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REPORT OF THE

Study Group on Ecosystem Assessment and Monitoring

ICES Headquarters, Copenhagen
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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

1 EXECUTIVE SUMMARY

The presentations of national and international activities related to the work of SGEAM demonstrated that ecosystem-based management and the development of indicators have become adopted by certain Member Countries, notably; the UK, Norway, Canada and the Baltic States. The methods being developed by these countries will help influence the development and implementation of an ICES-wide ecosystem-based assessment and management approach. SGEAM therefore recommends that ICES establish Regional Ecosystem Groups, REGs, to undertake the compilation and assessment of the periodic status reports from the various ICES working groups.

SGEAM recommends that ICES as a beginning establish an REG for the North Sea to meet the invitation from the Bergen Declaration, which was the conclusion of the Fifth North Sea Conference held in Bergen on 20 and 21 March 2002. SGEAM also recommends, as it did in 2001, that a REG for the Baltic Sea be established. SGEAM also proposes a framework for the preparation of environmental data and assessment reports on a regular basis.

SGEAM also recommends its termination, but recommends that a permanent working group should be established. Although the participation at the SGEAM meetings has not been particularly representative for the combined activities of ICES, SGEAM is of the opinion that there is a need for a forum within ICES where questions on how the ecosystem-based management approach can be implemented can be raised and discussed. A permanent working group will also be a valuable forum for exchange of national views on the development of indicators and for harmonizing the various approaches to ecosystem management.

2 OPENING OF THE MEETING

The third meeting of the Study Group on Ecosystem Assessment and Monitoring (SGEAM) was opened by the Chair, Lars Føyn, at 10.00 hrs on 29 April 2002 at ICES Headquarters in Copenhagen. The ICES Environment Adviser, Janet Pawlak, welcomed the Group to the ICES Headquarters.

As was the case for the meeting in 2001 and mentioned this year in several e-mails to the members of SGEAM, the Chair expressed some worries about the confusion of membership in SGEAM, both according to the actual participation of interested scientists and the official ICES list of members. For the purpose of further communication to interested scientists, the Chair underlined that it is of importance 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 never 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 participants at the meeting is given in Annex 1.

Terms of Reference

At the 88 th Statutory Meeting, SGEAM was given the following terms of reference (C. Res. 2001/2E08):

a) review and report on progress in the application of indicator-based approaches in national and international frameworks (e.g., GIWA, EEA, FAO, etc.);

b) elaborate a strategy and framework for the use of indicators in environmental assessments and reporting;

c) develop a discussion paper on the possible mechanisms for the preparation of environmental data and assessment reports by ICES on a regular basis.

SGEAM will report by 21 May 2002 for the attention of ACE (who will parent the Group) and the Marine Habitat Committee.

3 ADOPTION OF THE AGENDA

The draft agenda (Annex 2) was adopted. It was decided that agenda point 5 should be dealt with after point 2 on the agenda. The items on the agenda relating to the TOR for SGEAM are so interlinked that the discussion of each of them comprised also comments to the other items, which will also be reflected in the report.

4 ARRANGEMENT FOR THE PREPARATION OF THE REPORT

The participants were asked to prepare some paragraphs of their presentations and take notes of the discussion. The task of writing summaries of the discussions was distributed to the members of the group when coming to 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 recommendations prepared and added before closing of the meeting; 2) the complete draft report sent via e-mail to the participants for comments; 3) all comments have to be returned to the Chair no later than 20 May; and 4) final version of the report from SGEAM to be sent to ICES by 21 May.

5 REPORTS ON RELATED ACTIVITIES

The members of SGEAM were asked to report on what was known to them about national and international related activities in the context of ecosystem assessment and monitoring, the use of indicators and the implementation of ecosystem-based management advice. The reports were given as indicated below.

5.1 Activities in the UK

The following is a brief introduction to the complete report given by Andrew Kenny in Annex 3.

Following the general election for a new Government in the UK in 2001, a new environment department was established known as the Department for Environment, Food and Rural Affairs (DEFRA). This new department replaces the Ministry of Agriculture, Fisheries and Food (MAFF) and it has also taken over the responsibility for reporting under OSPAR, which was part of the "old" Department of Environment, Transport and the Regions (DETR). The DETR has accordingly been renamed and is now known as the Department of Transport and Local Regions (DTLR).

The department (DEFRA) has a number of overarching objectives, which underpin its policy, of which the most pertinent to this Study Group are:

- "to protect and improve the environment and conserve and enhance biodiversity, and to integrate these policies across Government…" and secondly;
- "to promote more sustainable management and use of natural resources in the UK…".

To support these objectives in the context of the marine environment, the department in consultation with other Government departments is currently preparing a marine Stewardship Report that describes the UK's development of an approach to the management of the marine environment based upon the following principles:

- Sustainable exploitation of marine resources;
- Ecosystem approach to the management and protection of the environment;
- Greater integration of monitoring and assessment;
- The application of the precautionary principle.

5.2 Activities in Canada

With the proclamation of the Oceans Act in December 1996, Canada has the broad context in which to implement an ecosystem approach to management. The Oceans Act preamble states that "Canada promotes the understanding of ocean processes, marine resources and marine ecosystems to foster the sustainable development of the oceans and their resources….". In Annex 4 Robert Siron reports of activities in Canada, comprising Canada's Oceans Strategy, oceans programmes, marine quality and ecosystem objectives, and examples of DFO monitoring programmes.

5.3 Activities in Norway

The Norwegian government presented in March 2002 a "white paper" to the Norwegian parliament that was devoted to ocean management. The white paper (St.meld. nr. 12 (2001 –2002) is called "Rent og rikt hav", a "clean and rich ocean".

It summarises briefly the present status of the Norwegian marine environment and the use of Norwegian waters for industrial purposes as, oil and gas exploitation, fisheries and aquaculture. Important messages in the "white paper" are the introduction of, in a political context, the use of ecosystem-based management advice and the establishment of ecological quality objectives.

The government will, as a start, establish a management plan for the Barents Sea where fisheries, oil and gas exploitation, shipping activities and aquaculture, and the environmental aspects of these activities as well as the socio-economic aspects are included. This work has already started and the Institute of Marine Research in Bergen has been given responsibility for a major part of this work, which is coordinated by the Ministry of Environment. First priority is given to an assessment of possible impacts from year-round oil and gas exploitation in the Barents Sea and on the shelf area from Lofoten and northwards.

Results from monitoring and assessment of the marine environment, the fish resources and aquaculture activities are given in three separate annual reports prepared by the Institute of Marine Research, IMR. For the marine environment and the fish resources the results are presented according to suitable marine ecosystems, i.e., the Barents Sea, the Norwegian Sea, the North Sea/Skagerrak, and coastal areas including the fjords. The annual exercise of producing these monitoring and assessment reports has proven to be most valuable. In the ten years these annual reports have been produced, the quality of the products has increased, and the mechanism for producing them has become easier.

5.4 Activities in Finland

Results from monitoring are given in annual reports. Annex 5 gives the full report of “The state of the Gulf of Finland in 2001” sent to the attention of SGEAM by Matti Perttilä who could not attend the meeting. The report is summarised as follows:

In the beginning of the year 2001, the salinity stratification of the Gulf of Finland, which had started already in previous years, still prevented the oxygen ventilation of the bottoms. The continued oxygen depletion weakened the populations of the bottom animals, and also accumulated phosphate nutrient from the sediments into the water.

Because of strong winds and storms in the autumn of 2001, the stratification was finally broken. New oxygen was forced to the bottom, while the accumulated bottom phosphate was driven abundantly to the surface.

Mainly because of the extended stratification in spring and summer, phosphate concentrations, which are critical in view of the late summer’s blue-green algal blooms, were only moderate. The breakdown of the stratification, bringing new phosphate to the surface, took place too late for the plankton bloom. In consequence, the bloom period of 2001 was only moderate.

Monitoring of radionuclides gained considerable interest after the Chernobyl accident. Because of the more effective water exchange, the Gulf of Finland is now cleaner than the Gulf of Bothnia with respect to radioactive substances.

The number of illegal oil outlets has grown from the previous year. Most of the spills are observed in the open Gulf of Finland. The Finnish authorities observed 107 oil spills in 2001, or 18 spills more than in year 2000.

There are 500–800 oil and bilge spills every year in the whole Baltic Sea area. The total number of spills is much greater because not all Baltic Sea countries have equipment for aerial observation.

5.5 The Bergen Declaration

The Ministers responsible for the protection of the environment of the North Sea and the Member of the European Commission responsible for environmental protection met in Bergen, Norway, on 20–21 March 2002 for the Fifth North Sea Conference. The Ministerial Declaration of the Fifth International Conference on the Protection of the North Sea comprised the following:

- Establishing an ecosystem approach to management
  (*inter alia* ICES, GLOBEC and other relevant scientific organizations and programmes are invited to consider the priority science issues from the Scientific Expert Conference in Bergen, 20–22 February 2002);
- Conservation, restoration and protection of species and habitats;
- Sustainable fisheries;
- Reducing the environmental impact from shipping;
- The prevention of pollution from hazardous substances;
- The prevention of eutrophication;
- The prevention of pollution from offshore installations;
- The prevention of pollution by radioactive substances;

- Promotion of renewable energy;
- Marine litter and waste management;
- Cooperation in the process of spatial planning in the North Sea;
- Future cooperation.

6 APPLICATION OF INDICATOR-BASED APPROACHES IN NATIONAL AND INTERNATIONAL FRAMEWORKS

6.1 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 assessment that may be used by GEF and its partners to identify priorities for remedial and mitigatory actions in international waters, designed to achieve significant environmental benefits, at national, regional and global levels.

The assessment has been organised on a global scale for 66 sub-regions as basic marine and catchment area units, which are similar to the designations of Large Marine Ecosystems (LMEs). For that purpose, GIWA has been elaborating its own methodology, the so-called "Scoping and Scaling Methodology". In Annex 6, Eugeniusz Andrulewicz has extracted examples and compiled tables from recent GIWA reports.

Compared to last year, GIWA has made significant progress: the Scoping and Scaling Methodology has been finalised and used for the assessment of 66 GIWA Sub-Regions (an example of results related to Sub-Region 17–Baltic Sea is given in Annex 6.

The next step in the GIWA process is the assessment of socio-economic drivers behind the environmental status of different sub-regions ("Casual Chain Analysis"). This is going to be the process of analysing social and economic drivers from direct driving forces to original root causes. SGEAM noted a very high degree of integration of environmental issues within the GIWA sub-regions. Therefore, the GIWA methodology is useful for the purpose of global assessment, and might also be useful for a comparison of the status of different seas and regions (e.g., scale of Pan-European seas). However, the high degree of agglomeration of information limits amount of knowledge that decision-makers have to absorb and should not be commonly applied in smaller scales for the regional seas assessments.

However, the general approach used by GIWA should be considered by the ICES entities that may be eventually charged with developing the indices for the comprehensive integrated assessments of geographic "regions".

6.2 HELCOM

HELCOM MONAS, at its meeting in 2001, has proposed to introduce new reporting requirements and working practices for the purpose of elaborating assessments of the environmental status of the Baltic Sea. There have been proposals to prepare "indicator-based assessments" and "thematic reports". They should be seen as a continuous assessment production towards "periodic assessments".

For the start-up selection of indicators they should be realistic and begin with a few carefully selected ones. Later when some more experience will be gained, the set of parameters could be reconsidered and expanded. MONAS agreed that the year 2002 would be the pilot year during which the following indicators would be elaborated:

- surface winter concentrations of inorganic N_{O3} + N_{O2} and P_{O4};
- riverine loads of total N and total P;
- summer mean chlorophyll concentrations;
- changes in depth range and distribution of bladderwrack *(Fucus vesiculosus)* and eelgrass *(Zostera marina);*
- waterborne: Hg, Pb, Cd and time series for 1994–2000;
- atmospheric: Hg, Pb, Cd based on model calculations;
- biota: Hg, Pb, Cd, ΣCB congeners) in Baltic herring.

There is a wish to develop further indicators. An immediate request has been put on:

- development of a robust method for using oxygen measurement as an indicator in relation to eutrophication;
- investigation how to use phytoplankton as an indicator;
- possible use of remote sensing data on cyanobacteria blooms;
- investigation on how to include ships of opportunity data.

It has been decided that the HELCOM Secretariat will compile the draft indicator report and submit it to the next meeting of HELCOM MONAS. ICES is looking forward to the process of developing a new HELCOM approach towards more timely and more easily digestible assessments.

6.3 The International Baltic Sea Fisheries Commission, IBSFC

Sustainable, productive fisheries are achieved when appropriate management ensures a high probability of stocks being able to replenish themselves over a long period of time within a sound ecosystem, while offering stable economic and social conditions for all those involved in the fishing activity.

Definition of Goals

Development of economically and socially sustainable, environmentally safe and responsible fisheries by:

- maintaining biologically viable fish stocks, the marine and aquatic environment and associated biodiversity;
- within these limits, establishing maximum fishing possibilities and appropriate selective fishing techniques for harvesting stocks;
- distributing the direct and indirect benefits of open sea and coastal fishery resources among local communities in an equitable manner.

Indicators

The following indicators are intended to highlight the trends in biological systems, and the economies of the fishery-dependent communities around the Baltic. The indicators will be provided by the coastal states.

Biological indicators

- Spawning Stock Biomass (SSB): The part of the biomass of cod, herring and sprat, taking part in the reproduction process, in tonnes. This is an important indicator of the biological health of a given stock. Scientific information is only available for the most important commercial stocks in the Baltic Sea;
- Fishing mortality: the proportion of the average population removed annually by fishing;
- Recruitment: the number of fish reaching the age where they enter the fisheries.

Economic indicators

- Landings per country: total amount of landings in tonnes of cod, salmon, herring, sprat;
- Number of fishing vessels per country operating in the Baltic Sea;
- Average engine power per country: total Kilowatt of the fleet, divided by the number of vessels;
- Fish consumption per capita per country.

Social indicators

Number of full-time fishermen engaged in the Baltic Sea Region, per country.

6.4 The European Environmental Agency, EEA

One of the main tasks of the EEA is to report on the state of the European environment. The Agency has adopted an indicator-based reporting system as its main tool for assessment, and communication to policy-makers and the public. The DPSIR (Driving force, Pressure, State, Impact and Response) framework, combined with an issues/thematic approach, was chosen as the basis for developing indicators. This framework organises environmental indicators by theme and enables links to be identified between pressures on the environment, such as direct inputs and emissions and their impact or changes on the ecosystem, resources or human health. It makes it easier for policy-makers to identify appropriate measures to improve the state of the environment by reducing the pressures.

Using this approach, the former ETC/MCE (European Topic Centre for marine and coastal environment) developed and tested a number of state and pressure indicators under the themes of eutrophication and hazardous substances. The EEA recognises the extensive experience of the regional Marine Conventions in the field of marine environmental monitoring and assessment, and has consequently established Memoranda of Understanding with the Conventions, with the aim of developing cooperation and harmonisation on issues such as data flow, use of GIS, reporting cycles and indicators. The ICES databank is the main source of marine data for the EEA.

Following a review and rationalisation of the Topic Centres in 2000, a new Topic Centre for Water was formed, led by the UK (WRc). One of the main tasks of the new Topic Centre is to develop a core set of indicators covering all water types, i.e., rivers, lakes, groundwaters, transitional and coastal. A core set of 86 indicators has been proposed, covering eutrophication and organic pollution, hazardous substances, groundwater quality and quantity, water stress, climate change, drinking water quality, microbiological contamination, impacts of fishing, ecological quality, aquatic biodiversity, and integrated coastal zone management. Approximately 30 of these indicators relate to transitional and coastal waters. The core set will be modified, improved and developed over time as more comparable and spatially extensive data sets become available and the Water Framework Directive is implemented by Member States. Fifty-nine of the indicators will be presented in a water indicator report to be published in June 2002.

SGEAM was, after a request to the EEA, kindly given the opportunity to look briefly into parts of the draft report "Environmental Signals 2002". SGEAM did not have enough time to review the document in detail, but remarked on the positive approach taken by EEA in describing the status of the various issues in a form that should be easy to understand both for laymen and administrators. In particular, the use of simple symbols of "smiling and non-smiling faces" was appreciated.

7 USE OF INDICATORS IN ENVIRONMENTAL ASSESSMENTS

There is both national and international work in progress for developing indicators for use in environmental assessments. In Sections 4 and 5, above, some examples of such work are presented. As can be seen, there are a number of approaches to the development of indicators, from the very simple ones that everybody understand to the more sophisticated ones requiring thorough knowledge of the actual ecosystem where the indicators are to be applied. SGEAM felt that neither the time available nor the number of participants present, with experience in developing indicators, allowed for any in-depth elaboration of a strategy and framework for the use of indicators in environmental assessment and reporting.

It was, however, noted that, although there is a clearly demonstrated urgent need for implementing indicators as reliable management tools, there is at the same time strong indications that great caution has to be taken when using certain indicators. The problem of misinterpretation can be illustrated when, for example, certain numbers or an increase above a fixed percentage of a value are used as indicators, as is proposed by OSPAR with regard to nutrients and eutrophication effects. In the ICES Marine Chemistry Working Group (MCWG) 2002 report, the use of "harmonised assessment criteria" is discussed as follows:

"The OSPAR region—in common with other coastal areas—is subject to large natural temporal and spatial variations in nutrient concentrations. One of the major deficiencies of the proposed criteria is that transboundary nutrient transports are not adequately taken into account. This is particularly important for inorganic nutrients since the natural fluxes in the North Sea are many orders of magnitude greater than the anthropogenic fluxes, which are also likely to be localised in space and time. Care must therefore be used in interpreting nutrient data since misleading or inappropriate conclusions may be drawn. For example, 'winter concentrations' of nutrients are only appropriate for the description of phytoplankton development in summer if it is confirmed that transboundary effects are not significant over the intervening period. Moreover, the definition of 'winter concentrations' is too broad, as this parameter is defined by the status of the ecosystem (maximum accumulation of nutrients and minimum primary productivity) and not by a specific time of the year. The start of the phytoplankton spring bloom may not necessarily occur at the same time for all stations.

The subgroup was also concerned that the criteria listed as 'Assessment Criteria' are not necessarily universally applicable and recommend that the listed criteria be checked for relevance to local conditions. For example, natural perturbations such as wind-induced mixing or upwelling need to be considered before deciding whether critical values have been exceeded. The rationale for assigning values to 'background concentrations' and 'elevated concentrations' is not always clear since we have limited information as to how the 'spatial/historical background concentrations' were fixed. The relevant information needs to be readily available. In addition, if the normal concentration of a nutrient is low, an increase of > 50 % may not be environmentally significant."

In the report from the Trace Metal Subgroup of the Marine Chemistry Working Group (MCWG) 2002, there are even some more rather critical remarks to the efforts from OSPAR and EEA to implement indicators based on monitoring data of trace metals. As a summary of the discussion within the three subgroups of the MCWG 2002 meeting, the following remark on the use and development of indicators was given:

"MCWG encouraged the development and use of environmental indicators. Firstly, however, the aims of such indicators need to be clear. They might be intended, for instance, to inform environmental managers of the effects of controls, inform the wider public of the efficacy of regulations intended to control pollution, or for other purposes. For each aim, differently derived indicators may be appropriate. Similar approaches have been implemented successfully in other areas of the world, and we should learn from the experiences of others. One example specifically mentioned during the discussions was the joint USA/Canada studies undertaken in the Great Lakes area, where indicators have been developed over the past 25 years. The development of these indicators and the means to represent them took time, but they have proved useful. Further development of these indicators is under way, and existing indicators are being maintained and updated. For further information, there is a website: **www.ijc.org**.

Additional examples which would merit study include the report no. 5052, 'Coasts and Seas', prepared by the Swedish EPA, and the programme 'Water Mondrian' being developed by the Rijkswaterstaat in the Netherlands (contact Erik Evers).

Within OSPAR and the EEA there is a desire to link input data with environmental data on the concentrations and/or effects of chemicals, but it seems to the MCWG that there needs to be some more focus on processes and the development of a holistic approach in order to facilitate this. For instance, input data are not always comprehensive and, currently, environmental sampling is not yet targeted towards those locations which would most directly reflect changes in inputs over time. The design of such a targeted monitoring strategy would benefit from discussions between the environmental managers, process modellers and oceanographers, as well as biologists, chemists and sedimentologists, to promote the exchange of ideas and to develop indicators which apply to both spatial and temporal scales, and are likely to provide a rapid response to changes. The whole process of the development of each indicator should be transparent, and data should carry information on the quality assurance and a statement of the associated uncertainties. It should be clearly stated which data have been used in preparing the indicators, whether there are gaps in these spatial and/or temporal data, and what process has been applied in order to generate the indicators from the data. It is also important to clearly demonstrate the environmental relevance of the indicators being reported, for instance, in relation to eutrophication and ecosystem effects.

This will require concerted action between ICES and OSPAR, and should include workshop(s) at which the development can progress."

The 2002 MCWG report clearly demonstrates the need for further elaboration on the concept of developing indicators. SGEAM concluded that in most cases it will be the interested scientists' scientific background and understanding of the purpose for which an indicator is developed that governs the view of the suitability of a specific indicator. SGEAM therefore supports the view of the MCWG and proposes that ICES, through its appropriate working groups, arranges a workshop with the aim of reaching a common agreement on the development and use of indicators within the ICES area of interest.

8 HOW CAN ICES PREPARE ENVIRONMENTAL DATA AND ASSESSMENT REPORTS ON A REGULAR BASIS?

Based on earlier discussions in SGEAM and in available reports, most of the 2002 meeting was devoted to the question of how ICES should meet the challenge of giving scientific advice for both national and international demands concerning the use of ecosystem-based approaches to ocean management.

8.1 Background

At its 2001 meeting, SGEAM reviewed the report "The Status of Fisheries and Related Environment of Northern Seas" prepared by ICES for the Nordic Council of Ministers, Nord 2000: 10. In its 2001 report, SGEAM concluded that ICES is well-suited to undertake the preparation of similar reports on a regular basis.

This year, SGEAM had the opportunity to discuss the aspect of preparation of assessment reports with the four scientific advisers of ICES. The Environment Adviser Janet Pawlak, the Oceanographer Harry Dooley, the Fisheries Adviser Hans Lassen, and the GLOBEC Coordinator Keith Brander all met together with SGEAM for a couple of hours' discussion on how ICES could contribute. Included in the discussion was also the request from Germany on how ICES could prepare a report on the status of the marine environment in the Northeast Atlantic, including the Baltic Sea, in layman's language. The finished product is intended as a contribution from the German Government to the Joint Ministerial Meeting of OSPAR and HELCOM, which will be held in Bremen in June 2003.

The German request clearly indicates the public demand for updated, understandable, and readable assessments, and SGEAM is of the opinion that ICES has, within its framework of working groups, the necessary instruments to provide the best available scientific basis for such assessments. SGEAM is also of the opinion that for the future development of ICES as the scientific adviser on the marine environment and its living resources, it is of utmost importance that ICES meets these new challenges of holistic assessments open-minded and with a willingness to seek new approaches to the tasks. In this context, the Bergen Declaration is an example of the important role ICES still has, i.e., ICES is invited together with other relevant scientific organisations to consider the priority scientific issues addressing the driving forces of North Sea ecosystems variability, including climatic, biological and human factors, which are critical for maintaining ecosystem structure and function.

There are already some regular assessments taking place in different ICES Working Groups and they can provide a basis for further extension. SGEAM recognised that the activities of the working groups on ocean climate (WGOH), zooplankton (WGZE), phytoplankton (WGPE), and harmful algal blooms (WGHAB) undertake assessments of their data on a seasonal basis and that the information is consistently reported to ICES on an annual basis. Collectively this information could be termed the "Ocean Climate Status" (OCS) report. SGEAM believes that more use of OCS data and information could be made by all other working groups and as a first step towards preparing integrated assessments of environmental quality, respective working groups should be encouraged to assess the OCS report, particularly in light of their own findings. To facilitate this, the information from OCS should be packaged in a "user-friendly" way and each working group should have a common term of reference to assess the findings presented in the OCS report.

8.2 Framework for ecosystem assessment

SGEAM discussed the possible mechanisms for the preparation of environmental data and assessments reports by ICES on a regular basis and compiled the following:

8.2.1 Introduction

Environmental assessments or quality status reports form an important part of environmental management at both national and international levels. International Conventions and Agencies such as AMAP, HELCOM, OSPAR, and EEA produce comprehensive environmental status reports at periodic intervals.

Environmental assessments can be either narrow thematic, e.g., assessing the state of eutrophication or the environmental impacts of fishing, or broad and holistic, e.g., assessing the state of the marine ecosystem. Thematic assessments can be useful and often necessary components of holistic environmental or ecosystem assessments.

Holistic environmental assessments will generally contain two main elements, namely: i) a description of the status and trends in the environmental conditions, and ii) an evaluation of the degree of human impact on the current status and trends. The purpose of an environmental assessment is, therefore, to provide a basis for evaluating whether existing policies and management measures are effective, and/or whether new policies and measures are required.

Marine ecosystems are open systems. Ocean currents flow through them carrying plankton and chemical substances. Fish, marine mammals, and seabirds may swim or migrate across any defined ecosystem boundaries. Climate variability is a major driving force for ecosystem variability, affecting in particular the recruitment and size of fish populations. The biological components are interlinked through trophic and other couplings. A number of human activities such as pollution, eutrophication, fishing, etc., impact not only the same ecosystem but, directly or indirectly, the same components of the marine ecosystem.

There are, therefore, two main challenges in carrying out an environmental assessment, namely: i) separating any influence of human impacts from the typically large natural variability in marine ecosystems, and ii) separating impacts from different human activities.

To carry out an integrated environmental or ecosystem assessment is a very demanding scientific task confounded by the general scarcity of information on many ecosystem components, e.g., habitats and non-commercial biota. At the same time, the scientific objectivity and integrity need to be protected from the influence of politicians and managers who may have an invested interest in the existing policies and measures that are being evaluated as an end product of the process.

ICES has a vision to be an organisation which delivers relevant, responsive, sound, and credible advice, concerning marine ecosystems and their relation to humanity. With the current political emphasis on adopting an ecosystem approach to the management of the marine environment, and the central role of environmental assessments in that context, there is a need to explore the mechanisms by which ICES can contribute to the preparation of such assessments and the ecosystem management framework in general. Central to this aim is the need to explore how the science and knowledge within ICES (via the contributions made by the individual working and study groups) can be integrated.

8.2.2 Proposed structure for integrating ICES science and advice to deliver ecosystem assessments

The basic information requirements for environmental assessments will generally comprise information on: i) geomorphology, ii) physical conditions, iii) chemical conditions, and iv) biological conditions. Table 8.2.2.1 gives a list of types of data that are needed for producing an integrated holistic assessment for a marine ecosystem.

Table 8.2.2.1. Overview of data types and major categories of assessment products.

Science Areas
Topography
Geology
Physical oceanography
Chemistry
- Nutrients
- Contaminants
Biology
- Plankton (zoo-, phyto-)
- Benthos
- Fish
- Marine mammals
- Seabirds
- Biological effects

Thematic Assessment Categories							
Habitat Maps	**Climate Change**	**Eutrophication**	**Fisheries**	**Introductions**	**Mariculture**	**Physical Impacts**	**Pollution**
Regional Ecosystem Assessment							

The approach is based upon recognising that the thematic categories are supported by the need to integrate the data and information from the science areas of ICES Working Groups. The thematic categories would therefore represent chapters in a comprehensive quality (ecosystem) status report.

An example of how the above framework may be applied can be best explained by considering the assessment category of "habitat maps", namely, the European Nature Information System (EUNIS) habitat classification system is hierarchical, with increasing resolution of biological information at higher levels of classification. At EUNIS level 3, the benthic habitats are classified based on water depth, bottom substrate, and hydrographic conditions. At level 4, main features of the benthic communities are taken into account, and from level 5 and onwards more detailed features are included.

As stated in the Bergen Declaration arising from the 5th North Sea Ministerial Conference, there is now a need to compile existing information to produce the first generation habitat maps at EUNIS level 3 and also, where possible, at level 4. For this purpose, there is a need to integrate information on topography, geology, physical oceanography, and biological communities. Habitat maps are "stationary" products in the sense that, once they are produced, they remain as basic descriptions of the ecosystem. There will be a need, however, to continuously improve them through more detailed mapping with higher spatial and biological resolution.

Assessment of eutrophication requires data on anthropogenic nutrient inputs with sufficient temporal and spatial resolution. The nutrients are being diluted, spread and transported by physical mixing and currents in the coastal areas. They stimulate the growth of plants and lead to altered flows of energy and matter in benthic and pelagic parts of the food web. Occurrence of harmful algal blooms and oxygen deficiency may be symptoms of eutrophication. The eutrophication effects will most often occur at other places and with a time delay in relation to where the inputs of nutrients occur. Thus, the spatial and temporal linkages are important, and hydrodynamic models may provide a useful tool to handle these.

Assessment of pollution similarly requires data on sources and inputs of contaminants, and the same physical processes that affect nutrients also affect the transport and distribution of contaminants. However, most contaminants are associated with particles and their transport and fate are closely related to sediment transport processes. Contaminants are taken up by organisms where they may bioaccumulate, be modified by metabolism, and be transported and biomagnified in food chains through trophic interactions. Biological effects techniques may be used to identify and interpret causal linkages between contaminant concentrations and their biological effects. Due to the multitude of contaminant substances and the complexity of the ecological systems, assessment of pollution is a very demanding task where we yet lack good conclusive power.

Assessment of ecological effects of fisheries requires information on fishing activities and fish catch statistics. Fishing affects directly targeted fish species and non-targeted by-catch species, as well as indirectly other species through predator-prey relationships in marine food webs. In addition, fishing with bottom gear may damage or destroy bottom habitats. Assessment therefore requires a broad range of biological information and information on bottom habitats.

Assessment of environmental effects of mariculture requires spatial information on the location of mariculture facilities, and on inputs and release of chemicals and organisms. Release of organic matter and nutrients may affect the water quality, oxygen conditions, and benthic communities. Disease organisms and parasites may be spread and transported with currents and may pose a risk to wild populations. Escaped farmed organisms may migrate and affect the genetic composition of wild stocks.

In addition to thematic assessments, there is a need for an overall assessment of the status of the ecosystem. An inherent difficulty and limitation in the thematic assessments is related to the issue of combined effects of different human activities. For example, benthic communities can be affected directly and indirectly by different activities such as eutrophication, fishing, and pollution. It may be difficult in each thematic assessment to deal with the issue of what are the effects from other activities. In the overall assessment, this becomes an important part. Also, there is the issue of the combined effects of all human activities. What is the total impact on the state of the ecosystem. The various thematic assessments and the assessments of the status of the various biological components would be important elements in the overall assessment.

The above framework also serves to provide some focus on how the thematic assessments may be integrated to provide an overall ecosystem assessment. In order to make this a manageable proposition, SGEAM recommends that this be dealt with on a regional level. SGEAM therefore recommends that such holistic assessments should be undertaken by a number of Regional Ecosystem Groups. This should be on an annual basis and in the first instance a pilot REG for the North Sea should be established for 2003. This would also have the advantage of addressing, in part, the German request for a quality status report in 2003. In addition, the task of the REG needs to be supported by the adoption of a common ToR for all working groups to undertake an assessment of their own data, as the examples of the ICES WGOH, WGZE, WGPE and WGHAB mentioned above.

9 THE FUTURE OF SGEAM

The Study Group on Ecosystem Assessment and Monitoring, SGEAM, has now existed for three years, and it may be time for discussion of its future. Both the fact that a study group is not meant to be a permanent establishment, and the serious problems of attracting enough members to the group led to the conclusion that there has to be a change in the status of SGEAM. When SGEAM was established it was meant in a way to be a revitalisation of some of the work that previously had taken place in the Working Group on Environmental Assessment and Monitoring Strategies, which again was a follow up of an earlier multidisciplinary working group on "pollution of the North Atlantic". However, SGEAM, was given specific terms of reference for discussion of the concept of ecosystem-based management advice.

The importance of ecosystem approaches to the management of marine areas is demonstrated by the activities that are taking place in various countries and international organizations as referred to above, and most recently in the Bergen Declaration from the Fifth International Conference on the Protection of the North Sea, held in Bergen, Norway, 20–21 March 2002.

In the report from the first meeting of SGEAM, the 2000 SGEAM report, the group presented a simplified framework for an ecosystem approach to the management of marine ecosystems to achieve sustainable use of ecosystem goods and services and conservation of ecosystem integrity. The SGEAM 2000 report also defined the many terms used in the context of explaining ecosystems. SGEAM 2000 further proposed the establishment of Regional Ecosystem Groups (REGs) within ICES. The work in the REGs was recommended to focus on the following tasks:

1) consider the general issue of integration of pertinent assessment information on the 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 LMEs in the region with the emphasis on:
    - climatic/physical driving forces, and
    - 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).

In the SGEAM 2001 report, the recommendation for establishing Regional Ecosystem Groups (REGs) was repeated and underlined. SGEAM 2001 also proposed that emphasis should be given to the Baltic Sea in particular, where the key benefit of establishing a multidisciplinary regional working group approach is the provision of integrated assessments; this was sketched in SGEAM 2001 Figure 5.2.2.3. The figure is repeated below as a documentation of a necessary approach to future work within ICES.

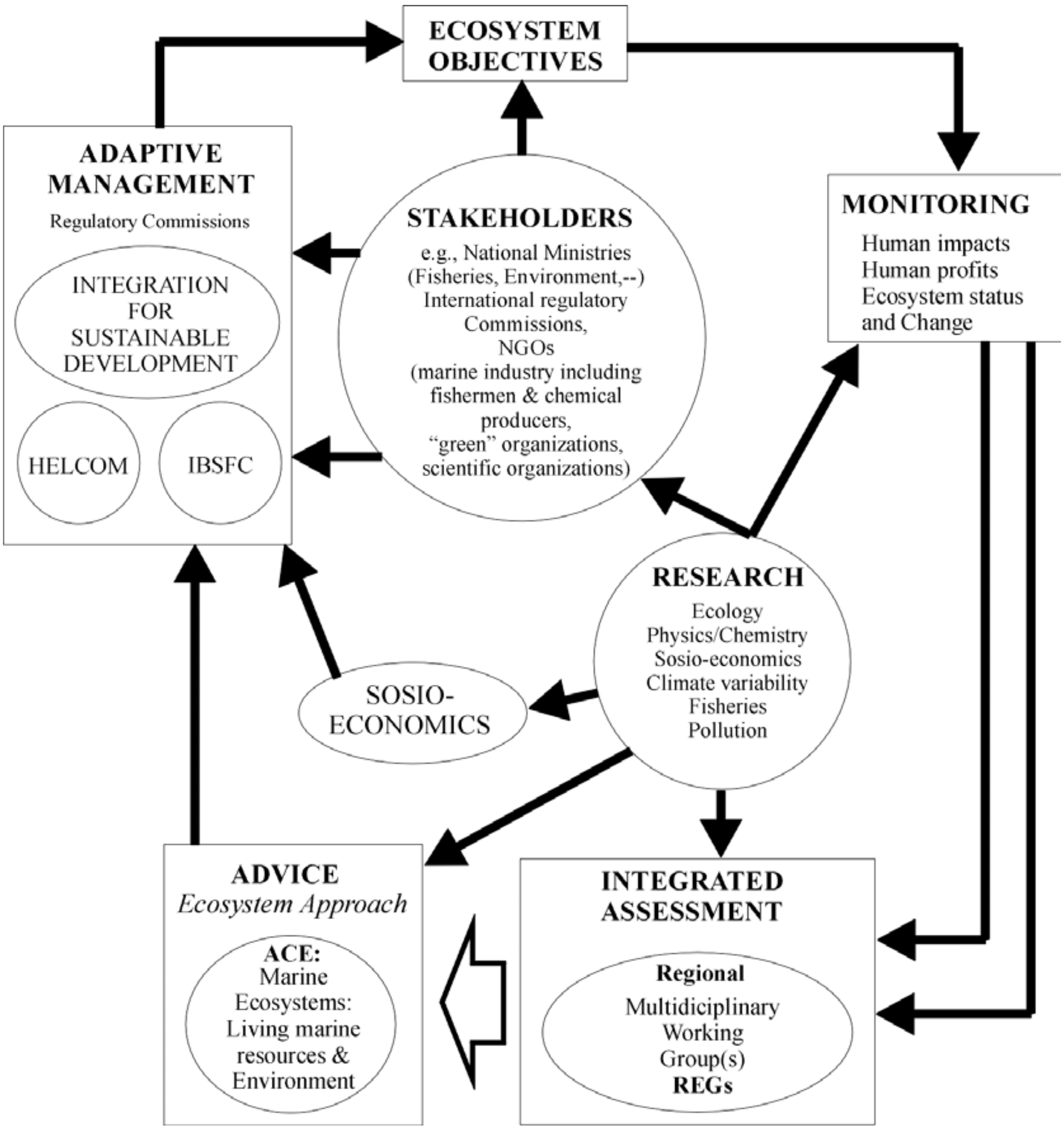

Figure 9.1 The proposed example of an ecosystem-based management framework for the Baltic Sea, where ICES could give substantial contributions through ACE and the proposed Regional Ecosystem Group (REG) for the Baltic (from the SGEAM report 2001).

SGEAM has proposed the establishment of Regional Ecosystem Groups (REGs) both in 2000 and 2001. In its 2000 report, SGEAM proposed that REGs should be considered established in general and that SGEAM should be given the task of defining regional ecosystems as well as the minimum scientific support needed in the different groups. In its 2001 report, SGEAM was more specific and proposed the establishment of a REG for the Baltic Sea as a first introduction to this new working concept. SGEAM was of the opinion that this approach was well applicable for the Baltic Sea having two international management organisations, HELCOM and the International Baltic Sea Fisheries Commission (IBSFC). Unfortunately, this approach has not yet been acknowledged by ICES. However, it is of great interest to notice that the IBSFC and HELCOM met for the first time in February this year in a joint seminar on fisheries issues and environmental protection in the Baltic Sea.

To meet the invitation to ICES stated in the Bergen Declaration, SGEAM proposes that a REG is established for the North Sea in addition to the already proposed Baltic Sea REG.

In the discussion of the future of SGEAM, it was concluded that the original work set out for the study group was fulfilled, i.e.;

- a set of necessary definitions concerning an ecosystem approach to management have been established (SGEAM 2000);
- a framework for integrated ecosystem-based management has been proposed (Figure 9.1) (SGEAM 2001);

- a structure for integrating ICES science and advice to deliver ecosystem assessments is proposed (2002).

Considering the poor attendance at the study group meetings, SGEAM felt it appropriate to propose the termination of SGEAM.

SGEAM also noted that the poor attendance and the low priority the work in SGEAM seems to have been given by the ICES Member Countries, were in strong contradiction to the attention ecosystem-based management is given both nationally and in other international organisations. It was also remarked that this fact may reflect the traditional national representation throughout ICES. Another remark was given to the fact that the results from the work of SGEAM have so far hardly been recognized in any other documents and work of ICES, and this has not been a particular encouraging signal for participation in SGEAM.

However, for the participants at the SGEAM meetings, the discussions and the proposals made for establishment of ecosystem-based management tools were highly appreciated as they proved most valuable in the participants' daily work when dealing with these issues on a national level. This is, for example, shown in the national reports (Sections 4.1, 2 and 3). SGEAM is therefore of the opinion that a permanent working group on ecosystem assessment and monitoring has to be established under the parentship of ACE. The task of such a permanent working group will be the following:

a) serve as a forum for reporting on national activities in ecosystem assessment and monitoring;
b) serve as a forum for discussions on harmonizing national and international activities regarding ecosystem approach to management;
c) review and secure that the regional ecosystem groups, REGs, follow a common strategy in their regular status reports.

As mentioned above, there is a great number of activities both on a national level as well as internationally on the aspects of holistic assessments and ecosystem-based management. SGEAM therefore anticipates a growing forum for discussion on ecosystem assessment and monitoring also within ICES. SGEAM is of the opinion that ICES does have to take the challenge of being the leading forum for discussions on scientific advice on holistic approaches to ocean management. The work within the proposed new permanent working group on ecosystem assessment and monitoring will move from a conceptual to a practical approach to the problems, and in this way be an important part of the ICES mechanisms for preparing regular status reports.

10 ANY OTHER BUSINESS

There were no other questions that were not dealt with within the discussion of the other items on the agenda.

11 CONSIDERATION AND APPROVAL OF RECOMMENDATIONS

The proposals for recommendations were discussed in connection with the various agenda items. The brief presentations of the proposals were approved by SGEAM and the Chair was given the approval to prepare the proper wording. The recommendations are presented in Annex 8.

12 CONSIDERATION AND APPROVAL OF THE MEETING REPORT

The report is based on written contributions from the participants and the draft compiled report was approved. The Chair was given the approval to prepare and finish the report for presentation to ICES. Due to the limited time available before the ACE meeting, the draft report would have to be sent to ICES parallel to being sent to the participants.

13 CLOSING OF THE MEETING

The Chair thanked the staff of ICES for all their help and hospitality and closed the meeting at 15.00 hrs on Friday, 3 May, wishing all the participants a safe journey home.

ANNEX 1: LIST OF PARTICIPANTS

Study Group on Ecosystem Assessment and Monitoring

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ANNEX 2: AGENDA

SGEAM meeting, 29 April–3 May 2002

1) Opening
2) Reports on related activities
3) Application of indicator-based approaches in national and international frameworks.
4) Use of indicators in environmental assessments.
5) How can ICES prepare environmental data and assessment reports on a regular basis ?
6) The future of SGEAM
7) Adoption of recommendations
8) Any other business
9) Closing

ANNEX 3: REPORT ON THE DEVELOPMENT OF ENVIRONMENTAL PERFORMANCE INDICATORS AND RELATED ACTIVITIES IN THE UK

Andrew Kenny, CEFAS, Burnham-on-Crouch, UK.

Indicators

Following the general election for a new Government in the UK in 2001 a new environment department was established known as the Department for Environment, Food and Rural Affairs (DEFRA). This new department replaces the Ministry of Agriculture Fisheries and Food (MAFF) and it has also taken over the responsibility for reporting under OSPAR which was part of the "old" Department of Environment, Transport and the Regions (DETR). The DETR has accordingly been renamed and is now known as the Department of Transport and Local Regions (DTLR).

The department (DEFRA) has a number of overarching objectives which underpin its policy, of which the most pertinent to this study group are:

- "to protect and improve the environment and conserve and enhance biodiversity, and to integrate these policies across Government…", and secondly,
- "to promote more sustainable management and use of natural resources in the UK…".

To support these objectives in the context of the marine environment the department in consultation with other Government departments is currently preparing a marine Stewardship Report which describes the UK's development of an approach to the management of the marine environment based upon the following principles:

- Sustainable exploitation of marine resources;
- Ecosystem approach to the management and protection of the environment;
- Greater integration of monitoring and assessment;
- The application of the precautionary principle.

To contribute to the work on EcoQOs under the OSPAR strategy to combat eutrophication and to stimulate UK thinking on EcoQOs and associated indicators of environmental quality, a project to consider the development of EcoQOs in relation to eutrophication was taken forward at a workshop held in Brighton in 2000. The achievements of this workshop were to: i) establish general EcoQO statements of quality, ii) establish a classification of water/seabed types, iii) define a set of indicators and iv) their corresponding threshold values.

As a result of the workshop the following general EcoQO for eutrophication was agreed:

"there should be no substantial change in phytoplankton communities from the reference level as a result of anthropogenic inputs of nutrients, as indicated by: biomass, production, species succession and composition, and duration of blooms".

During 2001/2002 three other workshops were held to develop Performance Indicators with the aim of informing progress against a wide range of management objectives relevant to the marine environment. The issues identified by the UK closely conform to those identified by the 4 th and 5 th North Sea Ministerial Conference, namely: i) exogenic unmanaged pressures (climate change), ii) hazardous substances, iii) radioactivity, iv) offshore industry, v) bathing waters, vi) shellfish, vii) protected areas, viii) species, ix) dredging including aggregate extraction, x) mariculture, xi) shipping, and xii) litter.

The first of these was a workshop held in Edinburgh in May 2001 which had the objective of identifying and developing three categories of performance indicators, namely: i) those which can be used now, ii) those which can be used with a little refinement from the National Marine AQC groups, and iii) those that require further R&D work before they can be adopted. In each case indicators were identified according to the requirements of the DPSIR framework, focusing mainly on identifying Pressure, State and Impact indicators. Details of the workshop results can be found at www.marlab.ac.uk/nmpr/nmp/htm.

The second workshop was held in Lowestoft in October 2001 with the objective of "discussing the feasibility and practicality of developing EcoQOs for aggregate extraction areas" (CEFAS, 2001[1]). The workshop concluded that the principal concerns with the activity of marine aggregate extraction arise from physical impacts at the seabed and the consequential biological responses. The workshop recommended four EcoQs for the management of marine aggregate extraction and envisaged that metrics developed for biological and physical impacts would contribute to their assessment. The four EcoQs are:

1) to have a proportion (%) of each habitat that is protected from human activities;
2) to ensure that the proportion of habitat and associated communities impacted does not prevent the proper functioning of that system during extraction and allows recovery once dredging ceases;
3) to ensure that best practice in dredging is adopted in order to promote the recovery of impacted ecosystems;
4) there should be no impact outside an agreed area of influence, this is the area of primary and secondary impacts.

The third workshop was held in February 2002 with the objective to "develop performance indicators for seabed disturbance". Like the workshop held in Edinburgh this workshop identified indicators according to the DPSIR framework, again focusing on Pressure, State and Impact indicators within the following categories: i) disposal of materials at sea, ii) developments within the nearshore coastal zone, iii) fisheries, iv) aggregate extraction, and v) cross-cutting issues.

An important outcome from these workshops is the recognition of the need to be cautious in placing too much reliance on the ability of individual indicators (often univariate in nature) to adequately describe environmental state and impact, since it is widely acknowledged that the most sensitive measures of environmental state and impact tend to be multivariate metrics, particularly when describing changes in biological communities. The challenge we face is to ensure that complex scientific understanding of multiple cause/effect processes (often described by models of response) developed over many years of R&D is not undermined by the need to adopt "simple" metrics of performance. Therefore a balance has to be struck between their scientific credibility and their ease of use for management purposes.

One possibility to achieve this balance is the development of integrated univariate metrics or indices. For example, in biological systems, because of the nature of the data, several complementary techniques should be used to detect robust patterns. The question is then how to integrate these in a transparent and credible way?

One approach, and which is the subject of a current research project, is to take the univariate biological indicators identified from the various workshops (described above) and then to generate a set of indicators such that no one single indicator will have overall dominance (see Figure A3.1). In any such treatment, however, there has to be a weighting of their importance or value and this is reflected in the final assigned score. Clearly the rationale for such scores has to be credible and explicitly defined. But inevitably, some of the indicators are going to be subjective and qualitative whereas others will be objective and quantitative.

From such a tabulation of indicators the final accumulated score may provide a more precise and reliable measure of environmental performance, particularly when supported by the use of standard multivariate numerical techniques to assess environmental state and impact.

Monitoring and Assessment

In parallel to these activities work has been under way to develop a strategy for integrating and harmonising the marine monitoring and assessment effort.

On various occasions over the years suggestions have been made that there ought to be a strategy for marine monitoring, or at least coordination of all the various relevant activities. To date, all such suggestions have failed to gain sufficient support from even the majority of parties involved in marine matters. In many respects this has not really mattered until fairly recently, because the amount of monitoring required was limited and the resources available to those involved were adequate to meet their own needs without having to be unduly concerned over who else might be doing something similar. However, this situation is changing rapidly. The costs of both collecting marine samples and analysing them according to present-day needs and standards are increasing rapidly. At the same time the number of legal requirements, both national and international, is increasing. Set against this, the resources in terms of manpower and cash are declining in real terms. There is, therefore, now a real need to examine our national and international

[1] CEFAS (2001). A workshop to discuss the feasibility and practicality of developing Ecological Quality Objectives for aggregate extraction. Final report of workshop held on 11 and 12 October, CEFAS, Lowestoft, pp93.

obligations and how these can be met effectively and efficiently. This is inevitably going to require real cooperation between the various organisations involved in order to achieve the common goal. This may not be easy, as devolution has tended to create more separate and independently minded bodies with their own interests. Furthermore, responsibilities for monitoring under EU Directives and consequent national legislation overlap with existing obligations, experience and abilities. Accordingly the Marine Pollution Monitoring Management Group was given the task to undertake a review of marine monitoring programmes and establish a framework for increased integration of monitoring and assessment programmes.

Such a framework is necessary in order for the UK to develop a strategic approach to new and emerging monitoring requirements from OSPAR, EC Directives such as the Water Framework Directive and the UK Chemicals Strategy. It will also enable the UK to establish a mechanism to demonstrate progress towards national and international policy targets to reduce discharges, emissions and losses of hazardous substances to the environment. Accordingly, the UK is working with other contracting parties to develop an adaptive, integrated and sustainable approach for the management, protection, conservation and exploitation of marine resources (ICES, 2001). This approach has recently been defined by a number of "high-level" goals and tasks, set out by DEFRA, as part of the drive towards better stewardship of the seas (Marine Stewardship Report, 2002). However, whilst DEFRA and the Marine Stewardship Report have defined the overall objectives or "goals" for sustainability, protection and conservation of the marine environment, the mechanisms by which such goals are achieved have to be assessed and agreed by those sectors with monitoring responsibility, namely: i) fisheries, ii) pollution, iii) conservation, and iv) ocean climate. This is shown diagrammatically in Figure A3.1.

Central to this model is the need to provide comprehensive assessments of ecosystem quality. This requirement has also been recognised by the International Council for the Exploration of the Sea (ICES), with the Council having 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). A driving force behind this organisational change is the need to offer a framework for an ecosystem approach to the management of marine ecosystems, which can deliver "sustainable use of ecosystem goods and services and conservation of ecosystem integrity". This framework has recently been described diagrammatically by the ICES Study Group on Ecosystem Assessment and Monitoring, which highlights the importance of monitoring (in one form or another) at a number of different stages within the stewardship framework. It is therefore essential that we understand "how" and "where" existing monitoring effort fits into this new management philosophy. This, therefore, represents an important consideration for the development of the UK strategy.

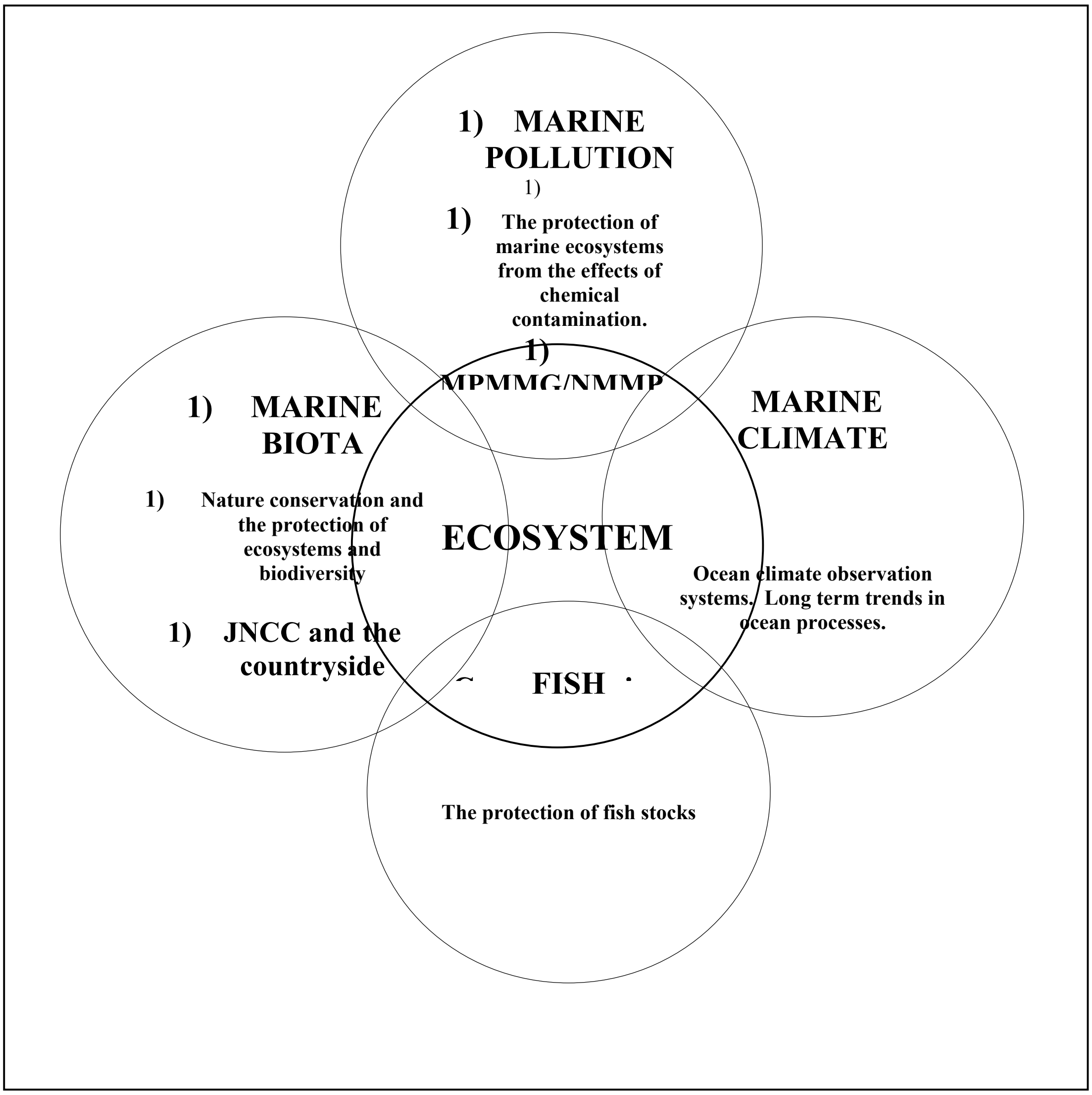

Figure A3.1.

The objectives of the strategy are

- to continue to fulfil all national and international reporting requirements;
- to make the best use of data and resources;
- to enable robust integrated assessments of the state of the marine environment in the UK;
- to support the development of performance indicators for management of the marine environment.

To achieve this, MPMMG, working in close collaboration with the other organisations having monitoring responsibilities, undertakes to:

- collate information on all current statutory and relevant non-statutory marine monitoring programmes including: national and international drivers, responsibilities of each marine monitoring organisation, objectives and associated resources, reporting commitments and cycles.
- evaluate this information with the aim of identifying knowledge gaps, areas of duplication, and anticipating changes for the future.
- present information on the costs and benefits of the existing monitoring arrangements.
- develop a strategy for drawing together all current marine monitoring programmes to provide a fully coordinated marine monitoring network.

- develop performance indicators to support assessment and reporting on the state of the marine environment, working towards producing an indicator-based State of the Seas Report at regular intervals.

A draft report titled “towards the development of a comprehensive marine monitoring programme in the UK” has been produced (January 2002) and this will hopefully be published by DEFRA during 2002.

ANNEX 4: ECOSYSTEM ASSESSMENT AND MONITORING ACTIVITIES WITHIN THE DEPARTMENT OF FISHERIES AND OCEANS OF CANADA: AN OVERVIEW [1]

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Content

1. Context

- At national level
  - Oceans Act
  - Canada's Oceans Strategy
  - Oceans programs
- On international scene
  - Global Programme of Action for the Protection of the Marine Environment from Land-Based Activities (GPA and Canada's NPA)
  - Global Ocean Observing System (GOOS)

2. Marine Environmental Quality and Ecosystem Objectives

- MEQ program
- MEQ objectives
- Technical support and guidance for Oceans Act programs
- MEQ / MEH indicators
- MEQ projects
- Ecosystem Objectives approach
- Next steps to achieve Ecosystem-based Management

3. Examples of DFO monitoring programs

- Stewardship initiatives
  - Streamkeepers and Shorekeepers (British Columbia)
  - The Tariuq (Ocean) program (Beaufort Sea)
- Real-time data and systems
  - Water Level Network and Canadian Tide Tables
  - Buoy program (Pacific coast)
  - Lighthouse sea surface temperature (Pacific coast)
  - Shipboard thermosalinographs (Gulf of St. Lawrence)
- The Atlantic Zone Monitoring Program
- Remote sensing surveys
  - Satellite imagery products
  - ARGO floats
- Regional-scale programs
  - The Bedford Basin Plankton Monitoring Programme (Nova-Scotia)
  - Aerial surveys of marine mammals (Estuary and Gulf of St. Lawrence)
- Focus on contaminants and ecosystem health
  - Contaminant tracking in Newfoundland coastal waters
  - Marine mammals health program (Pacific coast and St. Lawrence area)
  - Monitoring and assessment of salmon aquaculture (New-Brunswick)

4. Discussion

- Pointing out similarities on Ecosystem-based Management

[1] This working document was prepared during the meeting, as contribution to the Study Group on Ecosystem Assessment and Monitoring (SGEAM), April 29 – May 3, 2002. International Council for the Exploration of the Sea – Copenhagen (Denmark)

- High-level action plans
- Large-scale regional focus
- Ecosystem approach implementation
- State of the Environment reporting
- Fisheries Management

- Identifying gaps
- What we should do…

References

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1. Context

At national level

The Oceans Act (OA). First of all, the recent *Oceans Act* (Canada, 1996) is the broad context of our Oceans Management activities. The OA preamble states that "*Canada promotes the understanding of ocean processes, marine resources and marine ecosystems to foster the sustainable development of the oceans and their resources…*" Sustainable Development of the marine environment is the key-word giving orientation for all Oceans Act activities.

Canada's Oceans Strategy (COS). The OA calls on the Minister of Fisheries and Oceans to lead in the design and implementation of a comprehensive Oceans Strategy for Canada. The Strategy is under way and it is based on the three following principles: Sustainable Development, Integrated Management, and Precautionary Approach. It is important to note that the first Policy Objective of COS is aiming at understanding and protecting the marine environment, giving MEQ program a key-role as an integral part of the ongoing Strategy. (Note that other COS policy objectives are: (2) Supporting sustainable economic opportunities, and (3) International leadership.)

Oceans programs. Three core programs have been undertaken under the Oceans Act, as the three pillars upon which the OA implementation is based:

- Integrated Management (IM): A collaborative process to bring together interested parties to effectively plan and manage all human activities in the marine/coastal environment and to incorporate social, cultural, economic, and environmental values in ocean use planning.

- Marine Protected Area (MPA): Program aiming at the establishment of a national network of MPAs to conserve and protect marine resources and their habitats. MPA program uses a flexible approach (i.e., on a "site-by-site" basis). However, a set of specific key steps must be followed for the establishment of MPAs; for example, initial screenings (ecological overview) and ecosystem assessment are required of Area of Interest (AOIs), the initial step prior to the designation of each individual MPA by regulation.

- Marine Environmental Quality (MEQ): The program provides support and guidance to Oceans Management activities and, more specifically, to IM and MPA planning (see Section 2 for more details on MEQ program).

What has been done to date within DFO's Oceans programs? At this point of time (May 2002), four Large Oceans Management Areas (LOMAs) are priorities for DFO and do exist with approved IM plans, namely: *Gulf of St. Lawrence Integrated Management* (GOSLIM), *Eastern Scotian Shelf Integrated Management* (ESSIM), *Central Coast Integrated Management* (CCIM, on Pacific coast), and *Beaufort Sea Integrated Management Planning Initiative* (BSIM). All these LOMAs are facing increasing pressure due to human activities in coastal areas. LOMAs will address broad Ecosystem Objectives dealing with major ocean issues (e.g., shipping, oil and gas, species at risk). LOMAs will ultimately cover all Canada's marine environment. Ecosystem-based management (EBM), and associated Ecosystem Objectives established for all existing LOMAs, will be the framework for all the 21 IM coastal areas and 13 proposed MPAs (note that no legal MPA yet exists at this time, but Areas of Interests, as candidate MPAs).

On international scene

In addition to addressing domestic issues, DFO is also actively involved in many international organizations dealing with monitoring and assessment of marine ecosystems. Here are mentioned a couple of global initiatives, among the most important ones:

Global Programme of Action for the Protection of the Marine Environment from Land-Based Activities (GPA)

GPA was developed under the auspices of UNEP in response to Agenda 21 of the UN Conference on Environment and Development (UNCED) and adopted by Canada, together with 108 other maritime nations in 1995. As part of GPA, Canada has developed its own national component, the ***Canada's National Programme of Action*** (NPA, 2001). It's a partnership among federal, provincial, and territorial governments aimed at preventing marine pollution from land-based activities and protecting habitat in the near-shore and coastal zones of Canada. The NPA focuses on addressing problems within 14 categories under the broad themes of contaminants and physical alteration and destruction of habitat. The first NPA report (2001) also describes the current framework for managing the marine environment in Canada. The DFO Marine Environmental Quality (MEQ) program is mentioned as an important component of NPA's supporting programs for monitoring and assessing environmental trends in Canada.

Global Ocean ObservingSystem (GOOS)

GOOS is a high-level worldwide network with associated systems and regional/national components. Canada is an active participant in GOOS and other global observing systems (e.g., GCOS) through provision of oceanographic observations: sea surface temperature, sea level, temperature and salinity depth profiles, energy and carbon flux, etc. Canada has initiated a national review of its ocean observing networks, in order to determine shortcomings and systematically consolidate and enhance the long-term effectiveness of these systems. Canadian contributions to GOOS implementation are reviewed in the GOOS-Canada Annual Report 2001[1]). In addition, Canada has made significant strategic contributions to GOOS, through the ARGO project (details on ARGO are given in the third part of this paper, as example of real-time data/systems).

In addition to these global programs, Canada also collaborates with international groups like ICES, PICES, NAFO, and IOC through several international projects and the active participation of DFO staff to expert working groups on numerous topics.

2. Marine Environmental Quality and Ecosystem Objectives

DFO has developed national frameworks for both the MEQ program and Ecosystem Objectives Approach. DFO high-level policy managers recently approved these frameworks and asked Oceans Management team to make them operational. A MEQ pilot project should be initiated in a near future to operationalize MEQ program and to demonstrate how it works at the practical (local) level. Joint meetings with regional Integrated Management teams are planned and will be held throughout Canada to identify MEQ objectives and to insert them into local IM plans. This section details MEQ components and how they relate to other Oceans programs activities.

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[1] GOOS-Canada Annual Report 2001 is available at: http://ioc.unesco.org/MS/rpts/Canada_R01.htm)

MEQ program

Briefly, MEQ program can be seen as a bridge between data providers (science research, monitoring) and the decision-making process related to oceans management. The main goal of the program is to provide the science support and guidance for an Ecosystem-based Management. The MEQ operational framework is essentially based upon marine ecosystem health (MEH) indicators, or surrogate measures, that must be tracked over time. So, MEQ-associated long-term monitoring programs should exist, or will be developed, or will be improved to collect valuable data sets for sound ecosystem assessments. (Note that numerous examples of existing monitoring programs are presented in the third part of this paper.)

MEQ objectives

MEQ objectives, to be operational, must consist in a verb, an indicator and a reference point. Giving a practical example, the narrative sentence to translate a MEQ objective related to dredging or sewage effluents would be: "To keep concentrations of suspended solids (as indicator) below X mg/L (as reference point, or limit)." MEQ objectives are derived from sound technical information, such as more broadly based environmental information (e.g., Canadian Council of the Ministers of Environment quality guidelines) or other ecological assessments. Note that MEQ objectives (i.e., measurable objectives related to broad ecosystem objectives), and their associated metrics (indicators, reference points, etc.) should describe a desired physical, chemical or biological condition of the ecosystem (or of one of its components) that must be maintained over time. MEQ objectives may also be expressed as limits, where ecosystem conditions should be avoided. However, as operational objectives, MEQ objectives have to be set on a site-specific (or plan-specific) basis (to say for a specific ecosystem or a specific coastal management area). To do that, they are always tied to a particular IM or MPA management plan. Through this way, they will influence (or regulate, under the Oceans Act) all human activities in coastal/marine waters. MEQ objectives moreover will lead to the development of scientifically defensible indicators and monitoring programs (including performance measurement), with associated reference points.

The following figure summarizes the flow chart of the proposed MEQ operational framework:

Figure A4.1.

1:

Technical support and guidance for Oceans Act programs

In MEQ program, most of the core tasks (listed here below) will require *ad hoc* monitoring data, indicators and ecosystem assessments. For example,

MEQ will assist Integrated Management initiatives by:

- Developing guidelines, operational objectives, and criteria for IM plans;
- Providing the authority to make regulations (i.e., standards and requirements under the OA), based upon ecosystem objectives.

MEQ will assist Marine Protected Areas by:

- Providing inputs for initial screening ("Ecosystem Overviews");
- Assisting Area of interests with "Ecological Assessments";
- Coordinating scientific research and monitoring within MPAs.

MEQ program will support the Canada's Oceans Strategy implementation by:

- Delineating marine ecosystems (e.g., LOMAs boundaries);
- Identifying and understanding key ecosystem components (i.e., structure and function);
- Developing performance indicators for adaptive management purposes;
- Contributing to the "State of the Oceans" reporting.

MEQ will support the Ecosystem Objectives approach by:

- Providing sound science-based advice for EO implementation;
- Interpreting broad ecosystem objectives for each LOMA;
- Reviewing and testing associated metrics: indicators, reference points, limits and targets.

MEQ / MEH indicators

Because the choice of marine ecosystem health indicators can strongly influence the decision-making process, the selection of such indicators is a critical issue for ecosystem-based management. As part of the MEQ program implementation, DFO has recently contracted for a comprehensive inventory regarding potential indicators that could be used in Canada's marine environment. (Envirosphere Consultants Ltd, 2000; EcoHealth Consulting, 2001a, 2001b). Globally, MEH indicators can be grouped into the following categories:

- Contaminants (e.g., heavy metals, POPs, PCBs, dioxins, endocrine disrupters, etc.);
- Biodiversity and size spectrum (e.g., composition of phytoplankton communities, benthic communities, fish communities, etc.);
- Primary productivity and nutrients (e.g., chlorophyll-*a*, primary biomass, eutrophication, etc.);
- Pathogens, biotoxins and diseases (e.g., natural toxins, fecal coliforms, parasites, animal and human pathogens);
- Instability and physical parameters (e.g., temperature/salinity shifts, oxygen depletion, turbidity in coastal waters);
- Habitat condition (habitat quality mapping, marine protected areas).

Among the huge quantity of MEH indicators which have been developed and which are now available for "marketing", some of them will have to be tested for Canada's marine environment and for specific (i.e., local) oceanographic conditions. That is a core task of the DFO's MEQ program in order to coordinate the development of indicator sets, following Ecosystem Objectives set at higher levels.

MEQ projects

In addition, more than 30 MEQ projects are currently under way, covering all Canada's regions and concerning a broad range of topics (e.g., stewardship monitoring program, delineation of marine ecosystems, development of marine ecosystem health indicators, impacts of exotic species, fate and effects of contaminants, etc.) They are the core technical /science supports for IM and MPA plans.

Information about Oceans programs and related projects is available from the Oceans Programs Activity Tracking (OPAT) website[1]. This GIS-based system is accessible via Internet and gives geographical and technical information on ongoing projects related to programs: IM, MPA, and MEQ.

Ecosystem Objectives approach

The Ecosystem Objectives approach was designed and validated by the Working Group on Ecosystem Objectives (WGEO), a DFO inter-sectoral/inter-regional group of experts. As starting point, a national workshop on *Objectives and Indicators for Ecosystem-Based Management* was held in Sidney (British Columbia) in 2001 (Jamieson *et al.,* 2001). Now, DFO is developing the Ecosystem Objectives framework to make the ecosystem approach operational within supporting Oceans programs and tools (MEQ, IM, LOMAs,…) and also with other activity sectors (e.g., Objective-Based Fisheries Management). Basically, the EO approach is based on the so-called "unpacking" process: First of all, overarching EOs will be defined for each LOMA, as a nested set of high-level policy objectives to address major issues of a given LOMA. These EOs will be set for all aspects of a marine ecosystem (i.e., structure and function) which should not be compromised. EOs must relate to the following three key areas:

The first EO is related to <u>biodiversity</u>:

"Conserve enough components (e.g., species, populations, community, habitats) to maintain natural resilience of the ecosystem."

The second EO is related to <u>productivity:</u>

"Conserve function of each component (e.g., the primary production, trophic structure, or generation times) to maintain its natural role in marine food web."

The third EO example is related to <u>environmental quality</u>:

- "Conserve physical and chemical properties of ecosystem" (that includes critical landscape/bottomscape features in addition to quality of water column, sediment, and biota).

Then, moving from conceptual (high-level policy) to operational objectives, by "unpacking" EO; the "unpacking process" consists in defining more specific objectives (i.e., site-specific and/or plan-specific objectives) with associated MEQ metrics like operational objectives, indicators, reference points (and eventually limits and targets). Finally, management actions, which should be triggered from MEQ metrics and measurements, will be identified.

Following the nested approach, a more specific, and operational (MEQ) objective related to the biodiversity key-area would be, for instance:

- Rebuild species X above target abundance within specified time frame; that could trigger the following pre-established management measures, for example: Reduce/eliminate incidental mortality (fishing) or ship strikes (about marine mammals)

In the productivity key-area, an example of an operational objective would be:

- To prevent eutrophication, keep primary productivity below X mg C/yr in all coastal areas; and associated management measures would be, for example: To keep aquaculture (or land-based) effluents below level to meet the objective.

In the environmental quality key-area, an example of an operational objective would be:

[1] http://www.dfo-mpo.gc.ca/canoceans/

- Keep concentration of suspended solids below X mg/L in areas/times of herring spawning; an associated management action would be, for example: To manage dredging (or industrial / municipal discharge) to meet target.

Next steps… to achieve Ecosystem-based Management

In future developments, MEQ practitioners, ecosystem managers, decision-makers, and high-level policy-makers, all together will have to consider the following statements:

1) There is now an urgent need to develop environmental indicators parallel with socioeconomic ones, in an effort to address sustainable development issues (SGEAM Report 2001; CDG-AWI Conference, 2000). To address this issue, DFO is holding, in collaboration with IOC (UNESCO), and with the support of NOAA and IGU, an international workshop on the *Role of Indicators in Integrated Coastal Management* (Ottawa, April 29–May 3, 2002). The workshop aims to: (a) Assess the "State-of-the-Art" in the use of indicators to monitor and assess the effectiveness of coastal management efforts; (b) Review selected national and local case studies in the application of coastal management indicators; and (c) Develop a common framework and template for the selection and application of coastal management indicators in different contexts. Breakout working sessions are devoted to socioeconomic indicators, environmental health indicators, and governance indicators while plenary sessions are dealing with crosscutting issues such as quantitative objectives, goals, and scale of application of indicators, outcome mapping, performance measurement, and integration of different types of indicators to address specific policy issues (e.g., watershed and coastal management, marine protected areas, regional marine plans). In addition to reporting scientific contributions of key-speakers, Proceedings and outcomes of this workshop should contain practical recommendations targeted to the user community.
2) Hundreds of potential ecosystem health indicators have been developed to date, but how to select the most pertinent ones (i.e., sensitive, robust, etc.) for decision-making purposes? Some tools are under development and would be helpful to address this issue (Rice, in prep.).
3) Integrated Management planning is starting at the local level in Canada, throughout coastal management areas. MEQ program has been asked to provide Oceans managers and stakeholders involved in IM process with MEQ objectives and associated metrics. Most MEQ efforts will be devoted to focus on this task for the next years. The first step will be to design and coordinate the development of a MEQ pilot project (to be selected and proposed very soon). This pilot project will aim to demonstrate how MEQ program could address issues and needs raised in local IM planning; in other words, how does MEQ program work at the practical level?

3. Examples of DFO monitoring programs

This section is not a comprehensive review of all existing monitoring programs within DFO, but a selection of ongoing programs showing the great variety of data available, for the purpose of this overview. MEQ-related activities could be based on such monitoring programs, as primary data sources for indicator development and ecosystem assessment. Characteristics and strengths of each of the selected programs are briefly summarized here below.

3.1 Stewardship initiatives

Streamkeepers and Shorekeepers programs

These are volunteer-based programs which have been developed from local community initiatives for many years. They aim at monitoring British Columbia rivers and intertidal habitats. *Streamkeepers* collect water quality data (temperature, dissolved oxygen, pH, turbidity, etc.), while *Shorekeepers* collect data on habitat characteristics (e.g., area, slope, elevation, type of substrate, etc.) and biota (rockweed/eelgrass beds, plants and animal diversity, species abundance,…). Sampling protocols were designed by DFO scientists; scientists also analyze data collected from *Shorekeepers*. They have produced numerous monitoring tools like protocols, handbooks, water quality interpretation sheets, databases, training for volunteers, educational documents, and web resources[1].

The "Tariuq" (Ocean) monitoring program

This community-based program has been undertaken under the MEQ program, as part of the Beaufort Sea Integrated Management planning initiative. In addition to Department of Fisheries and Oceans, numerous partners and governmental agencies are involved in the program. Community members selected two indicators: water temperature and fish health (including species abundance and biochemical analysis).

3.2 "Real-time" data / systems

Water Level Network and Canadian Tide Tables

The DFO's Canadian Hydrographic Service (CHS) is the responsible authority for recording and delivering water level data and bathymetry for all Canadian waters (marine and freshwaters). CHS operates a network of water level gauges and provides the public and users with annual tide tables. The web version of the Canadian Tide Tables[2] gives access to predicted times of high/low waters, and hourly water levels for more than 600 inshore stations covering all Canada's waters. Prediction calculations posted on the CHS Website cover the current 30-day period.

Buoy program

This is a joint program undertaken in collaboration with the Department of the Environment, consisting in a network of 14 offshore buoys, off the British Columbia coast (Pacific region). Buoys record a continuous series of "sea state" data (sea surface temperature, wind speed, wave height, air pressure, etc.). Data are reported via satellite and can be visualized on DFO's intranet website, by using *ad hoc* software.

Lighthouse sea surface temperature

This program collects SST and salinity data from 20 inshore sampling sites, light stations along the British Columbia coast. In addition to the current stations (active series), a website[3] gives access to about 20 additional sites sampled long ago; some time series are from the 1930s. Data are also reported through SST and temperature anomaly maps.

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[1] *Shorekeepers* Web site: http://www.pac.dfo-mpo.gc.ca/sci/protocol/shorekeepers/default.htm
and *Streamkeepers* Web site: http://www-heb.pac.dfo-mpo.gc.ca/PSkF/home.htm
[2] Canadian Tide Tables: http://www.lau.chs-shc.dfo-mpo.gc.ca/marees/produits/accueil.htm
[3] Lighthouse Sea Surface Temperature Web site:
http://www.pac.dfo-mpo.gc.ca/sci/osap/projects/sst/Searchlighthouse.htm

Shipboard thermosalinographs

Real-time temperature and salinity data are collected in the St. Lawrence area from commercial ships along maritime routes (e.g., from Montreal to Newfoundland); a Canadian Coast Guard Ship also participates to this innovative project during scientific surveys. Data are then automatically transmitted to, and posted on, a DFO website (see note 9). Data and data products (e.g., maps, archives, temperature and salinity composites) cover a large portion of the Gulf of St. Lawrence. These data are used for predictive winter ice coverage and remote sensing calibrations.

3.3 The Atlantic Zone Monitoring Program (AZMP)

The main goals of AZMP are to detect and follow climate change and variability in the North Atlantic, with a focus on the Northwestern area and Gulf of St. Lawrence (GSL). This is a good example of a supra-program that makes an extensive use of existing monitoring programs, acting as coordinating structure. This program also extends existing monitoring programs where needed; field data (biological, physical and chemical data) are collected from six fixed stations and thirteen transects located in GSL and in Newfoundland and Labrador surrounding waters. The sampling strategy is based on seasonal and opportunistic samplings.

Other AZMP components are:

- ***Fish surveys***: Surveys are carried out in Atlantic Canada's large fishing zones (Great Banks and Gulf of St. Lawrence) for stock assessment purposes.
- ***Long-term temperature monitoring program (LTTMP):*** The GSL Thermograph Network[1] is a good example of LTTMP, providing scientists with time-series of temperature collected from 20 fixed stations since 1993. Thermograph network database also contains several hundreds of records from non-permanent stations. Temperatures are usually measured throughout the entire water column (1–100 m), in coastal waters.
- ***Toxic algae monitoring program:*** Following up an important shellfish poisoning event occurring in the GSL during the 1980s, this program was designed to monitor species abundance (including harmful microalgal species like *Alexandrium tamarense*, responsible for mortality years ago) at 11 inshore stations in the Quebec region since 1989. In addition to recording physical-chemical parameters and phytoplankton composition, the program includes toxicity measurements (amnesic/paralytic shellfish poisoning). The program is the science basis for bloom warnings during spring/summer seasons. Other governmental agencies concerned with food and fisheries collaborate with the program. Annual updates are available via Internet (see note 9).
- ***Data management and dissemination:*** Finally, note that all data sets collected within the AZMP are available on the web, either from the DFO's Marine Environmental Data Service (MEDS)[2], for national coordination and data delivery, or from the St. Lawrence Observatory Website (OSL)[3] for thematic data products.

3.4 Remote Sensing surveys

Satellite imagery products

DFO remote sensing facilities cover all Canada's marine environment, with a network of remote sensing laboratories located in important marine centers on Pacific (Institute of Oceans Science), Québec (Maurice Lamontagne Institute) and Atlantic coasts (Bedford Institute of Oceanography). Because of large areas covered, regional-scale phenomenacan be studied in whole through satellite imagery. A large variety of data products are available to scientists due to the wide wavelength spectrum used to collect source data. Among useful products for surveying the marine environmental quality are the following:

- Sea surface temperature maps (upwellings, freshwater runoffs, mixing zones, etc.);
- Ocean color images (chlorophyll pigment concentrations, coastal water turbidity);
- Altimeter backscatter measurements for ocean features (e.g., wind speed, sea level, wave height).

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[1] GSL-Thermograph Network Web site: http://eole.qc.dfo.ca/thermo/english/index.html
[2] AZMP Web site: http://www.meds-sdmm.dfo-mpo.gc.ca/zmp/main_zmp_e.html
[3] OSL Web site: http://www.osl.gc.ca/en/index.htm

ARGO floats

ARGO is a GOOS-supporting worldwide project that consists of large-scale float deployment (about 3000 floats over the entire Global Ocean up-to-date). DFO is the Canadian component in this international program, and 90 Canadian floats have been already deployed. Floats are launched from ship or aircraft, then sinking to pre-selected depths, drifting and automatically returning to sea surface while recording ocean properties (vertical profiles). Data are then reported to MEDS via satellite link.

3.5 Regional-scale programs

The Bedford Basin Plankton Monitoring Programme

The program covers the metropolitan Halifax area (DFO-Maritimes region). Physical-chemical data (temperature, salinity, dissolved oxygen, nutrients, etc.) are collected in addition to some unusual biological measurements for the planktonic component (e.g., cell abundance of phytoplankton, bacteria and viruses, and cytometric measurements of biological particles). The BBPMP core component is based on a weekly sampling time-series (uninterrupted since 1991), allowing scientists to consider seasonal events (e.g., phytoplankton blooms), and variability at annual and decade time scales for assessment of local change over time.

Aerial surveys of marine mammals (Gulf of St. Lawrence)

Aircraft surveys have been conducted since 1982, but on an irregular basis. However, some efforts have been made during past years to increase such activities (surveys conducted in 1995, 1996 and 1997). Most resident species (cetaceans and seals) were observed during surveys, but focus was made on the Beluga population, due to its "endangered species" status. Efforts are also made to standardize survey protocols (grid of transects, photographic/visual counts) in order to compare data sets and track trends over time (e.g., population recovery in terms of individual, adult and juvenile numbers).

3.6 Focus on contaminants and ecosystem health

Contaminant tracking in Newfoundland coastal waters:

- ***Harbour sediment database***: This database contains data on sediment contamination, tracking 38 chemicals in sediments of 119 harbours (Newfoundland and Labrador). Various agencies are involved in the data collection since 1970. For data reporting purposes, sediment samples are color-coded, based on chemical analysis results and sediment quality guidelines.
- ***Municipal Sewage Discharge database***: This database contains more than 600 sewage outfalls, with associated data on sewage treatments, outfall conditions (distance and depth), in addition to giving indication on the human pressure (population number).
- ***Point Source database***: This database contains information on more than 1200 point sources, dealing with chemical pollutants (metals, hydrocarbons, PCBs, dioxins and furans, etc.), nutrients and bacteria. All sectors with potential point-sources of pollutants are considered: mines, landfills, industrial effluents, municipal incinerators, aquaculture, oil storage, disposal sites, etc.

Marine Mammals Health Programs

Monitoring activities are carryied out on both the British Columbia coast (Pacific region) and in the Gulf of St. Lawrence (Quebec region). In BC, persistent organic contaminants (POPs) are tracked in Seals and Killer Whales. In GSL, all species have been considered but with focus on the Beluga population. Data come from both the stranded and free-ranging animals; in the GSL stranding events are systematically recorded since 1996, in collaboration with a network of observers that alerts DFO's scientists. Tissue collection and chemical analyses are made possible by using biopsies (free-ranging animals) or necropsies (stranded animals). Noticeably, such monitoring activities (as regular monitoring) are being conducted as part of larger research projects led by DFO scientists. Such programs with long time series records lead to proposing marine mammals as sentinel species for monitoring and assessment purposes. Indeed, marine ecosystem health indicators related to marine mammals would be of great value to provide useful complementary signals because of their unique biological characteristics (i.e., top level of the food web, long life, mammal development, bio accumulation of contaminants), although they are not easy to track on a routine basis.

Monitoring and Assessment of Salmon Aquaculture (New Brunswick)

This very new project was recently announced by DFO's Minister. It is a DFO/private sector joint project, addressing the aquaculture impact issue through the development and evaluation of new tools for monitoring and assessment of marine habitat related to salmon farming. Indeed, recent studies show that aquaculture facilities could have potential impacts on water, sediment community, and wild fish populations. Due to increasing aquaculture development in coastal zones, and with respect to cumulative effect issues, appropriate tools for monitoring these emerging activities are needed in Canada.

4. Discussion

Pointing out similarity about ecosystem management approaches

It is interesting to note that some initiatives undertaken in different ICES Member Countries during past years are somewhat similar with regard to ecosystem-based management. Here are some brief parallels:

High-level action plans:

The ongoing ***Canada's Oceans Strategy (COS)*** will be launched in the next months by the Department of Fisheries and Oceans. The Strategy will be the action plan related to Oceans Act and will make Oceans programs operational, in addition to making ecosystem approach the core component for managing all human activities in Canada's oceans and coastal waters. In March 2002, the Fifth North Sea (Ministers) Conference and members of the European Commission responsible for the protection of the environment adopted the ***Bergen Declaration (2002)***. The first part of the Ministerial Declaration aims at establishing an ecosystem approach to management, while the second part is considering the conservation, restoration and protection of species and habitats; the other parts are concerned with prevention of pollution. So, it's interesting to note that biodiversity conservation and sustainable development are the broad context of the Bergen Declaration, as well as the upcoming Canada's Oceans Strategy.

Large-scale regional focus

To achieve Oceans Management programs, **Large Oceans Management Areas (LOMAs)** are being developed for integrated management purposes. That will require supporting activities like ecosystem delineation, ecosystem monitoring and assessment, etc. Other organizations are dealing with the **Large Marine Ecosystems (LMEs)** framework to develop and manage ecosystem approaches at the global level. Furthermore, ICES has a list of Geographical Areas recommended for use in ICES status reports. Some of them are of interest for Canada: North Atlantic Ocean, Hudson Bay, Arctic Ocean, Labrador Sea, Bay of Fundy, Gulf of St. Lawrence.

Ecosystem approach implementation

For implementing an ecosystem-based management, a few overarching **Ecosystem Objectives (EOs)** will be set for each LOMA, and will be supported and coordinated by science-based programs as previously described in this paper. The Canadian EO approach is quite comparable to the **Ecological Quality / Ecological Quality Objectives (EcoQ/EcoQO)** concept which is promoted by supporting organizations in Europe (ICES, EEA, OSPAR, HELCOM). Some ICES countries (Norway, UK, and Canada) are now implementing the ecosystem approach for ecosystem management of regional areas of interest (e.g., North Sea, Baltic Sea, Gulf of St. Lawrence). The first step of this process is usually initiated by means of national scientific workshops, in order to provide decision-makers and policy with a strong science/technical support, in addition to seeking consensus and disseminating information (see: Jamieson *et al.,* (2001), CEFAS (2001), and IMR (2002a) for Canada, UK and Norway cases, respectively).

State of the Environment reporting

Within the upcoming Oceans Strategy, the "State-of-the-Oceans" reporting will be a core task for MEQ program. Some local initiatives have already been taken in an attempt to assess marine ecosystems, but at regional level (see for example the *St. Lawrence Action Plan Vision 2000*). Also, environmental assessment for Great Lakes has been reported within a joint US-Canada agreement (*State of the Great Lakes 2001*). Ultimately, on a regular basis, such a reporting process will be part of the overall "State of the Environment" for all Canada's ecozones (including forest, wetlands, drainage systems, freshwater and marine ecosystems). In that way, some efforts should be made for integrating data from various departments and agencies responsible for ecosystem assessment in their fields of interest. In Europe, several reports have been recently released at regional levels, drawing ecosystem assessment of European Seas and Northeastern Atlantic region (OSPAR, 2000; IMR 2002b).

Fisheries Management

Efforts are being made on both sides of the Atlantic to take into account the ecosystem objectives approach in the fisheries management process. In Canada, the *Objective-Based Fisheries Management (OBFM)* is progressively being implemented. Part 3 of the Bergen Declaration is dealing with *Sustainable Fisheries*. At the same time, some attempts for delivering integrated assessment (i.e., by merging fisheries and environmental aspects) come up, addressing ecosystem effects of fishing, fish disease and contaminants issues for North Atlantic areas of interest (ICES, 2000).

Identifying gaps…

A brief literature survey has permitted to say that most studies on the topic conclude that there is *"an abundance of indicators, but a scarcity of meaning"* (Millennium Ecosystem Assessment initiative; MEA 2002[1]). However, there is a real need *"for the development of SMART (Specific, Measurable, Accurate, Relevant, and Time-based) indicators for monitoring the state of the marine environment"* (Towards Earth Summit 2002). When selecting indicators, we should also keep in mind that "*each of indicators is important, but collectively they provide only a narrow window on the question of how well ecosystems are being managed."* (MEA, 2002). Finally, thinking about numerous initiatives which are going on for assessing ecosystems at the global level, *"harmonizing and standardizing is needed not only between countries, but also on local level and between land and water environments"* (EEA, 2000).

What we should do…

For developing sound indicators and for improving monitoring programs to further enhance the effectiveness of ecosystem assessment.

Environmental scientists should continue to make efforts to deliver monitoring data and "SMART" environmental indicators, and to make them available for all interested parties (i.e., other scientists, ocean managers, stakeholders and marine environment users).

In addition to developing indicators, MEQ scientists and managers should simultaneously deliver sound complementary information to ensure that stakeholders well understand scientific issues and that monitoring data and associated metrics are used in a well-advised manner in decision-making processes.

MEQ practitioners should share expertise and information to improve existing monitoring programs; to make them reliable and consistent through all management levels, i.e., at local (community-based initiatives, coastal management areas), regional (LOMAs, LMEs), and ultimately at the Global Ocean level.

The development of indicators and the design of efficient monitoring programs required for ecosystem health assessment of coastal zones are a big challenge for all people involved in the integrated coastal management because of the natural complexity and richness of this environment located at the land-sea interface (shoreline, wetlands, sensitive and unique habitats), in addition to experiencing increasing human pressures. This issue is of great concern for Canada and particularly for DFO because the country has the world's longest coastline (about 244,000 km !) with shores fronting on three major oceans (Pacific, Atlantic and Arctic) in addition to large inland lake shorelines (Great Lakes).

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[1] http://www.millenniumassessment.org/en/index.htm

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ANNEX 5: STATE OF THE GULF OF FINLAND IN 2001

In the beginning of the year 2001, the salinity stratification of the Gulf of Finland, which had started already in previous years, still prevented the oxygen ventilation of the bottoms. The continued oxygen depletion weakened the populations of the bottom animals, and also accumulated phosphate nutrient from the sediments into the water.

Because of strong winds and storms in the autumn of 2001, the stratification was finally broken. New oxygen was forced to the bottom, while the accumulated bottom phosphate was driven abundantly to the surface.

Mainly because of the extended stratification in spring and summer, phosphate concentrations, which are critical in view of the late summer's blue-green algal blooms, were only moderate. The breakdown of the stratification, bringing new phosphate to the surface, took place too late for the plankton bloom. In consequence, the bloom period of 2001 was only moderate.

Monitoring of radioactive substances gained considerable interest after the Chernobyl accident. Because of the more effective water exchange, the Gulf of Finland is now cleaner than the Gulf of Bothnia with respect to radioactive substances.

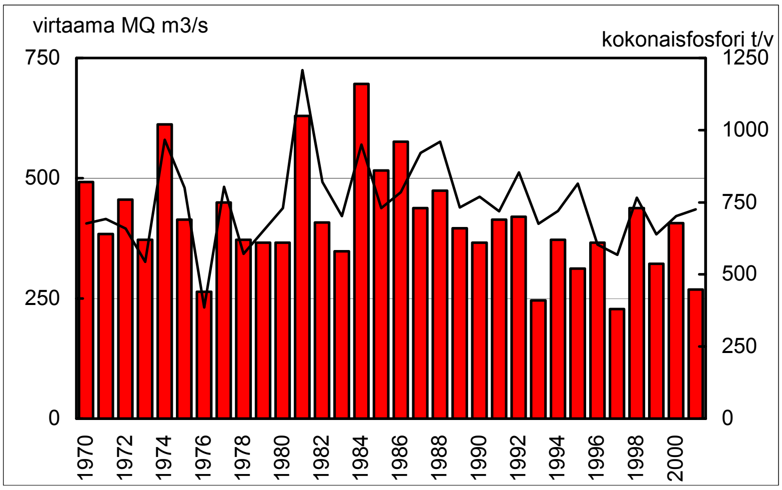
The number of illegal oil outlets has grown from the previous year. Most of the spills are observed in the open Gulf of Finland. The Finnish authorities observed 107 oil spills in 2001, or 18 spills more than year 2000.

There are 500–800 oil and bilge spills every year in the whole Baltic Sea area. The total number of spills is much greater because not all Baltic Sea countries have equipment for aerial observation.

Breakdown of stratification in autumn – surface phosphate increased, bottom oxygen starting to increase

Especially the surface phosphate concentration in the winter period is crucial for the next summer's bloom of blue-green algae. The phosphate concentration in the surface layer is affected not only by discharges, but also, to a large extent, by mixing of the water masses between the bottom and surface layers. Large sedimentation of organic matter, due to the increased primary production, accelerates the oxygen depletion in the bottom layer. Because of the entering of the Baltic Proper water, and also owing to the fluctuation of the deep water masses within the Gulf, salinity changes take place rapidly in the bottom layer. Salinity increase leads into the strengthening of the halocline, thereby preventing the vertical mixing and leading into oxygen decrease, even oxygen depletion. Oxygen decrease leads to the re-dissolution of phosphate and silicate from the sediments. During strong upwelling situations and, in shallower areas, also strong vertical mixing may transport this phosphate into the surface waters.

The nitrate concentrations have been on the rise since the beginning of the regular nutrient monitoring in the early 1960s. However, it appears that a maximum in the winter-period concentrations occurred in 1990–1992, and during the last 8–10 years, a levelling-off, even a slight decrease, has been detected. This decrease is most probably connected to the general decrease of nitrogen loading to the Gulf from both the drainage area and atmosphere.



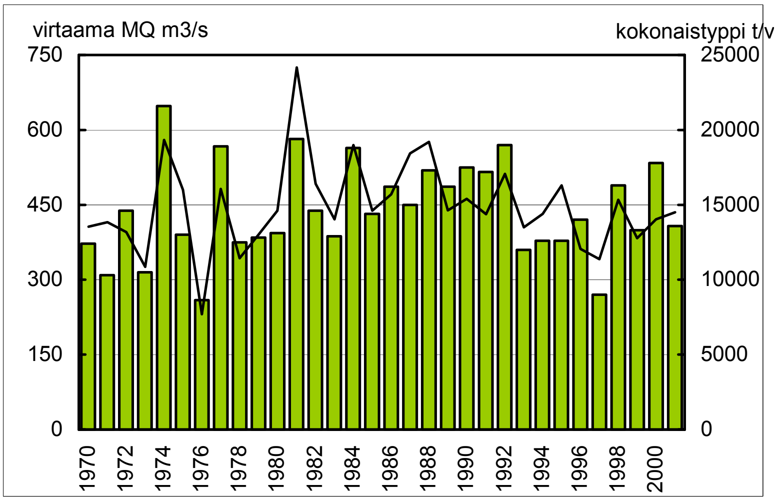


Figure A5.1. River transport of phosphorus (upper graph) and nitrogen (lower graph) into the Gulf of Finland in 1970-2001.

In 2001, the whole Gulf hydrography was characterized by strong stratification, which had already started in the previous year. During the year, phosphate and silicate concentrations followed the salinity variations in the deep water. In early winter, bottom salinity in central Gulf area was roughly one unit higher than in the previous winter. In accordance to the salinity increase, there was only a modest amount of dissolved oxygen left (compared to 7.5 ml/l in January 2000). In consequence, both the bottom phosphate and silicate had more than doubled from the previous year. During the year, stratification was further strengthened, with bottom salinities at in the middle of the Gulf increasing steadily until August-September, when maximum salinity, minimum oxygen (close to zero) and maximum phosphate and maximum silicate were observed.

Surface phosphate during the early winter period and spring of 2001 was very low, also indicating the absence of vertical mixing. However, in October–November 2001, bottom salinity suddenly decreased, indicating a breakdown of the stratification. In consequence, the bottom oxygen concentration increased to acceptable level, while phosphate and silicate decreased. In line with the assumed mechanism, exceptionally high surface phosphate concentrations were detected in the open Gulf and close to the northern coast.

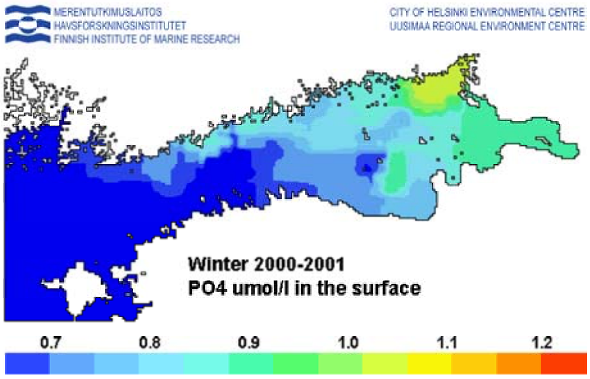


Figure A5..2 Surface phosphate distribution in winter 2000–2001 and winter 2001–2002.

In general, the low-oxygen bottom-near area in the open sea areas of the Gulf of Finland has increased in 2001 in comparison with the previous year.

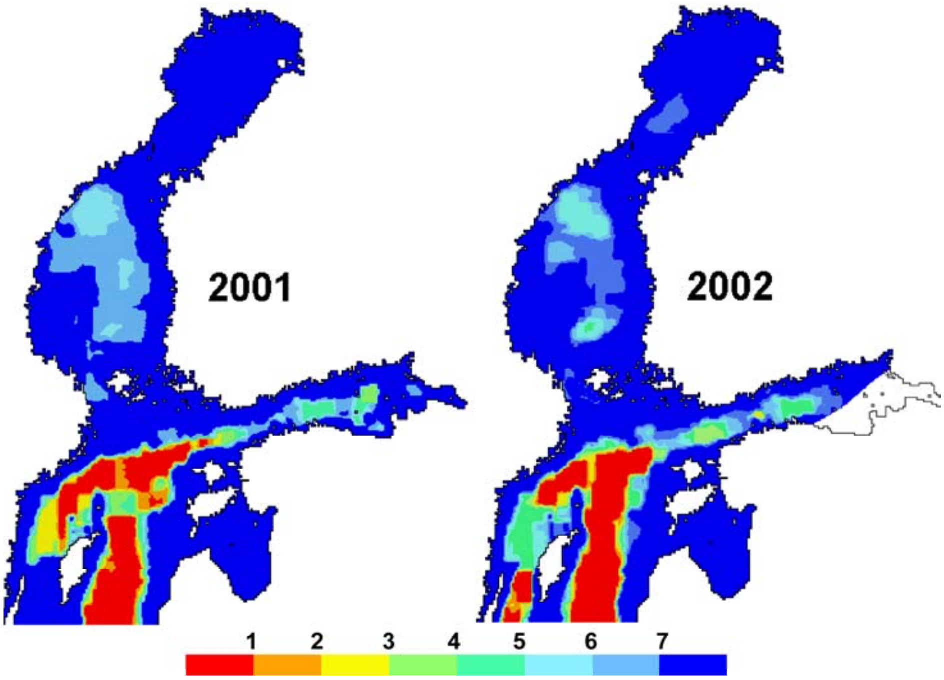


Figure A5.3. Oxygen distribution in bottom-near layer in 2001 and in 2002.

A similar development occurred also in the coastal waters; the near-bottom oxygen conditions in 2001 were much weaker than in the previous year. As in open waters, the reason for this was the strong density stratification and poor vertical mixing. Dead bottom areas with practically no benthic fauna were also found in the 30–40 m deep transition area between the coastal and open sea areas of the Gulf.

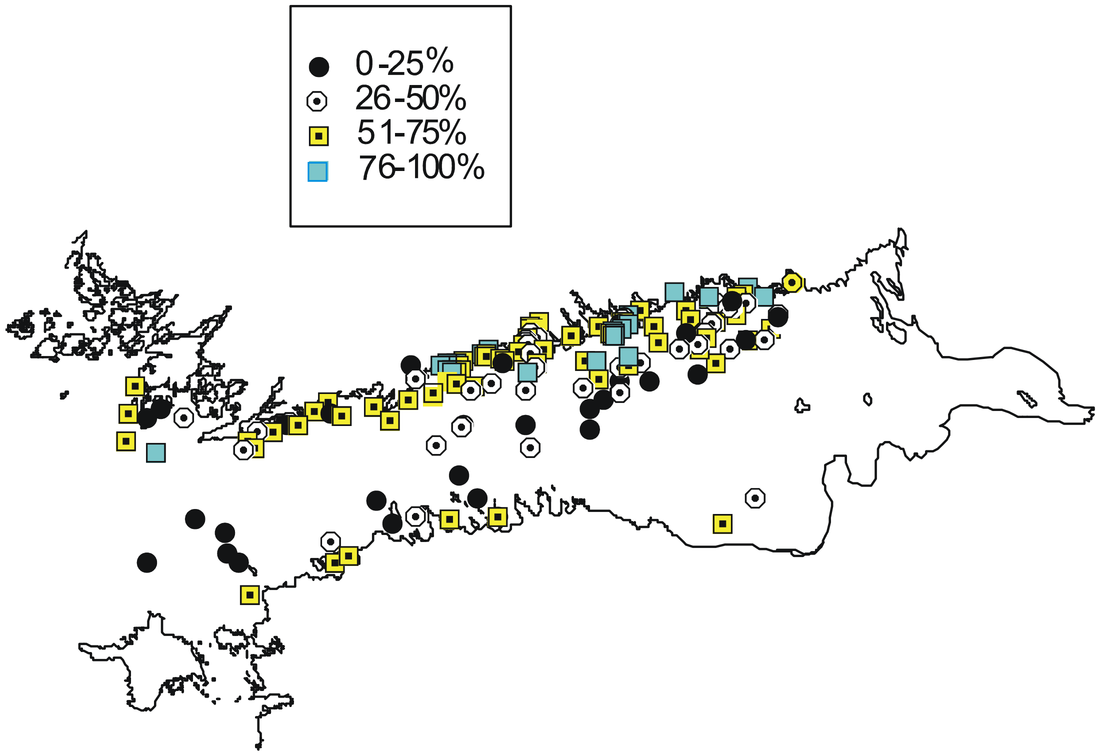


Figure A5.4. Oxygen saturation percentage in the bottom-near layer in the Gulf of Finland in 2001.

More information on the oxygen situation in the Gulf of Finland: http://www.vyh.fi/, http://www.fimr.fi/, http://www.vyh.fi/tila/uyk/vesi/laatu/Kartta.htm

Benthic animals suffer from poor oxygen conditions. Benthic macrofauna abundance and species composition indicate well the overall state of the bottoms. The communities are especially affected by oxygen deficiency and respond even to short-term events, which are not always caught by other measurements.

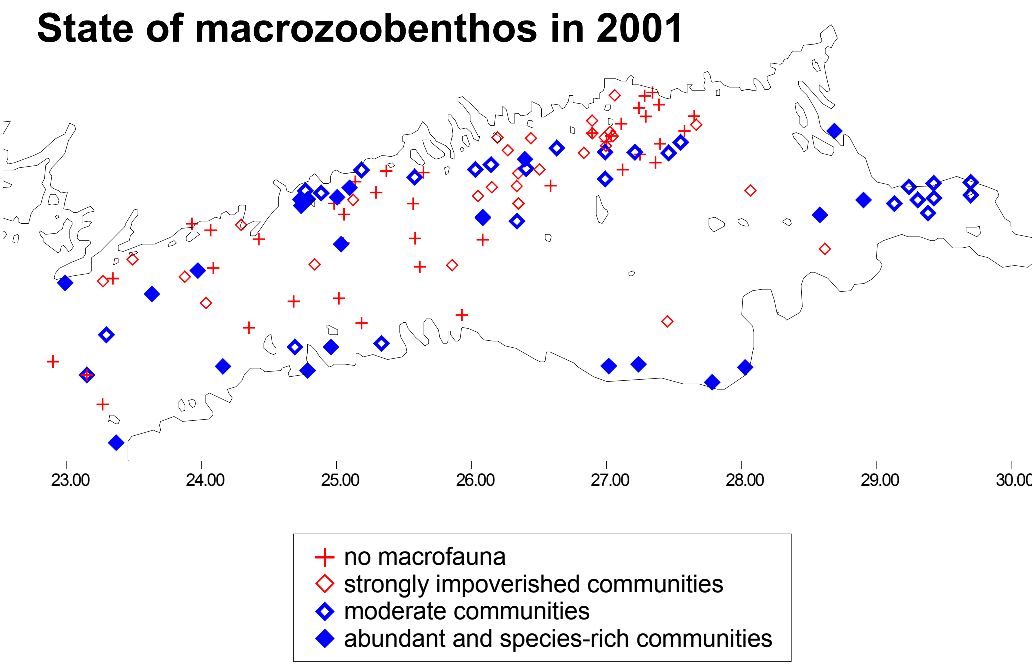


Figure A5.5. State of macrobenthos in 2001.

In 2001, large areas were found to be devoid of macrofauna. Only some 30 % of the bottoms had a normal species composition and moderate or high densities of the benthic invertebrates. The state of benthos was found to be weak especially in the eastern parts of the northern coast, where poor conditions prevailed over large basins in the shallower archipelago area and were not only restricted to isolated deeps. Normal macrofauna communities were found only on bottoms affected by strong underwater currents and thus better water exchange and oxygen conditions. Also in the deep open Gulf of Finland large areas were devoid of macrofauna or with strongly impoverished communities, due to the low oxygen concentrations.

Locally however, the long-term monitoring showed a slow recovery of macrofauna from the collapse in 1996–1997, but the communities are still far from the rich and abundant state observed in the early 1990s.

The non-indigenous polychaete *Marenzelleria viridis*, which was introduced to the northern Gulf of Finland in 1990, has become a permanent part of the benthic communities and can be found commonly in the coastal waters down to 50 m depth. The species was recorded in Estonian waters for the first time in 1994 and in Neva Bay in 1996. In 2001 *Marenzelleria* had invaded the southeastern coast also, where it occurred in high densities.

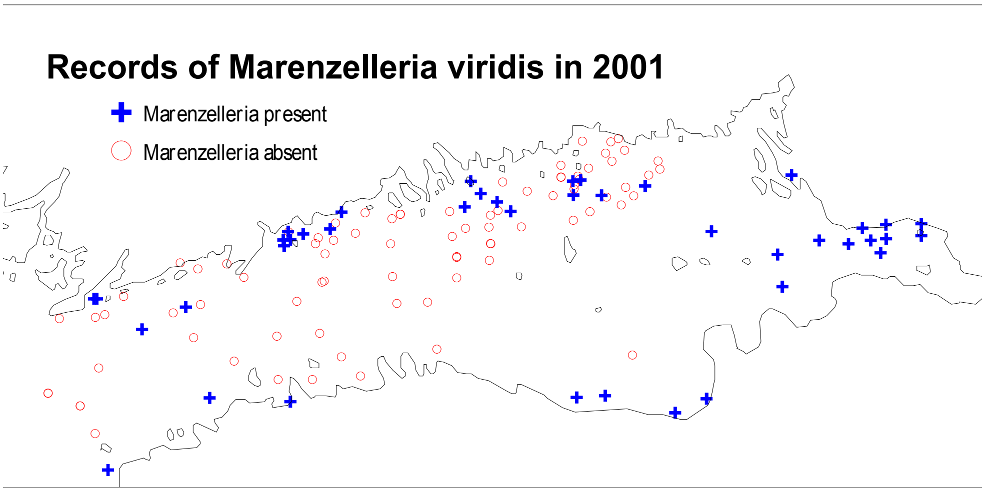


Figure A5.5. Records of *Marenzelleria viridis* in 2001.

More information on the salinity-oxygen-nutrients-benthos in the Baltic Sea: http://www.fimr.fi/, http://www.itameriportaali.fi/.

No exceptional blooms in 2001

Due to the mild winter in 2001 the spring bloom started in the western Gulf of Finland in mid-March and reached its maximum in mid-April, two weeks earlier than the average time during the last ten years. The spring bloom was of average duration and intensity. The summer minimum was in early June, but in mid-June the biomass started to increase when the weather started to get warmer. The summer maximum was observed in July. In late July also the blooms of the blue-green algae were most intense in the entire gulf. The blooms were strongest in the central and eastern parts on the Finnish side of the gulf, and in the Narva Bay. The cold weather and strong winds during the first week in August effectively mixed the surface blooms into the water column.

In the open sea *Aphanizomenon* sp. was the dominant blue-green algal species during the summer. The toxic *Nodularia spumigena* was common especially in August, whereas the potentially toxic *Anabaena lemmermannii* was fairly common in the central Gulf of Finland in July.

Local variations in blue-green algal species composition occurred in the Finnish coastal areas. In general, *Aphanizomenon* sp. dominated in early July, but the abundance of *N. spumigena* and *Anabaena* spp. increased in late July and early August.

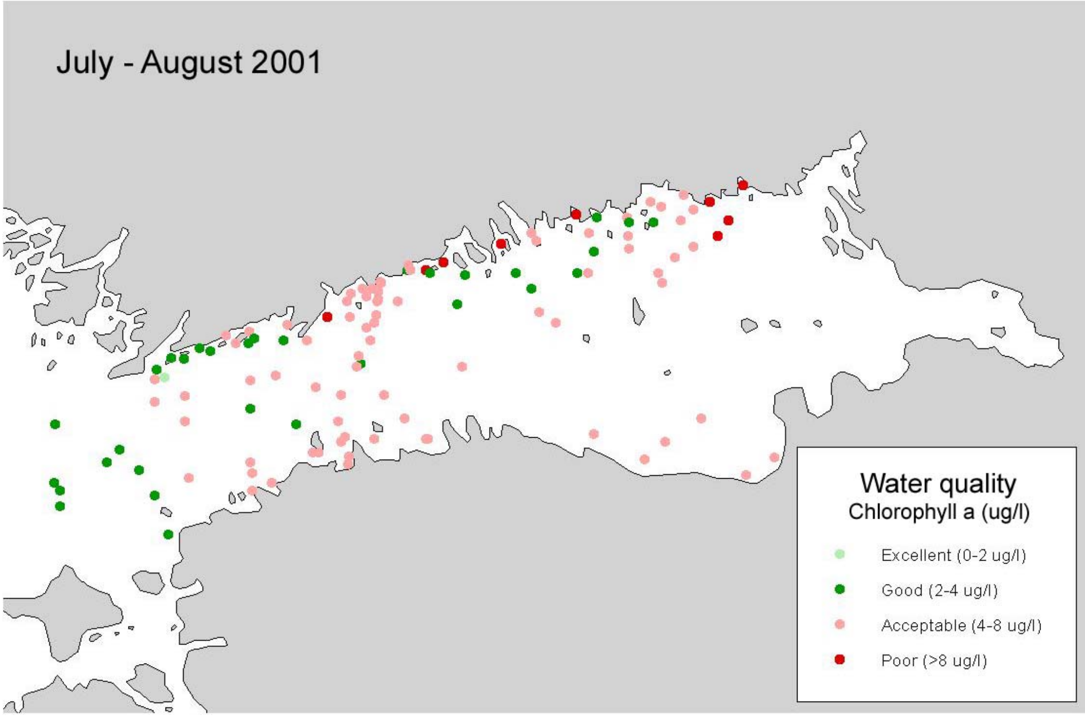


Figure A5.6. Water quality in the Gulf of Finland in July-August 2001.

Tentative algal toxin monitoring has started. *Nodularia spumigena* is a common bloom-forming species, and it can excrete highly toxic metabolites, especially nodularin. Because of the potential threat to humans and animals, a tentative monitoring program was started in 2000 to screen the occurrence of nodularin in algae. In the open Gulf of Finland, low to moderate amounts of nodularin were measured in the beginning of August.

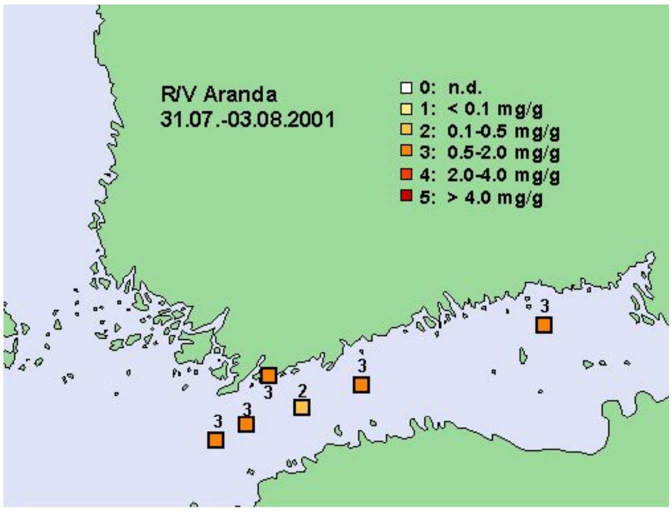


Figure A5.7. The amount of the toxin nodularin in algal samples (per dry weight).

Radioactive exposure decreasing

The closeness of potential radioactive sources has increased the interest in monitoring radioactive substances in the Baltic Sea. In general, because of the fallout from several sources, most notably the Chernobyl accident in 1986, and because of the very restricted water exchange with the adjacent North Sea, e.g., the concentration of radioactive cesium is still relatively high. The original distribution pattern from the Chernobyl fallout, with highest radioactivity in the eastern Gulf of Finland and in the Bothnian Sea, has changed by mixing of water masses, sedimentation and underwater currents. In this respect, the Gulf of Finland has benefited from the relatively free water exchange with the rest of the Baltic Sea. Cesium concentrations in water, fish and sediments are now generally lower than in the Bothnian Sea or Baltic Proper.

The decrease in cesium concentration in the Gulf of Finland has been dramatic. Highest values after the Chernobyl accident were close to 300 Bq kg^{-1}. In 2001 the cesium concentration in Gulf of Finland pike was 17–19 Bq kg^{-1} and in herring 6–7 Bq kg^{-1}. The maximum radiation intake from the marine environment after the Chernobyl accident was estimated to be roughly 0.2 mSv in 1986. In Finland, the average radiation intake from other sources is estimated to be 3.7 mSv, half of which from breathing radon in air.

More information: Finnish Radiation Protection Institute, http://www.stuk.fi/sateily_ymparistossa/itameri.html.

Oil discharges from ships increased

The number of illegal oil outlets in the Gulf of Finland has grown from the previous year, in spite of the improved regulation and absence of special fees for oil waste disposal in harbours. The illegal oil discharges take place in the international waters.

Unfortunately in 2001 more oil spills have been observed than in any other years previously in the Gulf of Finland. It seems that the amount of spills will not decrease despite prevention recommendations by HELCOM. In Finland Border Guards are responsible for aerial observation within Finnish territorial waters. Most of the spills are still observed outside of the Finnish territorial waters. 107 oil spills have been observed in 2001, or 18 spills more than in the previous year.

Every year there are 500–800 oil and bilge spills in the whole Baltic Sea area. The total number of spills is much greater because not all Baltic Sea countries have equipment for aerial observation.

More information on oil discharges and prevention: Finnish Environment Institute, http://www.vyh.fi/vahinko/torjunta/tulokset.htm.

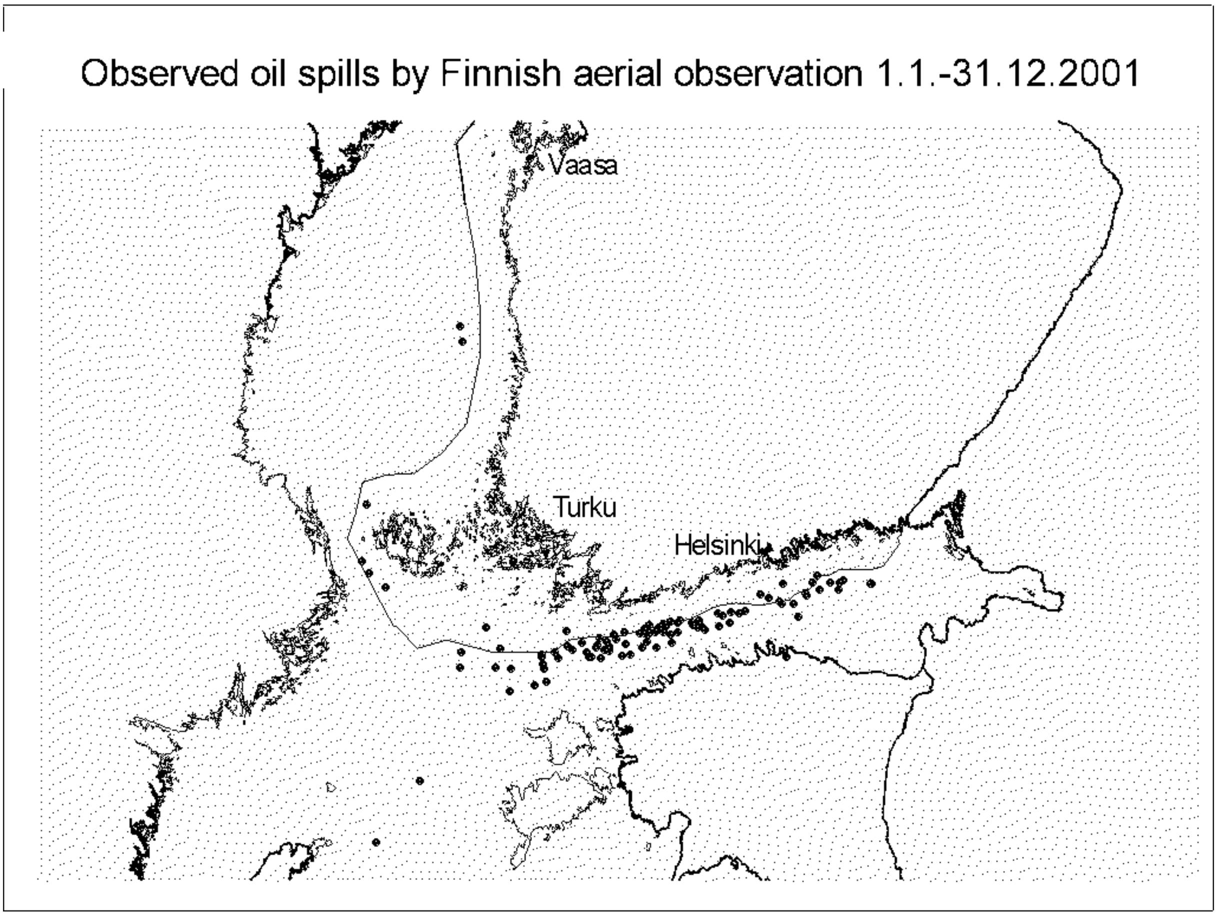


Figure A5.8. Observed oil spills by Finnish aerial observation 1.1–31.12.2001.

ANNEX 6: GLOBAL INTERNATIONAL WATERS ASSESSMENT (GIWA)

[Based on documents: GIWA Methodology: Introduction and Scoping/Scaling, 31 May 2001, and Draft Report GIWA Baltic Sea Sub-Region 17, February 2002–01–21]

Compiled by Eugeniusz Andrulewicz.

The objective of the GIWA project, funded by the Global Environment Facility (GEF), UNEP and other donors, is:

> to develop a comprehensive strategic assessment that may be used by GEF and its partners to identify priorities for remedial and mitigatory actions in international waters, designed to achieve significant environmental benefits, at national, regional and global level.

Assessments are organised on a global scale for 66 sub-regions as basic marine and catchment area units, which are similar to the designations of Large Marine Ecosystems (LMEs) (Table A6.1). For that purpose GIWA has been elaborating its own methodology, so-called "Scoping and Scaling Methodology".

Table A6.1. The geographical Sub-Regions in the GIWA Project (asterisk indicates LME).

Arctic

1. Arctic

North Atlantic

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

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

Eastern South America
38. Patagonian Shelf*
39. Brazil Current*
40. Northeast Brazil Shelf*
40a.Brazilian Northeast
40b.Amazon

Sub-Saharan Africa
41. Canary Current*
42. Gulf of Guinea*
43. Lake Chad
44. Benguela Current*
45. Agulhas Current*
46. Somali Coastal Current*
47. East African Rift Valley Lakes

Indian Ocean
48. Gulf of Aden
49. Red Sea*
50. The Gulf
51. Jordan
52. Arabian Sea*
53. Bay of Bengal

Southeast Asia and South Pacific
54. South China Sea*
55. Mekong River
56. Sulu-Celebes Sea*
57. Indonesian Seas*
58. North Australian Shelf*
59. Coral Sea Basin
60. Great Barrier Reef*
61. Great Australian Bight
62. Small Island States
63. Tasman Sea

Southeast Pacific

64. Humboldt Current*

63. Eastern Equatorial Pacific

Antarctic

66. Antarctic*

Compared to last year, GIWA has made significant progress: Scoping and Scaling Methodology has been finalised and is now ready to be used for the assessment of 66 GIWA Sub-Regions. The impact of each environmental issue and concern is to be assessed on a four-point scale, where:

0 = no known impact

1 = slight impact

2 = moderate impact

3 = severe impact

All impacts are assumed to be negative unless prefaced by a positive sign (e.g., +1).

It has already been used in some GIWA sub-regions including the Baltic Sea Sub-Region No. 17 which has been selected (together with the Gulf of Thailand) as a testing area.

GIWA has assessed the Baltic Sea's present status (Table A6.2) as "Severe" (Score 3) in case of eutrophication and over-exploitation of fish resources; as "Moderate" (Score 2) in case of pollution of existing supplies, chemical pollution of marine area, oil spills at sea, modification of ecosystems or ecotones, decreased viability of fish stock through pollution and disease, impact on biological and genetic diversity; as "Slight" (score 1) in case of modification of stream flows, changes in the water table, microbiological pollution, suspended solids, solid wastes, radionuclide pollution, loss of ecosystems, excessive by-catch and discards, destructive fishing practices. "No known" (score 0) as for thermal pollution, sea level change, increased UV-B radiation as a result of ozone depletion, changes in ocean CO_2 source/sink function.

Table A6.2. Environmental Impact under Present Conditions for the Baltic Sea.

Environmental Issues	**Score**	**Environmental Concerns**	**Score**
1. Modification of stream flow	1		
2. Pollution of existing supplies	2 1	I Freshwater shortage	2
3. Changes in the water table			
4. Microbiological	1		
5. Eutrophication	3	II Pollution	3
6. Chemical	2		
7. Suspended solids	1		
8. Solid wastes	1		
9. Thermal	0		
10. Radionuclide	1		
11. Spills	2		
12. Loss of ecosystems	1		
13. Modification of ecosystems or ecotones, including community structure and/or species composition	2	III Habitat and community modification	2
14. Over-exploitation	3		

Environmental Issues	Score	Environmental Concerns	Score
15. Excessive bycatch and discards	1	IV Unsustainable exploitation of fisheries and other living resources	2
16. Destructive fishing practices	1		
17. Decreased viability of stock through pollution and disease	2		
18. Impact on biological and genetic diversity	2		
19. Changes in hydrological cycle	1	V Global change	0
20. Sea level change	0		
21. Increased UV-B radiation as a result of ozone depletion	0		
22. Changes in ocean CO_2 source/sink function	0		

According to GIWA the impact of pollution in the Baltic Region should continue to improve from "severe" to "moderate" (Table A6.3). The following future scenario appears to be likely in the Baltic Sea Region:

- Eutrophication and its effects will continue to be a problem in the foreseeable future (toxic blooms, filamentous algal blooms, diminished depth range of macrophytes, etc.);
- Concentrations of harmful substances in marine animals will continue to decline (although new contaminants may appear);
- Fishery will be maintained at approximately the same total level with changes in proportions of some fish species;
- Sanitary conditions will continue to improve;
- Growing pressure on the coastline (privatisation of land, development pressure on former military-"protected" areas, tourism, urbanisation).

Table A6.3. Environmental Impact under Future Conditions for the Baltic Sea.

Environmental Issues	Environmental Concerns	Change	Score
1. Modification of stream flow			
2. Pollution of existing supplies	I Freshwater shortage	-	2
3. Changes in the water table			
4. Microbiological			
5. Eutrophication	II Pollution	+	2
6. Chemical			
7. Suspended solids			
8. Solid wastes			
9. Thermal			
10. Radionuclide			
11. Spills			
12. Loss of ecosystems	III Habitat and community modification		
13. Modification of ecosystems or ecotones, including community structure and/or species composition		+	2

Environmental Issues	Environmental Concerns	Change	Score
14. Over-exploitation 15. Excessive bycatch and discards 16. Destructive fishing practices 17. Decreased viability of stock through pollution and disease 18. Impact on biological and genetic diversity	IV Unsustainable exploitation of fisheries and other living resources	+	2
19. Changes in hydrological cycle 20. Sea level change 21. Increased UV-B radiation as a result of ozone depletion 22. Changes in ocean CO_2 source/sink function	V Global change	-	1

The next step in the GIWA process is the assessment of socio-economic drivers ("Caual Chain Analysis") for different sub-regions. This process will cover analyses of social and economic drivers from direct driving forces to original root causes.

SGEAM noted a very high degree of integration of environmental issues within GIWA Sub-regions. Therefore, GIWA methodology is useful for the purpose of global assessment, and might also be useful for comparison of the status of different seas and regions (e.g., scale of Pan-European seas). However, that high degree of agglomeration of information limits the amount of knowledge that decision-makers have to absorb.

However, the general approach used by GIWA should be considered by the ICES entities that may be eventually charged with developing the indices for the comprehensive integrated assessments of geographic "regions".

GIWA has also made an attempt to assess:

- Socio-Economic Impacts under Present Conditions for the Baltic Sea (Table A6.4);
- Socio-Economic Impacts under Future Conditions for the Baltic Sea (Table A6.5);
- Losses of priority habitat/community types and scoring of environmental impacts (Table A6.6);
- Modification of priority habitat/community types and scoring of environmental impacts (Table A6.7);
- Environmental and Socio-Economic Impacts, under Present Conditions, in Key Areas of Concern (listed in descending order of severity of impacts) for the Baltic Sea (Table A6.8);
- Environmental and Socio-Economic Impacts, under Future Conditions, in Key Areas of Concern (listed in descending order of severity of impacts) for the Baltic Sea (Table A6.9);
- Prioritization Analysis for the Major Concern for the present and 2020 for the Baltic Sea sub-region. Each concern is scored according to its priority from 1 (highest) and to 5 (lowest) (Table A6.10).

Table A6.4. Socio-Economic Impacts under Present Conditions for the Baltic Sea.

Key areas of concern	Economic Impacts	Health Impacts	Other Social and Community Impacts
I Freshwater Shortage	1	1	1
II Pollution	2	2	1
III Habitat and community modification	1	1	1
IV Unsustainable exploitation of fisheries, etc.	2	0	2
V Global change	1	1	1

Table A6.5. Socio-Economic Impacts under Future Conditions for the Baltic Sea.

Key areas of concern	Economic Impacts		Health Impacts		Other Social and Community Impacts	
	Change	Score	Change	Score	Change	Score
I Freshwater Shortage	+	1	+	1	+	1
II Pollution	−	3	+/-	2	−	2
III Habitat and community modification	−	2	+	1	+/-	1
IV Unsustainable exploitation of fisheries, etc.	−	2	+/-	0	+	2
V Global change	−	2	−	2	−	2

Table A6.6. Losses of priority habitat/community types and scoring of environmental impacts.

Habitat / Community type	Reason for selection as priority	Score
	Wetlands	
Peat bogs	Peat bogs are subject to extraction and drainage especially in northern and eastern parts of the Baltic Sea.	1
Marshlands	Marshlands suffer from more losses in the southern parts of the Baltic Sea due to the drainage (amelioration) works.	2
Littoral belts alongside lakes and ponds	There is no evidence of losses of ecosystem in littoral belts alongside lakes and ponds.	0
Wetlands related to running water (tidal rivers were excluded)	Wetlands related to running water suffer due to drainage (amelioration) works. Impacts are larger than score 1 in the southern part of the Baltic Sea.	1
Wetlands of saline habitats	There is no evidence of losses of ecosystems or habitats	0
	Open or running waters	
Running waters and standing waters	Ecosystems of running waters were not significantly affected. Lakes and ponds (a, oligotrophic, b, mesotrophic, c, eutrophic, and d, dystrophic) generally turn more rich in nutrients. The trophic status changes, which affects flora and fauna but in general there is no evidence of losses of ecosystems or habitats.	0
	Marine habitats	
	Coastal marine ecotones	
Sandy foreshores	Sandy foreshores (dunes were included here) are affected by tourism, pollution and also by construction.	1
Shingle foreshores, lagoons, muddy foreshores, estuaries, rocky foreshores.	There is no evidence of losses of ecosystems or habitats in shingle foreshores, lagoons, muddy foreshores, estuaries and rocky foreshores.	0
	Other benthic marine habitats	
Sea grass and *Fucus* meadows, mud bottom and rocky bottom	There is no evidence of losses of ecosystems or habitats in sea grass and *Fucus* meadows, mud bottom and rocky bottom.	0
Sandy and gravel bottom	In sandy and gravel bottom there was determined slight impact of excavation.	1
	Pelagic habitats	
Pelagic habitats (a, above, and b, below the halocline)	Pelagic habitats (a, above, and b, below the halocline) suffer from change of light above the halocline and from oxygen shortage below the halocline but there is no evidence of losses of ecosystem or habitats.	0

Table A6.7. Modification of priority habitat/community types and scoring of environmental impacts.

Habitat / Community type	Reason for selection as priority	Score
	Wetlands	
Peat bogs	Peat bogs are subject to extraction and drainage especially in northern and eastern parts of the Baltic Sea. Due to intensive extraction and drainage of peat bogs the corresponding influence to the modification of ecosystem was assessed as moderate.	2
Marshlands	Marshlands suffer from more modifications in the southern parts of the Baltic Sea. Despite the restorations, which also take place.	2
Littoral belts alongside lakes and ponds	Littoral belts (a, north, and b, south) impacts are severe in the southern parts and slight in the northern parts of the Baltic Sea.	1–3
Wetlands related to running water (tidal rivers were excluded)	Modification of ecosystems and ecotones is connected to the drainage and agricultural activity. Impacts are larger than score 1 in the southern parts.	1
Wetlands of saline habitats	Wetlands of saline habitats (inland salt marshes were excluded) are not very affected.	0
	Open or running waters	
Running waters	Running waters (a, fast flowing, stony bottomed, and b, sandy/muddy flood plain rivers) are affected by pollution and construction of dams.	a-1 b-2
Standing waters (a, oligotrophic, b, mesotrophic, c, eutrophic, and d, dystrophic)	Lakes and ponds generally turn more rich in nutrients due to the agricultural activities (diffused discharges) and discharges from point sources (municipal and industrial discharges). The trophic status changes affect flora and fauna.	a-2 b-2 c-1 d-0
	Marine habitats	
	Coastal marine ecotones	
Sandy foreshores (dunes were included here)	Sandy foreshores are affected by tourism, pollution, but also by construction. Sandy foreshores are more sensitive to the anthropogenic influence than the other areas.	2
Shingle foreshores, lagoons, muddy foreshores, estuaries, rocky foreshores.	Shingle foreshores are mostly affected by construction and urbanization, which are well regulated by national and international (HELCOM Recommendations) legislative acts and less accessible to the human activities.	1
Lagoons	Lagoons are threatened by pollution, urbanization, industry, agriculture and dredging.	2
Muddy foreshores	Muddy foreshores (only small areas) experienced the largest changes before baseline used. These areas are affected by dredging.	1
Estuaries	Estuaries suffer from land-based pollution and construction of, e.g., harbours.	2
Rocky foreshores	Rocky foreshores affected by construction of harbours (Sweden, Finland).	1
	Other benthic marine habitats	
Sea grass and *Fucus* meadows	Sea grass and *Fucus* meadows are affected moderately by pollution.	2
Mud bottom	Mud bottom suffered from oxygen depletion even before the industrialization.	0
Sandy and gravel bottom	Sand and gravel bottoms are used for extraction of sand and gravel and ecosystems have suffered slightly.	1
Rocky bottoms	No known impact.	0
	Pelagic habitats	
Pelagic habitats (a, above, and b, below the halocline)	Pelagic habitats suffer from change of light above the halocline and from oxygen shortage below the halocline.	1

Table A6.8. Environmental and Socio-Economic Impacts, under Present Conditions, in Key Areas of Concern (listed in descending order of severity of impacts) for the Baltic Sea.

Types of Impacts							
Environmental		**Economic**		**Human Health**		**Social and Community**	
Concern	**Score**	**Concern**	**Score**	**Concern**	**Score**	**Concern**	**Score**
II	3	II	2	II	2	IV	2
I	2	IV	2	I	1	I	1
III	2	I	1	III	1	II	1
IV	2	III	1	V	1	III	1
V	0	V	1	IV	0	V	1

Table A6.9. Environmental and Socio-Economic Impacts, under Future Conditions, in Key Areas of Concern (listed in descending order of severity of impacts) for the Baltic Sea.

Types of Impacts							
Environmental		**Economic**		**Human Health**		**Social & Community**	
Concern	**Score**	**Concern**	**Score**	**Concern**	**Score**	**Concern**	**Score**
II	3	II	3	II	2	II	2
III	2	I	2	V	2	IV	2
IV	2	III	2	I	1	V	2
I	1	V	2	III	1	I	1
V	1	IV	1	IV	1	III	1

Table A6.10. Prioritization Analysis for the Major Concern for the present and 2020 for the Baltic Sea sub-region. Each concern is scored according to its priority from 1 (highest) to 5 (lowest).

Major Concern	Present	2020
Freshwater shortage	2	2
Pollution	3	2
Habitat and community modification	2	2
Unsustainable exploitation of fisheries and other living resources	2	2
Global changes	0	1

ANNEX 7: JOINT MEETING BETWEEN HELCOM AND IBSFC

Reported by Eugene Andrulewicz

The cooperation between IBSFC and HELCOM is the first case of a common effort made by an international fishery management organization and an environmental organization.

The 1992 Helsinki Convention - the Convention on the Protection of the Marine Environment of the Baltic Sea Area - aims to protect the marine environment of the Baltic Sea i.e., water body, seabed, living resources, from all sources of pollution (land, ships, airborne). The Helsinki Convention covers the whole Baltic Sea including the internal waters, i.e., for the purpose of this Convention, waters on the landward side of the baselines from which the breadth of the territorial sea is measured up to the landward limit according to the designation by the Contracting Parties.

According to the Gdansk Convention (1973) IBSFC is responsible for the protection and the rational utilization of the marine living resources of the Baltic Sea. The Convention Area covers all waters of the Baltic Sea and the Belts, excluding internal waters. As the Lead Party Fisheries under the "Baltic Agenda 21", IBSFC is also, to a certain degree, responsible for the reporting on fishery issues in inland waters.

The results of the Seminar are as follows:

1. The Seminar is conscious of the sensitivity of the marine environment and nature of the Baltic Sea Area and of the importance it represents to the people living around it for ecological, economic, social, recreational and cultural reasons.

2. The Seminar is also aware of the need to protect this shared resource for the benefit of present and future generations through the implementation of an integrated ecological approach as envisaged in the concept of sustainability.

3. The Seminar is aware that deterioration of the marine environment has resulted in loss of spawning areas, decrease in fish stocks, contamination of fish by hazardous substances and increased fish diseases.

4. The Seminar also recognizes that when harmful substances are introduced to this vulnerable sea they remain there for a long time. They also have significant effects on fish and other species and direct effect on the fishery sector. The HELCOM objective to prevent pollution of the Convention Area by continuously reducing discharges, emissions and losses of hazardous substances towards the target of their cessation by the year 2020, with the ultimate aim of achieving concentrations in the environment near background values for naturally occurring substances and close to zero for man-made substances is, therefore, a priority.

5. The Seminar is also aware that the current intensity of commercial fishery has significantly influenced the Baltic Sea ecosystem, species composition and size distribution of the main target species. The non-commercial fish stocks have changed; by-catches have negative effects on non-targeted species such as marine mammals and birds.

6. It expresses serious concerns about introduction of non-indigenous species, which may affect the Baltic food web and fish community structure as well as may have negative effects on fishery.

7. The Seminar also recognizes that several recent other human activities in coastal and offshore waters, such as offshore wind energy plants, oil spillages, affect important fish habitats, especially spawning and nursery areas.

8. The Seminar noted that in HELCOM and IBFSC, there is professional competence available for both fisheries and environmental issues. For scientific advice, HELCOM and IBSFC both see ICES as the main advisory body and the activities of ICES include work on the effects of human activities on the ecosystem in the Baltic Sea and integration of environmental and fisheries issues.

9. The Seminar agrees that environmental and nature conservation mid- and long-term objectives and sector targets for fishery are complementary. Integration of environmental and nature conservation issues into fishery policies and integration of fishery issues into environmental and nature conservation policies is an ongoing process both in HELCOM and IBSFC.

10. The Seminar addresses the importance of having a common understanding on both sides in regard to objectives for ecosystem-based management of fisheries.

11. The Seminar agrees that progress in the field of protection, conservation and sustainable use of the Baltic Sea fish communities of target and non-target species for the benefits of both the fisheries and nature conservation will only be possible by applying an ecosystem-based approach and when there is a close cooperation between HELCOM and IBSFC.

Proposals for joint actions:

The Seminar is of the opinion that a further close cooperation between HELCOM and IBSFC is needed, especially in the following fields:

a) Reduction of by-catches and discards;

b) Development of selective fishing gears and better fishing practices;

c) Protection of local seal populations and the possible management based on scientifically approved information on the status of the seal populations;

d) Restoration of wild salmon stocks and other salmonids, including their spawning and nursery areas, according to the IBSFC Salmon Action Plan 1997–2010;

e) Restoration of a common sturgeon (*Acipenser sturio* L.) population;

f) Europe-wide measures to restore eel stocks;

g) Initiate and promote relevant joint research projects, such as:

- monitoring of by-catch of birds, harbour porpoise and other non-target species;
- monitoring of the harbour porpoise populations to get better understanding on the actual size of the population.

h) Intensifying the monitoring and research, and providing for recent information on contaminants in fishes affecting the fisheries sector (e.g., dioxin);

i) Further look into possible solutions for conflicts between fishermen, protection of seals and management of fisheries, e.g., salmon fisheries;

j) Encourage studies on environmental impacts of offshore wind mill plants, e.g., regarding fish population, spawning grounds and on important bird areas;

k) IBSFC and HELCOM should consult each other before submitting their contributions to “Baltic 21” in so far as it refers to matters of common interest to both Commissions;

l) Continue to develop ecosystem status indicators.

Arrangements for cooperation

The cooperation will be carried out by:

- Intensifying liaison on issues of common interest:
  - HELCOM representation in the work of IBSFC;
  - IBSFC representation in the work of HELCOM, especially in HELCOM HABITAT;
  - Meetings of Executive Secretaries and relevant Chairpersons from both Commissions as appropriate.
- Arranging seminars/workshops on joint issues, with the participation of stakeholders.

ANNEX 8: RECOMMENDATIONS

1. Proposal for establishment of Regional Ecosystem Groups, REGs

SGEAM recommended both in 2000 and in 2001 the establishment of Regional Ecosystem Groups (REGs). In the 2001 report, the proposal was that ICES should establish a REG for the Baltic Sea for the benefit of the two regional international organisations, HELCOM and IBSFC. The German request to ICES to prepare a report on the status of the marine environment in the Northeast Atlantic and the invitation to ICES in the Bergen Declaration to develop and implement an ecosystem approach to manage the seas reinforce the need for ICES to establish REGs.

To facilitate this process, SGEAM recommends that ICES, in the first instance, establish REGs for the Baltic Sea and the North Sea.

The main purpose for the REGs will be to prepare periodic (annual) status reports.

The work in the REGs should focus on the following tasks:

- consider the requirement for integrated assessments and data provision to underpin the ecosystem approach and to specify the structure and content of such assessments,
- consider the mechanism by which periodic (annual) assessment of the status and trends in fish stocks and environmental conditions in the region could be most effectively achieved, drawing mainly from the disciplines of:
    - i) climatic/physical driving forces; and
    - ii) biological (e.g., multispecies) interactions.

The further work in the REGs should be based on the pulling together of data, information and assessment reports by the ICES Secretariat from each of the ICES Working Groups on a time scale appropriate to the production of periodic REG assessments.

2. Proposal for giving relevant ICES working groups a common term of reference

Various ICES WGs currently provide annual status reports within their scientific field. The reports are presented in different formats. In order to streamline the consideration of these reports and their integration into an overall or Regional Status Report, SGEAM recommends that the ICES Working Groups are given a common Term of Reference (ToR). The ToR should include a request for the WGs to provide an annual assessment of trends in their status data (this will require discussion within each group in order to establish what parameters they feel could be reported to reflect trends in their status). The report should follow the following outline as far as it is relevant to their theme and should include:

1) Headline – ICES (year) Annual Environmental Status Report on the theme of the actual WG.
2) General overview/executive summary highlighting the main conclusions of the report.
3) Review and establish appropriate parameters which can be used to monitor trends in the status of the actual theme of the WG and which would most effectively contribute to the production of an REG assessment.
4) Provide a brief scientific rationale for the selection of parameters and a description of the principal mechanisms driving the observed changes, in non-specialist terms. These descriptions should be written in such a way as to allow for easy updates from year to year. Base description on selected time series. The aggregated data on which these time series are based should be provided.

It is envisaged that in the first year these tasks will occupy a significant proportion of each WG's time, but that in subsequent years the process will become "well oiled" and will become a matter of routine, occupying no more than 20 % of their time. However, from the start it is important that each WG has ownership of the task to contribute, in a coordinated and as far as possible standard way, to the overall production of a REG assessment. Therefore, considerable debate and discussion will be required within each WG in the first year in order to set specific and appropriate ToR relevant to the periodic production of the REG assessments.

3 Proposal for establishing a permanent ICES WG on ecosystem assessment and monitoring

SGEAM is of the opinion that there is a need for a forum for presentation of various ecosystem-based approaches which are being developed by a select few Member Countries and recommends therefore that a new working group on ecosystem monitoring and assessment be established to allow effective feedback to ICES on the status and progress towards the implementation of the ecosystem-based approach at the national level. It is the opinion of SGEAM that the poor attendance at SGEAM reflects the lack of progress by many member states in progressing the aims of the ecosystem-based approach. However, following the Bergen Declaration and the proposed creation by ICES of REGs, it is anticipated that greater participation of the proposed WG would materialise, since it would provide the necessary forum by which to ensure the development of standard reporting and assessment methods throughout ICES. The UK, Canada, Norway and Baltic States are leading the way in developing methods at the national level (as evidenced by their continued participation at SGEAM).

The new WG would therefore provide:

a) a forum for reporting on national activities in ecosystem assessment and monitoring,

b) a forum for discussions on harmonizing national and international activities regarding ecosystem approach to management,

c) a steer to ensure that the regional ecosystem groups (REGs) follow a common strategy in their regular status report.

4 Proposal for termination of the work of SGEAM

SGEAM has operated for three years and has fulfilled most of the tasks originally set by ICES. Although there has been at times poor attendance at the SGEAM meetings, the general discussions have proved very valuable and it is notable that the output of the group has underpinned the development of a framework, which will support the implementation of integrated monitoring and assessment throughout ICES. However, SGEAM is a study group, which has now completed its purpose, and as such SGEAM should now be terminated and replaced with a Working Group as indicated above.