Team. & Technical partners	Meeting Report and agree methodology for scenario development and policy options analysis
4.3 Regional and Sub-regional scenario development by thematic/regional TTs	October 2000 - September, 2001	Core Team., Donors, Regional bodies	• **Regional & sub-regional scenarios of future state of international waters based on trends & rates of change in industrialisation, population growth and development.**
4.4 Stakeholders meeting to review the initial conclusions of the policy options analysis	September, 2001	Core Team	Meeting Report
4.5 Joint Economic TT and Core Team 'task force' to examine global issues of concern to GIWA and to complete assessment	April - September, 2001	Core Team and technical partners	• **Detailed scheme for decision making concerning priority areas for action at national, regional and global levels** • **A global overview of the relative importance of the various issues and their principal causes.**
5. Outreach activities and diffusion of the GIWA products			
5.1 Meeting of the GIWA Steering Group	October, 2001	UNEP	Review of 2000 project implementation and results, approval of 2001 annual workplan
5.2 Incorporation of additional expertise on public information in the Core Team	October 2001	UNEP	
5.3 Meetings of key members of the regional and thematic TTs to plan and produce region-specific and thematic information products	October 2001 - April 2002	Core Team, Donors, Regional bodies	• **Public information plain language technical reviews** • **Popular educational and information materials specific to the regions & sub-regions**
5.4 Expansion of GIWA Website as a tool for education and production of GIWA CD-ROM	October 2001 - September 2002	Core Team, Donors, Technical Partners	• **GIWA Website with regional reviews** • **GIWA educational CD-ROM** • **GIWA Reports and data base on CD-ROM** • **Meta-data catalogue on Website & CD-ROM**
5.5 Production of global information products	December 2001 - October 2002	Core Team.	• **Comprehensible, illustrated Global Waters Assessment (sales publication)**
5.6 Evaulation and reports to co-sponsoring organisations	Oct. - Dec. 2002	UNEP/Core team	• **Evaluation reports**

ANNEX 4: DEVELOPING INDICATORS FOR ECOSYSTEM QUALITY ASSESSMENT (WORKING DOCUMENT)

Conceptual issues and practical examples related to the Baltic Sea, Eugeniusz Andrulewicz

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Key words: environmental indicators, marine environment, ecological quality objectives, and background values.

Abstract

This paper attempts to integrate existing knowledge about the marine environment in order to develop an ecosystem health assessment concept by applying environmental quality indicators. The focus is on environmental quality indicators, but relevant discussions about related topics such as environmental quality objectives, background values and the identification of ecological systems is included where considered necessary for a comprehensive understanding of the topic.

Basic problems caused by anthropogenic pressure on the marine environment are considered, i.e., eutrophication, contamination by toxic substances, exploitation of living and mineral resources, oil (petroleum hydrocarbons) pollution, artificial radionuclides, bacteriological pollution, coastal degradation and the threat to marine biodiversity.

A conceptualised set of basic chemical and biological indicators based on the Organization for Economic Co-operation and Development (OECD) concept of indicators is presented as a point of departure for further development, covering the status of the marine environment (S-type indicators), anthropogenic pressure on the marine environment (P-type indicators) and the response of society (R-type indicators). This kind of development is needed for the purpose of creating a "toolbox" for a decision-making process related to protection and sustainable use of the marine environment.

1. Introduction

Environmental quality aspects are traditionally considered during the assessment process as an integrated part of monitoring projects. Examples include: the Cooperative Monitoring and Assessment Programme (COMBINE) for the Baltic Sea; the OSPAR Joint Assessment and Monitoring Programme (JAMP) for the North Sea; the Arctic Monitoring and Assessment Programme (AMAP) for Arctic seas. Periodical Quality Status Reports (Assessments) integrated into these programs relate to environmental quality. Within the scope of the monitoring programmes, a great deal of relevant data on the marine environment has been collected and is readily available, but this data in many cases has not been synthesized into a useable form, and, in some cases, has not even been processed. Very little cross-disciplinary ecosystem interpretation has been undertaken to date. Further development of assessment activities seems to be the application of indicators for the assessment of the quality of marine ecosystems.

A very good reason for developing an ecosystem quality assessment system based on indicators is related to the idea of sustainable development, widely introduced after the Earth (Rio) Summit (UNCED) in 1992. The idea of sustainable development involves two aspects interacting with each other, namely the environment and the economy. Therefore, there is a need to develop socioeconomic indicators (pressure and response) parallel with the environmental state indicators.

2. Developing the concept of ecosystem quality assessment

No definition of marine environmental quality has been agreed upon, although it is generally understood that such a definition would reflect a "healthy" environment (e.g., healthy fish, healthy seals, etc.). It can also be regarded as an unpolluted environment. The definition of pollution proposed by GESAMP (ICES-ACMP, 1991) has been widely adopted:

"Pollution means the introduction by Man, directly or indirectly, of substances or energy into the marine environment (including estuaries) resulting in such deleterious effects as harm to living resources, hazards to human health, hindrance to marine activities including fishing, impairment of quality for use of sea water and reduction of amenities."

The opposite of this definition can be regarded as a definition for a healthy marine environment, which is:

"…a clean, unpolluted sea, where no deleterious effects to living resources and to human health are recorded and no reduction of natural amenities occurs."

ICES is in the process of defining the criteria of a "healthy ecosystem" as one which provides both "goods" and "services" to humanity (ICES – SGEAM 2000).

ICES is also attempting to develop Ecological Quality Objectives (EcoQOs) (ICES-ACMP 1994; ICES-WGEAMS 1998; Skjoldal 1998; ICES 2000). Ecological quality objectives frameworks are also being developed by OSPAR and EEA for their areas of responsibilities (EEA 1999, 2000; RIKZ Report 2000). Preliminary developments will likely be of a scientific nature. In a later stage, this work will hopefully be transformed into a "toolbox" for decision makers. EcoQOs are understood as a desirable environmental goal for the protection of marine life. In practice, this means that decisions concerning ecosystems are based on:

"the desired level of ecological quality relative to a reference level" (ICES 2000).

The concept of EcoQOs involves the idea of "reference level" which can encompass different issues, such as: reference/background values, reference periods (in the past) and/or reference (pristine) areas. The concept of reference levels is not yet fully developed. For example, data alone is useless for environmental quality assessment in the absence of "reference values." Therefore these values must be identified in order to assess relative degrees of degradation, trends, as well as progress made in solving environmental problems. A simple definition of a reference value is:

"…a value against which indicators can be compared so that users are able to assess the significance of values associated with them…" (ETC. 1997).

Background values are historical/pre-pollution values, which unfortunately are not always available. In the Baltic Sea, for example, background values would generally correspond to those registered 50 years ago when the Baltic Sea was still relatively pristine. As some background values are unknown at some locations, determining them will require some degree of consensus.

The identification of reference values has generally not been undertaken in a systematic way. In 1997, OSPAR adopted background concentrations for contaminants in water, biota, and sediments (OSPAR, 1997). The concepts used in the OSPAR Workshop could be utilized as a starting point for developing similar types of values in other water bodies.

A systematic approach is also needed to select reference/pristine areas and reference (historical) periods for the proper assessment of the present ecological status of the marine environment.

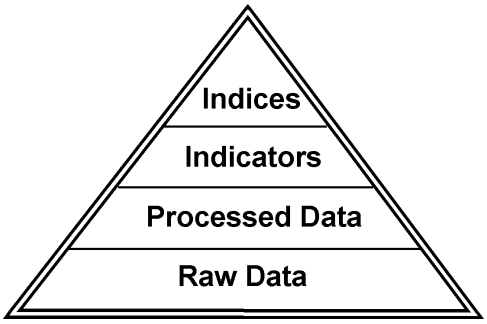
3. Developing the concept of environmental quality indicators

The term "indicator" has been given various definitions, but generally it refers to a measure of something. The OECD defined indicator as:

"A parameter, or a value derived from parameters, which points to / provides information about / describes the state of a phenomenon / environment / area with a significance extending beyond that directly associated with a parameter value (OECD, 1993)".

The relationship of indicators to the information on which they are based is illustrated in Hammond's information pyramid (Hammond, 1995) (Figure A4.1). Basically, data or information is processed, then refined to form indicators. In this case, indices refer to aggregations of indicators or processed data. Indices are developed in order to limit the amount of information that decision makers and other interested parties have to absorb. By their nature, indices are less informative than their indicator components, since the process of agglomeration dampens the impact of the individual indicators. Development of indices must therefore be done cautiously.

Figure A4.1. The information pyramid (Hammond, 1995)



Generally speaking, the information available from scientific papers as present and periodic assessments is at the "Processed Data" level; as such, it is not very useful to decision makers. Therefore, a strong pressure is put on experts to identify the problem and indicate effects in a descriptive and quantifiable way in form of indicators or even indices. Indices represent the most integrated information with the least amount of detail. Indices can also be expressed as classes (e.g., from first to fifth or from "no impact" through "slight", "moderate" to "severe").

The OECD developed a systematic framework for environmental indicators commonly referred to as "pressure-state-response" (OECD, 1993) which is based on the following causality chain:

"Human activities exert pressures on the environment ("pressure") and change its quality and the quantity of natural resources ("state"). Society responds to these changes through environmental, general economic and sectorial policies (the "societal response"). The latter form a feedback loop to pressures through human activities" (OECD, 1993).

Indicators of pressure (P) can also be called indicators of driving forces or stressors. In the case of eutrophication or contamination, pressure on the marine environment is caused by the direct input from point and diffuse sources of anthropogenic matter. The pollution load can be regarded as primary pressure indicators. However, the original cause of pressure is sometimes created far from the sea. The identification of pressure requires knowledge of socio-economic systems within the catchment basin. The reason for the original pressure might be poor governance or economic or social problems. A casual chain analysis is needed to identify the original source of pressure. Therefore, we might have primary pressure indicators or secondary pressure indicators. The examples of the pressure indicators given below are only related to primary (direct) pressure. Pressure indicators include general social and economic indicators related to wealth, population and other demographics, as well as more specific indicators relating to the consumption and use of natural resources. In many cases, in principal, the same pressure will cause different problems, e.g., eutrophication and contamination and loss of diversity.

State (S) indicators are needed to properly assess the state of the marine ecosystem. This knowledge comes through research and monitoring. This is why establishing proper monitoring and research programmes is an important task. State indicators are measures of the state of environmental quality, such as concentrations of pollutants.

Response (R) indicators should help the decision-making process, aid in developing regulatory standards, and in identifying the actions needed. The response in most of the cases should be based on modelling scenarios which show the effects of different decisions. However, modelling can produce a reliable answer only if based on sound data sets obtained within monitoring and research programs. Response indicators include government policies and regulatory efforts, as well as societal responses through individual and collective actions. These response activities usually result in changes in the pressure indicators, thus closing the loop.

Due to the complicated nature of ecosystems, indicators cannot perfectly represent the state of the environment or the complex interrelationships between the natural environment and anthropogenic activities. Indicator systems need to strike a balance between sophistication, as measured by the number of indicators and degree of functional representation, and simplicity and cost considerations. Very sophisticated systems including a large amount of data and complicated mathematical formulas may be a more accurate reflection of environmental conditions, but decision makers may not be able to make use of them.

Presently, indicators are utilized in a non-systematic way in national, annual, and periodical reports, as well as by multinational bodies. The indicators provided in these reports vary somewhat, making them generally incomparable. To date, there have been few efforts made to utilize indicators in a more systematic way.

4. Examples of indicators for basic marine environment problems

The following examples of marine environment quality indicators are based on the OECD pressure-state-response (P-S-R) framework. These examples are by no means a complete identification of all related indicators.

4.1 Eutrophication

Eutrophication has been defined by OECD as the "over-nourishment of aquatic plants" (OECD, 1993). ICES-ACMP (1992) defines it simply as "nutrient enrichment". According to EEA (ETC. 1997):

"Eutrophication means the enrichment of water by nutrients, especially compounds of nitrogen and/or phosphorus causing an accelerated growth of algae and higher forms of plant life to produce an undesirable disturbance of the balance of organisms present in the water and to the quality of water concerned." (EEA, 1999).

Eutrophication is a particularly important problem in semi-enclosed seas (such as the Baltic Sea), bays and lagoons, and some coastal areas. It has caused significant adverse biological effects over the past few decades. The effects of eutrophication, as well as its consequences for the marine environment in an ecosystem are complex and include all the components of the system, i.e., water, sediments and biota.

Eutrophication usually brings structural changes in the pelagic and benthic system, particularly structural changes in bottom communities below the halocline. Following combination of causes and consequences are noted:

- Increased phytoplankton production/ Reduced light penetration in water;
- More filamentous algae/Fewer macrophytes;
- Increased sedimentation of organic matter/More organic matter in bottom sediments;
- Increased oxygen consumption in deep water and on bottoms/Possible hydrogen sulfide formation below the halocline;
- More zooplankton/more fish above the halocline;
- More benthic animals above the halocline/Elimination of benthic animals below the halocline.G

All the effects can also be regarded as state (S) indicators of eutrophication. The following set of P-S-R indicators is proposed in a "toolbox" reflecting eutrophication.

Anthropogenic Pressure (P) Indicators

- Discharge of nutrients from point sources
- Discharge of nutrients from diffuse sources
- Fallout of nitrogen and phosphorus from the atmosphere

⇓

Environmental State (S) Indicators

- Winter concentrations of nitrogen and phosphorous
- [N/P (Redfield) ratio]
- Chlorophyll-*a* concentration
- Secchi-disk visibility
- Depth range of macrophytes
- Oxygen depletion (in historically oxygenated areas)
- H_2S formation in historically oxygenated areas
- Phytoplankton indicator species (such as some blue-green alga)

- More frequent presence of potentially toxic algal species
- Large accumulation of opportunistic macroalgae on the seashore
- Increased biomass of fish above the halocline

⇓

Government/Society Response (R) Indicators

- Reduction of nutrient discharges from point sources
- Construction of waste water treatment facilities
- Reduction of nutrient discharges from diffuse sources
- Reduction of the use of fertilizers and detergents containing phosphorous
- Buffer strips trapping nutrients for preventing eutrophication
- Adoption of better agricultural practices (sustainable agriculture)

For practical reasons, a limited number of indicators are given in these boxes. It is therefore advised to identify the best, most suitable and the most specific indicators for the selected water basin. A eutrophication indicator which is suitable for one water basin will not necessarily be appropriate for another.

Improving the environmental situation with regards to eutrophication will require the reduction of the nutrient load to the marine environment. The pertinent question is to what extent should nutrients be reduced to restore ecological balance? This is a difficult question, however, the answer depends on environmental targets. One obvious environmental target is to attain the trophic status from the "pre-pollution" period, i.e., that of the 1950s. The reduction of nutrient concentrations to those from the 1950s does not necessarily mean going back to the ecological balance from this time. It would, however, stop some unwanted changes. Therefore the proposed EcoQOs for the eutrophication status of the Baltic Sea are to:

Reduce nutrient concentration values to the 1950s level

4.2 Contamination

Contamination and its adverse effects are caused by the presence of a substance or group of substances that are toxic, persistent, and liable to bioaccumulate. These include inorganic (heavy metals), organic (some biocides and industrial compounds, usually halogenated, and some polycyclic aromatic hydrocarbons) and organometallic compounds (organic compounds of mercury and tin).

Persistent harmful substances seem to be the most important component of chemical pollution. This does not include chemical volatile compounds - numerous other compounds which may reach the marine environment but do not persist there.

"Contamination - is used to describe the situation which exists where either the concentration of a natural substance (e.g., a metal) is clearly above normal, or the concentration of a purely man-made substance (e.g., DDT) is readily detectable, but where no judgement is passed as to existence of pollution (i.e., adverse effects)" (ICES-ACMP, 1991).

Anthropogenic Pressure (P) Indicators

- Discharges of toxic compounds from land-based point sources (mainly industrial activities)
- Discharges of toxic compounds from land-based diffused sources (mainly agriculture and community activities)
- Discharges of toxic compounds from sea-based sources (mainly marine transport)
- Amount of deposition of toxic compounds via atmosphere/fallout into the sea

⇓

Environmental State (S) Indicators

- Contamination (levels/concentrations in water sediments and biota; long-term trends in concentration levels)
- Bioaccumulation/bioconcentration (levels/rates) in organisms
- Biomagnification (rates) in the food chain
- Ecotoxicological effects (biomarkers)
    - hormone disruption (reproductive disturbances)
    - immunosupression,
    - carcinogenic effects (e.g., liver neoplasmia)
    - genotoxic effects (cytogenetic and DNA damage)
- Multiple stress factors on marine species/communities (e.g., stress proteins)

⇓

Government/Society Response (R) Indicators

- Improvement/construction of wastewater treatment facilities
- Ban or significant reduction in production and/or use of substances (i.e., DDT)
- Reduction of toxic emissions at sources

Examples of a limited number of indicators are given here. For example, under ecotoxicological effects there can be a large number of indicators related to histopathological changes, reproduction impairment, immunocompetence, genetic toxicity, carcinogenicity, endocrine hormone disruption, etc. There is also a need to identify specific chemical pollution problems in the marine environment. For example, if anti-fouling paints are an environmental problem, specific indicators will be related to effects of organotin compounds: metallothioneins, intersex/imposex, and shell thickening.

Meanwhile, more research is needed to determine the link between contamination levels and their effects. Currently, research on top predators (seals, sea eagles) is ongoing and it indicates negative effects on the reproduction of both seals and eagles. Seal fertilization was influenced. An appropriate indicator for this phenomenon would be sex hormone disrupters. In the case of eagles, eggshells became thinner which decreased reproductive success.

The environmental target to decrease harmful substance contamination in the marine environment has to be defined. It is not possible to eliminate toxic chemicals from modern life. However, it should be possible to considerably reduce concentration of toxic chemicals in the marine environment and particularly to withdraw bioaccumulative chemicals and substitute them with more easily degradable substances. Therefore, EcoQOs (also defined by various international bodies) are:

Reduce contamination level close to "0"/below detection limit

and

Substitute bioaccumulative chemicals with easily degradable substances

More research is needed on biological effects of toxic chemicals, particularly in the low levels of the food chain.

4.3 Exploitation of living resources

Exploited living resources in the Baltic Sea, are almost exclusively fish. The main problem of Baltic fishery is overexploitation of commercial resources which is mainly caused by non-sustainable use of these resources. The following indicators are related only to those fish which are of market value.

Management advise for fishery in the ICES area is well-established and has almost 100 years tradition. However, there are still problems related to catch statistics, illegal catches and fishery control.

Anthropogenic Pressure (P) Indicators

- Landings of fish per country (e.g., for the Baltic Sea total amount of landings in tons of cod, salmon, herring, sprat)
- Number of fishing vessels per country operating in the area under consideration
- Average engine power per country: total kilowatt of the fleet, divided by the number of vessels
- Number of full-time fishermen engaged in the area, by country

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Environmental State (S) Indicators

- Spawning stock bio-mass (SSB)
- Fishing mortality rate
- Recruitment rate
- The ratio between Yield and SSB
- Recent SSB compared to the average of the baseline period

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Government/Society Response (R) Indicators

- Regulation of landings (total allowable catches (TACs), per country)
- Technical measures (regulation on fish gear, number and size of nets, etc.)
- Temporary closure of fishing (fishing grounds, time of fishing, etc.)
- Reduction in the number of licensed commercial fisherman

For many years the exploitation objectives of fishery were interested to maintain commercial fish stocks. However, at present, under the policy of ecosystem based fishery these objectives are insufficient. The focus is not only on preservation of commercial stocks but also on the preservation of other amenities of the ecosystem. This will involve a number of new indicators such as:

- the amount of dumped fish offal and fish discards (locally contributing to oxygen depletion at the bottom);
- the amount and composition of by-catches (such as non-target fish species, birds, mammals);
- damage to bottom habitats (due to trawling activities);
- changes in species composition of fish catches due to depletion of one or more key species or even changes in ecological balance.

ICES is developing an EcoQOs for fishery which is to:

Develop and implement an Action Plan for ecosystem-based fishery

4.4 Oil (petroleum hydrocarbons) pollution

After many years of studies on petroleum hydrocarbon pollution, there is still no consensus on the definition of oil pollution. Different authors define these issues in different ways, which is why it is very often difficult to compare the results of their studies. For the purpose of this paper, the following definition is proposed:

"Oil (petroleum hydrocarbons) pollution includes pollution of the marine environment by crude oil, crude oil derivatives (except solvents) and polycyclic aromatic hydrocarbons (PAHs) derived by the combustion of fossil fuels" (Andrulewicz *et al*. 1996)

This definition facilitates the interpretation of results of chemical analysis in which PAHs are usually determined. It also allows for a clear/univocal assessment of the level of marine environment contamination by compounds which are toxic, persistent and bioaccumulative or mutagenic and carcinogenic.

Anthropogenic Pressure (P) Indicators

- Frequency and amount of transported crude oil and oil derivatives (number and amount of discharges)
- Number of accidents/collisions at sea/level at risk for spills
- Amount of land based discharges (sewage out-falls and river run-off)
- Amount of atmospheric deposition (from transport and combustion of fossil fuels)
- Number of offshore oil and gas production platforms

⇓

Environmental State (S) Indicators

- Levels of oil residues in sea water and sediments
- Number of oil slicks on the sea surface
- Concentrations of PAHs in water, sediments and some marine organisms
- PAH-related effects in marine organisms (e.g., liver neoplasmia)
- Number of oiled/beached birds
- Produced water

⇓

Government/Society Response (R) Indicators

- Regulations on discharges (e.g., on offshore oil and gas industry)
- Regulations on transport (including ship requirements)
- Reception facilities in ports
- Inspections of marine transport activities (e.g., aerial surveillance)

In the case of oil/petroleum hydrocarbon pollution, the most effective course of action is to prevent oil spills. Therefore, aerial surveillance, combating fleet and port reception facilities are of the utmost importance. Preventive measures will not entirely preclude the possibility of oil spills, so an effective combat system is still needed. Additional information on the present level of petroleum hydrocarbons is needed in order to establish reference values for clean-up purposes, particularly in high-risk locations: ports, oil terminals, offshore oil rigs, and shipping lanes. Cleaning operations should lead to the possible full recovery of the environment. Proposed EcoQOs for the prevention of oil/petroleum hydrocarbon pollution of the Baltic Sea has also been developed by HELCOM and is to:

Develop an oil pollution prevention system and an oil pollution combating system able to remove oil from the sea in the event of spills

4.5 Exploitation of crude oil

Commercial off-shore crude oil exploitation in the Baltic Sea began in the Polish Marine Area in 1994. At present, two oil production platforms have been operating in the same crude oil field. However, there are prospects for further development of off-shore oil production not only in the Polish Marine Areas but also in Latvian, Lithuanian and

Russian/Kalilingrad economic zones. Environmental problems of crude oil exploitation relate to possible accidental contamination as well as operational contamination and discharges.

Anthropogenic Pressure (P) Indicators

- Exploration activities (e.g., amount of explosives used)
- Extraction activities (e.g., number of oil rigs)
- Operational discharges (amount and quality of discharge material)
- Intensification of oil transport and/or construction of cables and pipelines

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Environmental State (S) Indicators

- Local changes in the structure of bottom fauna and flora communities
- Amount of produced water and composition of dissolved components
- Amount of discharged drill cuttings
- Discharge and use of oil based drilling muds

⇓

Government/Society Response (R) Indicators

- Licensing/permission respecting environmental safety conditions
- Environmental impact assessments
- Guidelines and /or code of practices for crude oil exploitation
- Monitoring of effects/national or international surveillance activities

EcoQOs for the exploitation of crude oil are to:

Prevent oil pollution from drilling and operational discharges

4.6 Exploitation of sand and gravel

Anthropogenic Pressure (P) Indicators

- Extraction activities (number and size of sand and gravel extraction activities)
- Intensification of transport

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Environmental State (S) Indicators

- Morphological changes on the bottom (sand and gravel extraction)
- Effects of changes of the natural balance of currents (sand and gravel extraction)
- Effects of changes in the structure of bottom fauna and flora communities
- Creation of suspended matter plumes (diminishing light penetration to the bottom)

⇓

Government/Society Response (R) Indicators

- Licensing/permission respecting environmental safety conditions
- Environmental impact assessments
- Guidelines and /or code of practices for sand and gravel exploitation
- Monitoring of effects/national or international reporting activities

The aim of environmental policy regarding sand and gravel extraction is to prevent irreversible effects on the bottom habitats, including loss of species and modification of communities. Sand and gravel exploitation activities are covered by international guidelines and codes of practice. EcoQOs for the exploitation of mineral resources are to:

Respect international guidelines

and codes of practice

4.7 Sanitary state of bathing waters

Sanitary conditions are generally assessed by estimating the presence of pathogenic bacteria in bathing waters in a given coastal area. Existing classification systems are usually based on existing legal indicators which are usually concentrations of coliform bacteria in bathing waters.

Anthropogenic Pressure (P) Indicators

- Amount of untreated sewage discharge
- Run-off from polluted rivers and streams
- High number of tourists
- Lack of or insufficient sanitary facilities

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Environmental State (S) Indicators

- Fecal coliform index
- Presence of other bacteria (e.g., streptococci, salmonellas, vibrio)
- Presence of harmful parasites
- Presence of items affecting aesthetic values
- Presence of decaying algae
- Number of closed beaches

⇓

Government/Society Response (R) Indicators

- Monitoring of bathing waters
- Licensing beaches for bathing water quality
- Closing beaches
- Construction of sewage treatment facilities

Quality objectives for the sanitary state of marine bathing waters are anthropocentric in nature, as there is not enough evidence that bacteriological pollution presents problems to marine life, therefore it is sufficient that:

Bathing waters must not be harmful to human health

4.8 Coastal degradation

There is no universal definition of what is the coastal zone. The coastal zone includes the marine/terrestrial interface and adjacent marine and terrestrial areas, however, its landward and seaward range usually depends on the purpose of the defining body.

At present, there is growing anthropogenic pressure on the coast including a rapid increase in coastal population, growing coastal tourism, industrial development, coastal defence, and the drainage of coastal lagoons and wetlands. Not surprisingly, there is much conflict of interest regarding different uses of the coastal zone.

The environmental indicators proposed here are mostly related to the state of conservation of the coast.

Anthropogenic Pressure (P) Indicators

- Number of inhabitants per a given length of coastline (e.g., per 10 km)
- Demographics- permanent population, temporary population, tourism
- Non-marine land use (housing, commercial, tourism, etc.)
- Marine-related land use (shipbuilding and repair, fisheries, marinas, etc.)
- Coastal defense measures (usually change natural coastal dynamics)
- Loss of coastal wetlands through anthropogenic activities
- Exploration of mineral resources
- Number of fish farms
- Port developments (dredging activities)

⇓

Environmental State (S) Indicators

- Natural morphology of the coast and the bottom
- Natural plant composition (versus reference points)
- Natural animal communities (endogenous) (versus reference points)
- Percentage of the coastal zone in a natural state, including morphology, wetlands and lagoons, river mouths, etc.
- Natural coastal dynamics
- Preserved biological diversity

⇓

Government/Society Response (R) Indicators

- Zoning (restrictions on use) of privately owned land
- Protective measures- designation of protected areas
- Limits on anthropogenic activities
- Licensing of specific uses (e.g., mineral extraction, mariculture facilities)

The environmental target in relation to anthropogenic pressure on the coast is to preserve the natural state of the coast in undeveloped areas and in the vicinity of already highly urbanized areas (this applies to the natural morphology of the coast, natural plant and animal communities, and unspoiled landscapes). The key issue here is not to stop activities but

to ensure sustainable development through integrated coastal zone management plans. The proposed EcoQOs for coastal degradation in the Baltic Sea are to:

Preserve the natural coastal dynamics, flora, fauna, and landscape

4.9 Threat to marine biodiversity

The Rio Convention (1992) has defined biodiversity as:

"The variability among living organisms from all sources including terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems".

According to this interpretation, biological diversity is defined at the levels of genes, species, ecosystems and landscapes. An Action Plan for preserving biological diversity should contain baseline information about existing biological diversity, actions to control and restore biodiversity and a monitoring programme (Rio Convention, 1992).

Anthropogenic Pressure (P) Indicators

- Physical habitat destruction or fragmentation of habitats (e.g., marine aggregate extraction, large scale technical construction)
- Eutrophication (discharge of nutrients)
- Contamination (discharge of toxic substances)
- Overexploitation of living resources and benthic organisms
- Destruction of bottom communities by heavy trawling
- Human-induced transfer of non-indigenous species

⇓

Environmental State (S) Indicators

- Overall number of species
- Overall number of biotopes
- Number of trophic levels
- Overall number of landscape types
- Genetic diversity (number of genotypes)
- Presence of keystone species
- Biological diversity indicators (e.g., Shanon-Wiener, etc.)

⇓

Government/Society Response (R) Indicators

- Reduction of nutrient load
- Reduction of harmful substances load
- Protection of habitats
- Protection of endangered species
- Establishment of protected areas
- Regulated catches of exploited species
- Restoration of habitats

EcoQOs for biological diversity as defined by the Rio Convention are to:

Develop and implement an Action Plan for preserving biological diversity at gene, species, ecosystem and landscape levels

4.10 Invasion of non-indigenous species

Anthropogenic Pressure (P) Indicators

- Marine transport (amount and type of ballast waters)
- Introduction programs
- Natural migration

⇓

Environmental State (S) Indicators

- Number and abundance of alien species
- Nature of interaction with native species
- Economical losses from interaction with native species and costs of combat measures

⇓

Government/Society Response (R) Indicators

- Regulations on ballast waters
- Regulations on native species reintroduction
- Regulations on the introduction of alien species

The proposed EcoQOs for the invasion of non-indigenous in the Baltic Sea are to:

Develop and implement an Action Plan to prevent the anthropogenic transfer of coastal and marine species

4.11 Dumping of dredged material

Dredge spoils can be dumped according to international conventions, however, certain restrictions on quality should be followed (HELCOM Recommendation 13/1: "Disposal of dredged spoils") according to the "Revised guidelines for the disposal of dredged spoils".

Anthropogenic Pressure (P) Indicators

- Amount of dumped/disposed dredged spoils
- Quality of dredged spoils (e.g., concentration of harmful substances, amount of oxygen consuming substances)

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Environmental State (S) Indicators

- Fate of dredged material after dumping (disperse/deposition rate)
- Biological effects on dumping site (e.g., number of damaged organisms)
- Recovery rate of dumping site

⇓

Government/Society Response (R) Indicators

- Obeying international regulations
- Obeying national regulations
- Monitoring effects

There are national and international quality standards of dredged material, however, they are not related to dumping sites or the fate of material after dumping. Therefore, ecological criteria regarding the proper disposal of dredge spoils must be developed. The proposed EcoQOs for dumping of dredged material in the Baltic Sea are:

Levels of contaminants in dredged spoils should not be higher that those found in the nearest final sedimentation/deposition areas.

Dumping sites should not receive more dumping material than their carrying capacity to ensure full recovery in a reasonable time frame

4.12 Artificial radionuclides

Radionuclides in marine ecosystems, similar to trace metals, are of natural, as well as, anthropogenic origin. Long-lived artificial radionuclides [28–30 years] (^{137}Cs, ^{134}Cs, ^{90}Sr) are human health considerations; therefore they are the subject of monitoring. Short-lived artificial radionuclides [half-life measured in days] (^{239}Pu, ^{240}Pu, ^{240}Am) are also harmful to human health, but they are only occasionally the subject of studies that follow contamination events.

Artificial radionuclides appear in the marine environment following nuclear bomb tests mostly from atmospheric fallout; as well as operational releases from nuclear power plants. There have also been some incidental releases from nuclear power plants via the atmosphere, usually of local importance. A largest-scale artificial radionuclide contamination incident was the Chernobyl disaster in 1986.

Anthropogenic Pressure (P) Indicators

- Enrichment of radioactive ores (radioactive wastes)
- Operational discharges from the nuclear industry
- Accidental emissions from nuclear power plants
- Operational discharges from nuclear submarines
- Radioactive ash as a by-product of coal combustion
- Chernobyl disaster (in the case of the Baltic Sea)

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Environmental State (S) Indicators

- Contamination level of water (^{137}Cs, ^{134}Cs, ^{90}Sr) as an indicator of potential level of bioaccumulation
- Contamination of fish and in some cases other biota (^{137}Cs, ^{134}Cs, ^{90}Sr)
- Contamination of sediments in deep deposition basins (^{137}Cs, ^{134}Cs, ^{90}Sr) as an indicator of historical changes

⇓

Government/Society Response (R) Indicators

- Restrictions on nuclear weapon production
- Construction of safer nuclear power plants
- Restrictions on atomic energy production

- Safer storage of radioactive wastes

Monitoring of radionuclides is necessary to determine levels of natural and artificial nuclides in the ecosystem and to ensure that there is no growing trend of concentration of radionuclides in the marine environment. The proposed EcoQO for radionuclides in the Baltic Sea is to:

Maintain radionuclide concentrations at the present level or lower and to inhibit an increasing trend

4.13 Indicators of specific environmental problems

There may be other environmental problems which will require elaboration of indicators. They may be related to different uses of the open sea and coastal area, such as previous dumping of industrial wastes or wrecks containing dangerous material (e.g., radioactive or toxic), or military activities. They will require specific approaches according to the problem.

5. The use of indicators for management

"Marine pollution" includes a number of separate issues such as: eutrophication (nutrient overloading), contamination by persistent and toxic substances, oil pollution, microbiological pollution, etc. Different uses of the sea, like exploiting living or mineral resources, can cause serious degradation of the coastal and marine environments. All these problems affect marine biodiversity which can be regarded as a separate environmental problem. Most of the areas have their own special problems. For the Baltic Sea these include chemical weapons dumping, large number of non-indigenous species, some technical constructions (such as the Oresund Bridge), and fallout of artificial radionuclides related to the Chernobyl disaster. Specific problems will require the elaboration of a separate set of indicators.

The first step in management is problem identification and definition—it is often considered to be implicitly understood, and is glossed over in indicator development efforts. This can be a mistake, because experts as well as practitioners often do not agree on exactly what the environmental problems are. Following agreement on problem definition, a set of ecological quality objectives should be agreed upon, which pinpoint short-, mid-, and long-term environmental quality management objectives. If attention is not paid to these first two steps, indicator developers run the risk of developing a set of indicators that do not provide the necessary information to make appropriate, informed environmental management decisions, which should be the aim of environmental quality indicators.

It is easier (and cheaper) to solve environmental problems early on, before they manifest themselves in more visible forms. From this stems the importance of identifying early symptoms of environmental degradation. It is not difficult to prioritise acute and visible problems, however, "invisible events" often are hidden behind natural fluctuations of the system. Priorities may be different for different areas. Describing and combating these problems will require different indices and different cost-benefit calculations. Although marine environmental quality may be manifested by either water, sediments or marine organisms, such a distinction is not made in this paper.

Important step towards management of the selected basin is understanding and identifying its hydro-geo-morphological system (HGMU) (Vadinaneau, 1999). The most obvious feature of the system is its morphology; while other features such as trophic status, driving forces, limitations of productivity and energy flow are not so obvious. Today, human-dominated systems are the most common (Jansson 1980, Weslawski 1998, Wulff and Niemi 1992), which makes understanding such systems even more complicated. It is also necessary to understand the natural variability of the measured parameters and the natural diversity of biotopes to be able to distinguish between natural and human-induced effects.

6. Conclusions

The aim of this paper is not to offer a complete indicator system, but to start a process which will lead to the development of a quantified indicator system in the future. This paper deals only with environmental problems related to anthropogenic pressure. It does not consider problems related to natural phenomenon such as coastal erosion, and the effects of geological and meteorological forces.

The OECD system of Pressures-State-Response (P-S-R) indicators is proposed for describing the principle marine environmental issues, which were identified here as eutrophication, contamination by persistent harmful substances, exploitation of living resources, bacteriological pollution, oil (petroleum hydrocarbons) pollution, presence of artificial radionuclides, exploitation of mineral resources, coastal degradation and threat to marine biodiversity. It is clear that the priorities can be different for different seas and/or water bodies.

The environment classification system should not be a relative issue and based only on arbitrary decisions (as it is in fresh water classification systems). The most difficult and challenging aspect is to build up a quantitative system, because it has to be based on a good historical data and knowledge about the ecosystem.

In order to develop a system of marine environmental quality indicators, it will be necessary to involve experts from different fields, as well as the ultimate end-product users. A number of issues must be discussed and agreed upon, including identifying and prioritising the most important issues to marine environmental quality, agreement on reference and target values as well as the selection of the most relevant indicators. These discussions will themselves highlight critical gaps in information availability, and thereby also identify monitoring needs. Quantifying measures of quality is generally a difficult task, but it is essential for decision-making purposes.

The examples of marine environmental quality issues as well as the example of indicators included in this paper were selected to cover the issues considered to be of major importance, and presented in a way to facilitate their use by decision makers as well as understanding by the general public. It is important that the usefulness of indicators to the ultimate users is kept in mind throughout the entire development process.

Sustainable development is widely understood to be an interaction of two components: environmental protection and economic growth. There is an obvious conflict between these components. However, sustainable developments means also economical growth/development and equal chances of growth for all sectors. Sustainable development is a long-term strategy ensuring a safe and balanced environment for future generations.

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