Marine and coastal environment
Annual topic update 2000

Prepared by:
Marcello Peronaci
ETC/MCE Leader

Project Manager:
Anita Künitzer
European Environment Agency

European Environment Agency

Layout: Folkmann Design

A great deal of additional information on the European Union is available on the Internet.
It can be accessed through the Europa server (http://europa.eu.int).

Cataloguing data can be found at the end of this publication.

Contents

1. Introduction

1.1.   The European Environment Agency

The European Environment Agency (EEA) was established in 1990 by Council Regulation (EEC) No 1210/90. This regulation also aimed to set up a European environment information and observation network (EIONET), which consists of coordinating institutes (national focal points) and expertise centres (national reference centres) in the participating countries, as well as European topic centres.

The mission of the Agency is:

to support sustainable development and to help to achieve significant and measurable improvement in Europe's environment through the provision of targeted, timely, relevant and reliable information to policy-making agents and the public.

The EEA and its ETCs use the existing capacities in participating countries and also cooperate actively with the Community institutions, other bodies and international organisations to build synergy and avoid duplication of effort in the provision of policy-relevant information.

1.2.   The European Topic Centre on Marine and Coastal Environment

The European Topic Centre on Marine and Coastal Environment (ETC/MCE) was established in 1994 with the aim to help the European Environment Agency to carry out its work programme on the issues related to marine and coastal environments.
The main objective of ETC/MCE is to provide reliable and comparable information regarding the state of the marine and coastal environments of Europe and the pressures acting on them. ETC/MCE also has the mandate to develop appropriate tools and procedures to assess the quality of the environment. To achieve this, an effort towards the harmonisation of reporting and assessment was initiated by ETC/MCE and is still in progress.

The ETC/MCE consortium consists of experts from six national institutes:
* Ente Per le Nuove Tecnologie, l'Energia e l'Ambiente (ENEA), CRAM, La Spezia, Italy
* Institute Francais de Recherche pour l'Exploitation de la Mer (Ifremer), Brest and Toulon, France
* National Centre for Marine Research (NCMR), Athens, Greece
* National Environment Research Institute (NERI), Roskilde, Denmark
* National Institute for Coastal and Marine Management (RIKZ), The Hague, Netherlands
* Norwegian Institute for Water Research (NIVA), Oslo, Norway

The ETC/MCE Leader in 2000 was Marcello Peronaci
ENEA — Centro Ricerche Ambiente Marino
PO Box 316, 19100 La Spezia, Italy
Tel: (39) 01 87 97 81 11
Fax: (39) 01 87 97 82 93
E-mail: etc-mce@estosf.santateresa.enea.it

The Management Committee of ETC/MCE consists of representatives from each of the partner institutions and meets in a plenary session at least twice a year to discuss the state-of-play on the activities, problems encountered, future plans, and to present to the EEA project manager proposals for the future activities.

Representatives of the Joint Research Centre participate in the Management Committee meetings in order to plan and develop joint activities.

The work to be performed by ETC/MCE in 2000 was outlined in the EEA annual work programme 2000. The activities were further specified in the technical annex to the 2000 agreement between the EEA and ETC/MCE. In this topic update the tasks accomplished and products provided during the 2000 subvention period are described.

Each task has been developed by a team consisting of relevant experts from the ETC/MCE consortium and led by a task leader, who is responsible for the activities and related deliverables and reports to the ETC Leader.

In 2000, the EEA management board agreed to a reorganisation of ETCs including the merger of work and expertise on inland and marine waters to form an ETC on water, which started work in March 2001.

1.3. Main contacts

In order to develop the activities, ETC/MCE has established direct contact with relevant international and national organisations.

Table 1 on the next page lists the national primary contact points in 2000: some of them are EEA national focal points (NFP), others are national reference centres (NRC).

ETC/MCE also has contacts and cooperation with the following regional marine conventions:
- Osparcom (Oslo and Paris Commission of the Convention for the Protection of the Marine Environment of the North-East Atlantic)
- Helcom (Helsinki Commission of the Convention for the Protection of the Marine Environment of the Baltic Sea)
- MAP (Mediterranean action plan)
- AMAP (Arctic monitoring assessment programme)
- BSEP (Black Sea environment programme)
- ICES (International Council for the Exploration of the Sea).

Cooperation has also been established with the Space Applications Institute of the EU Joint Research Centre (JRC) in Ispra.

1.4. Main objectives for 2000

The main objectives of the work of ETC/MCE in 2000 were:
- to maintain the activities of the Inter-Regional Forum through the cooperation with the regional marine conventions, JRC and the Environment DG within three working groups on indicators, data flow and GIS;
- to cooperate in the writing of several reports (such as the yearly indicator-based report, Europe's biodiversity report, TERM, etc.);
- to develop and test marine and coastal indicators by evaluating the data and information gathered through previous years, assessing how this information serves the needs of the EEA, the member countries and the Environment DG;
- to finalise the selected environmental indicators (including assessing their limits and the gaps in current knowledge and assessing whether the indicators are versatile for all European basins for policy purposes, etc.), the statistical methods used to treat them, and the ways of presenting them;
- to support and represent the EEA on relevant matters through the ad-hoc support and the supply of information to EIONET (NFPs and NRCs).

| | Main contacts | | | Table 1 |

Country	Name		Institution	Tel./fax/e-mail
Austria	Wilhelm Vogel	NFP	Federal Environment Agency	(43-1) 313 04 35 50 (43-1) 313 04 54 00 vogel@ubavie.gv.at
Belgium	Jan Voet	NFP	Inter-Regional Cell for the Environment	(32-2) 649 81 91 (32-2) 644 23 91 celinair@irceline.be
Denmark	Peter Sandbeck	NRC	NERI	(45) 46 30 12 61 (45) 46 30 11 14 PS@dmu.dk
Finland	Saara Back	NRC	Finnish Environment Institute Impact Research Division	(358-9) 403 00 17 (358-9) 40 30 03 90 saara.back@vuh.fi
France	Jean Louis Weber	NFP	IFEN	(33) 238 79 78 78 (33) 238 79 78 70 jlweber@aol.com
Germany	Claudia Lohmann	NRC	UBA, Germany	Claudia.lohmann@uba.de
Greece	Mata Aravantinou	NFP	Ministry of the Environment	(30-1) 864 37 37 (30-1) 864 37 37 mata@nfp-gr.eionet.eu.int
Iceland	David Egilsson	NRC	Ocean Pollution Department, Environment and Food Agency	(354) 568 88 48 (354) 568 18 96
Ireland	Bronwyn Cahill	NFP	Irish Marine Institute	(353-1) 474 51 00 (353-1) 475 71 04 ronwyn.cahill@marine.ie
Italy	Claudio Maricchiolo Gianna Casazza	NFP	ANPA, Agenzia Nazionale per l'Ambiente	(39) 06 50 07 21 77 (39) 06 50 07 22 21 maricchiolo@anpa.it
Liechtenstein	Petra Bockmuhl	NFP	National Office for Forests, Nature and Landscape	(423) 236 64 00 (423) 236 64 14 Petra.bockmuehl@awnl.llv.li
Luxembourg	Jean Paul Feltgen	NFP	Ministere de l'Environnement	(352) 478 68 13 (352) 40 04 10 jean-pall.feltgen@life.lu
Netherlands	Adriaan Minderhoud	NFP	Rijksinstituut voor Volksgezondheid en Milieu RIVM	(31-30) 274 20 35 (31-30) 274 44 05 Ad. Minderhoud@rivm.nl
Norway	Harald Loeng	NRC	Institute of Marine Research, Bergen	harald.loeng@imr.no
Portugal	Maria Leonor Gomes	NFP	Direccao-General do Ambiente (Sinaia)	(351) 214 72 82 00 (351) 214 71 90 74 leonor.gomes @dga.min-amb.pt
Spain	Juan Martinez Sànchez	NFP	Ministerio de Medio Ambiente	(34) 15 97 58 12 (34) 15 97 58 57 juan.martinez @sgca.mma.es
Sweden	Tove Lundeberg	NRC	Swedish EPA	(46 8) 698 10 00 (46-8) 698 15 85 tove.lundeberg @environ.se
United Kingdom	Andrew Franklin	NRC	CEFAS Burnham Laboratory	(44-1621) 78 72 00 (44-1621) 78 49 89 a.franklin@cefas.co.uk

2. Progress

2.1.Cooperation between the EEA, ETC/MCE and European marine regional conventions/action plans

2.1.1. Background

The Inter-Regional Forum (IRF) was set up in 1995 by the EEA with the following main objectives:
• to facilitate the exchange and possible integration of existing data and information produced by the European marine regional conventions/action plans with the EEA and ETC/MCE;
• to improve working relations and task sharing, according to the EEA's mandate of providing reliable, harmonised and objective information on the state of the European environment.

Three IRF meetings have been held so far. The first two meetings were held in Rome in October 1996 and November 1997, respectively; the third meeting was held in Venice on September 1999 and concentrated attention on the topics selected by the previous IRF meeting. These were:
• geographical information systems;
• statistical tools;
• biological effects of contaminants and transport models;
• use of earth observation data for the assessment of the status of the marine/coastal environment;
• harmonisation of reporting, data exchange and management among conventions and the EEA.

The third meeting concluded that follow-up activities were needed to improve availability, access and management of data, identification of indicators and the use of GIS as a tool for the environmental assessment.

Three working groups were convened with the participations of representatives from the EEA, ETC/MCE, OSPAR, Helcom, AMAP, MAP, BSEP, ICES, European Commission (JRC-SAI and the Environment DG). Each working group met twice in 2000 and reported to the IRF Steering Group at the meeting in Copenhagen on 14 and 15 December 2000.

2.1.2. IRF Working Group on Data Strategy

The working group followed an approach for a 'data strategy' which consisted of the following three steps:
• the setting of an objective (as an ultimate aim) for an 'ideal' situation with regard to availability, access and management of marine environmental data;
• a comparison of that ideal with the present situation;
• development of the pathway to reach the ideal.

The working group considered a data strategy in relation to the development of indicator-based reports that are intended to provide timely information in a user-friendly manner on priority policy.

Aggregated data (annual mean values per country or station/area) for indicators are needed on an annual and timely basis for the following priority topics:
• eutrophication: riverine inputs of P and N, atmospheric deposition of P and N, marine concentration of P and N (impact indicators on plankton and benthos are under development);
• hazardous substances: riverine inputs, atmospheric deposition and concentrations in biota (and sediment) of Hg, Pb, Cd, PCBs, lindane, (TBT);

- oil: accidental oil spills, aerial surveillance of oil spills;
- fisheries;
- integrated coastal zone management (ICZM).

Recommendation

The Steering Group of the Inter-Regional Forum recommended to the governing bodies of the organisations involved in the forum to agree:

(i) that there is an urgent need to improve the situation with regard to the handling and management of data and information for the purpose of marine environmental assessments on a European level;

(ii) that such improvements should be based upon a harmonised data policy, inter alia, regarding access and availability of data and its transparent use;

(iii) to the following basic principles to improve the situation:
- taking into account existing agreements, individual data providers should be able to submit the same type of data to a single specialist data centre (or a functional equivalent). The data centre together with its functional equivalents (handling data of a specific type) should supply data to all data receivers of European data;
- all relevant data receivers and data users should be able to use the information in the data centre for their own purposes in an efficient way;
- with a view to ensuring cost efficiency and continuity, all principle data receivers should contribute to maintaining the data centres in proportion to the use they are making of these centres;
- when developing reporting systems and assessment methodologies, the requirements of data handling should be fully taken into account.

To this end, the Steering Group of the Inter-Regional Forum agreed to invite:
- all partners of the IRF to harmonise their data policies taking into account the principles in point (iii) above;
- the EEA to analyse and to evaluate its reporting obligations database (ROD) on reporting requirements for member countries to OECD/Eurostat and marine conventions, with the aim to streamline reporting;
- the EEA, in cooperation and consultation with all European marine conventions, to undertake, as a matter of urgency, a detailed analysis of ways and means to include marine convention needs on land-based water data (e.g. riverine input, discharges, losses) into 'Waterbase', the database being developed within the EEA work programme to hold water data relevant at the European level, for use by all data users;
- the EEA and ICES to conclude, as soon as possible, their negotiations aimed at the EEA making use of the data held in the ICES database (thereby avoiding the need to duplicate data in other databases) and to inform the other partners about the outcome of these negotiations;
- MAP and BSEP to work together with ICES with the view to harmonising the handling and maintenance of their marine environmental monitoring data and to report on the outcome of these considerations at the earliest possible opportunity;
- the EEA member countries in the Mediterranean area to report data to MAP/Medpol using existing procedures;
- the EEA to bring the problems related to data flow in the Mediterranean to the attention of the EEA Management Board, and to encourage the relevant national representatives to strengthen and support the present network of experts, set up for this purpose by UNEP-MAP, with a view to further addressing these problems.

2.1.3. IRF Working Group on Indicators

The aim of this working group was to:
- identify and assess the status of development of marine indicators (with the DPSIR assessment framework) within different organisations and countries;
- identify and agree on issues of common interest linked to policy objectives;
- identify and agree on DPSIR-indicators for common issues;
- identify the data needs and data sources for these indicators;
- identify and agree on the statistical treatment of the data for marine PSI-indicators;
- identify and agree on the presentation of these indicators (software, maps, graphs,

classification, threshold values);
• discuss the interpretation of the assessments made.

The first meeting considered the common major themes for marine policy and the related framework for DPSIR indicators: the working group identified the framework for the development of a core set of indicators for the priority themes of eutrophication, hazardous substances, radioactive substances, oil pollution, micro-biological pollution, climate change, waste and dumping, fisheries, introduction of non-indigenous species, nature and biodiversity and coastal zones/integrated coastal zone management.

The DPSIR assessment framework for issues relevant to the marine and coastal environment covering the priority themes within the marine conventions/action programmes and the EU is presented in Table 2. The framework describes the information demand at the European level. The grey boxes show the fields of presently developed indicators by the EEA and marine conventions. Indicators for the input of nutrients and hazardous substances and the concentrations of nutrients and contaminants in organisms have been tested by the ETC/MCE. Indicators for pressures are also being developed by Eurostat independently. OSPAR is identifying indicators for biological state variables to be applicable for the development of ecological quality objectives and Helcom started developing indicators for eutrophication in the Baltic Sea.

Table 2		Major themes and indicators within the DPSIR assessment framework for marine waters and coastal zones as identified in the Inter-Regional Forum Working Group on Indicators				

Common themes	Driving force	Pressure	State	Impact	Response
Eutrophication	agriculture industry population transport	direct and indirect inputs from point and diffuse sources atmosphere	*nutrients bottom oxygen chlorophyll*	algal blooms macro algae productivity macrobenthos	reduction at sources
Hazardous substances	transport industry (including offshore) agriculture population military activity and obsolete ammunition	*inputs from point and diffuse sources and dumping (via various pathways) atmosphere* offshore volume of produced water long distance sources	concentrations in sediment concentrations *in biota*	species and populations biodiversity ecosystem health human health	reduction at/ of sources
Radioactive substances	energy industry military activitiy	inputs from point and diffusive sources and dumping (via air, rivers, direct) long distance sources	concentrations water, sediment and biota	species and (including human) populations biodiversity and ecosystem health	reduction at/ of sources
Oil pollution	*transport industry energy (activity) population run off*	*shipping spill accidents offshore volume produced* water *run off waste water*	affected species/ populations coastal zones oil spills (legal, illegal, accidental)	species and habitats	preventive measures standards
Micro-biological pollution	tourism aquaculture agriculture agrofood industry	domestic and industrial waste water discharges aquaculture	salinity conditions in water	effects on human health and ecosystem health	preventive measures at sources
Climate change/ introduction of greenhouse gases	*energy agriculture population transport* fertiliser industry	*greenhouse-gases emissions* fires vulcanos emissions deforestation	change in currents, temperature, salinity and stratification sea level rise	species and habitats human societies	adaptation global preventive measures

Common themes	Driving force	Pressure	State	Impact	Response
Waste, dumping	transport industry dredging fishing	leaching of contaminants spill (container breaks) dumped dredged material discards	litter effects on benthos sediment contamination	mammals seabirds seabed destruction	different measures preventive measures port reception facilities
Fisheries	fisheries technology socioeconomic	discards total catch bycatch fleet characteristics fishing intensity	commercial species fish stock characteristics sea bed characteristics	species and habitats seabed-disturbance	precautionary measures quota management fishing equipment improvement zoning zone management fishing effort control and enforcement fisheries restructuration
Introduction of non-indigenous species	noncommercial transport (ballast water) aquaculture commercial transport of species	shipping aquaculture commercial inputs	non-indigenous species species composition	health eco-system genetic disturbances	precautionary measures codes of practice (ICES and IMO)
Nature and biodiversity	fisheries tourism transport spatial development	fisheries tourism dredging sand/gravel extraction pollution	habitats species ecosystem health	habitats species ecosystem health	water management precautionary fisheries ICZM ecological quality ecosystem approach to management
Coastal zones, estuaries, fjords, including wetlands	spatial development (related to sector and urban development) extraction/deposition of material	drainage irrigation infrastructural works land reclamation	land use changes coastline-characteristics	ecosystem health human health morphology/sediment budget	integrated coastal zone management (ICZM)

The IRF Steering Group considered it essential to involve the marine conventions as well as EIONET in the further development of indicator reporting. Discussions should lead to agreement on the use of common spatial aggregation of data, representativeness of monitoring stations and time series.

A joint EEA/ETC/marine conventions workshop based on the EEA indicators developed up to now was recommended and will be held during 2001, based on the following terms of reference:
• develop criteria and methodologies to be used to derive indicators;
• taking this into account, verify the applicability of the proposed indicators;
• propose requirements for the selection of the representative stations;
• check availability and quality of data and identify gaps in data/information;
• check to which European indicators the marine convention would be able to contribute.

2.1.4. IRF Working Group on Geographic Information Systems (GIS)

This working group based its activities on the results of previous activities undertaken by ETC/MCE on GIS through the development of a GIS prototype of a European marine information system (Eumaris).

The recommendations of the IRF working group on GIS were as follows.
- It is recognised that GIS is a useful tool in an integrated environmental assessment process; its implementation and use within the EEA and the regional marine conventions must be encouraged. It should cover the whole DPSIR chain.
- It is also recognised that the products of a GIS should be used carefully, because:
    - some expertise cannot be part of an automatic process;
    - proper expertise is necessary to overcome the lack of data in terms of geographical andtemporal coverage (this depends on the area to be studied as well as the parameters/ indicators mapped).
- The GIS can be used for modelling.
- The GIS can be used for maps on:
    - sea surface information (algal blooms, chlorophyll-a, plankton communities),
    - sea bottom information (sediment, benthic communities, benthic habitats),
    - land-based pressures (inputs, direct discharges, emissions).
- The GIS should not be considered only as a stand-alone tool but also as a tool to be accessed through the Internet; however it must be considered that, at the moment, only some functions of a GIS can be used through the Internet, since the technology for web-GIS is not developed enough to recommend its use at present.
- The GIS can be used in a decentralised approach: each organisation could implement its own GIS specifically designed to meet its needs and use data stored in databases located eventually in different data centres.
- The GIS can be used in a harmonised centralised approach; the EEA is responsible for environmental assessment at European level, while the conventions are responsible for environmental assessment at the regional level; in order to ensure full compatibility of the assessments done at different geographical levels it is crucial that:
    - an agreement is reached on the basic GIS data (coastline, bathymetry, etc.), the environmental data and information as well as the level of data aggregation needed by the parties involved (EEA, marine regional conventions, JRC) to meet their own needs;
    - the mutual electronic access to the databases and the information agreed upon is allowed.
- In order to electronically upload databases retrieved from different data centres into a GIS, they have to be properly formatted; this implies that some kind of (software) interface should be in place; although writing these interfaces does not imply any major technical problem, it is very time-consuming and therefore should be done only for some selected, agreed databases.
- Web publication: the GIS, in combination with the Internet, can be used to view geo-referenced information (maps) and to distribute the related data-sets. The information system Natlan, developed by the EEA for viewing and distributing thematic maps and related information and data at European level through the Internet, is such a GIS-based tool. The conventions should consider the opportunity of using Natlan as a means for publication of harmonised geo-referenced thematic maps, as well as GIS data-sets and information related to those maps.

In 2001 a practical test case will be carried out, in cooperation between marine conventions and the new ETC/Water, with the aim of:
- recommending the EEA and the regional marine conventions to improve in a harmonised way the use of GIS;
- verifying to what extent the data/information/indicators as well as the thematic maps selected for the test case can support the environmental assessment;
- producing the maps which are needed in the context of the pan-European Kiev report, to be prepared in 2002 (Europe's environment, the third assessment)

The test case will be based on the information needs for the pan-European Kiev report and will involve Helcom, Osparcom, UNEP/MAP, BSEP, AMAP, ICES, JRC, EEA and ETC/Water.

2.1.5. MAP/Medpol workshop on marine data flow in the Mediterranean

The need to improve the harmonisation, management and flow of data/information among the EIONET - Mediterranean countries, UNEP/MAP and the EEA was widely recognised at the marine EIONET workshop, held in Italy on November 1999.

As a result the EEA and ETC/MCE held a workshop on Marine Data Flow in the Mediterranean countries (Athens, October 2000). The meeting was attended by representatives of the EEA, ETC/MCE, NRCs for France, Greece, Italy and Spain, representatives of MAP/Medpol and the representatives of the MAP/Medpol European countries.

The workshop covered topics related to the status of present marine and coastal water quality data collection in the Mediterranean by UNEP/MAP (Medpol programme) and the EEA member countries at national level as well as the future data needs of the EEA and the Medpol programme, and the ways to improve data collection.

The main recommendations from the workshop were as follows.
• Data flow from the European countries in the Mediterranean to both MAP/Medpol and the EEA is insufficient and needs to be improved.
• The national authorities of the European MAP member countries should formulate and finalise the MAP/Medpol national monitoring agreement.
• Long-term data flow from MAP/Medpol to the EEA will take place after countries have signed the Medpol agreement; in the short and medium term, data flow will be necessary from NRCs directly to the EEA.
• MAP/Medpol monitoring programme foreseen in Phase III should form the basis for EEA data collection in the Mediterranean.
• As European countries report their raw data for hazardous substances to MAP/Medpol, MAP/Medpol would report the same data in aggregated form to the EEA.
• Although the parameters needed to evaluate eutrophication are not mandatory parameters for the countries at the moment, MAP/Medpol would aim to include these parameters into the Phase III monitoring programme.

The workshop highlighted the different situations in the EEA member countries: France has a good monitoring programme but no regular data flow towards Medpol and the EEA; Greece has a national monitoring programme which fits the Medpol requirements; in Italy the national monitoring programme has to fit more to the Medpol requirements and the data flow should be improved; Spain has to further improve the data flow to Medpol and the EEA.

2.1.6. Main achievements

The Inter-Regional Forum has become a recognised and successful platform for collaboration and information-flow between the EEA, ETC/MCE and regional marine conventions/action plans. It went through the stages of 'getting acquainted' to that of 'working together', and is now actively progressing toward goals that are of common interest for both the EEA and the Conventions, mainly but not exclusively on indicators, tools for assessment (using GIS), and data flow.

2.2. Cooperation with EIONET

The third marine EIONET workshop was held at the Ifremer premises in Paris on 30 November and 1 December 2000. It was attended by 23 participants, representing 10 EEA member countries, EEA, JRC, ETC/MCE and ETC on inland waters.

The following main issues were presented and discussed:
• activities carried out by the ETC/MCE in 1999 and 2000;
• future activities of the new topic centre on water (ETC/Water), future cooperation between the EEA, ETC Water and the marine representatives of EIONET, as well as a proposal for a possible different structure of EIONET;
• outcome and recommendations from the International Conference on 'Ecological status of transitional and coastal waters' (Edinburgh, 20–22 November), with regard to the planning of future activities in relation to the EU water framework directive.

The meeting drew the following conclusions:
- the need to further strengthen cooperation between the EEA, ETC/Water, EEA member countries and the marine conventions, through the already existing contacts (Inter-Regional Forum, EIONET meetings, ad-hoc meetings) and through the development of joint activities where appropriate;
- the need to improve the data flow from member countries to the EEA and the marine conventions; the lack of data from the Mediterranean and the Black Sea was particularly highlighted;
- the need to harmonise the activities of the ETC/MCE and the ETC/IW;
- the need to further test and develop core sets of indicators for the EEA's future indicator-based reports;
- the need to further develop and update the ETC/MCE Marinebase within Waterbase to bring together inland, marine, coastal and transitional waters;
- the possibility of using thematic maps as tool for integrated environmental assessments and also to disseminate and publish (through Natlan) the ETC's products and results.

2.3. Evaluation of eutrophication in European marine community waters

The main objective of the report was to evaluate the causes, state and development of eutrophication in European coastal waters, and to identify areas where more monitoring data is needed for assessment. Furthermore, a first evaluation of the use of a trophic index for water quality assessment and the use of remote sensing as a eutrophication monitoring tool in northern seas was made. The definition of eutrophication in this report means enhanced primary production due to excess supply of nutrients from human activities, independent of the natural productivity level for the area in question.

Data and information from the regional marine conventions and national reference centres were used, as well as information in grey and scientific literature. However, the data available for the project were scarce and with the exception of some regions inadequate for assessing the state and trends of eutrophication at a European level. Eutrophication data was missing especially from the Bay of Biscay, the Iberian Coast and the Mediterranean Sea.
The report will be published by the EEA as a topic report in 2001.

Results for pressures
The main increase in nutrient load took place before monitoring programmes and pollution load compilations were started. Derived from information in the literature a conservative estimate of the increase in nitrogen loads from land and atmosphere to the Baltic and North Sea regions is a doubling from the 1950s to the 1980s, and a fourfold increase in the phosphorus load from the 1940s to the 1970s. The development in load to the Mediterranean Sea is unknown, but probably of the same magnitude.

Since the middle of the 1980s the phosphorus load has generally been reduced, in some Baltic Sea and North-East Atlantic areas up to 50 %, due to improved sewage treatment and phosphate-free detergents. The nitrogen load from point sources has been reduced too, but there is no discernible reduction in the main diffuse nitrogen source from agriculture to the North Sea. However, the nitrogen load to the Baltic Sea is assumed to have decreased slightly due to the reduction in the fertiliser usage in the countries in transition.
The atmospheric nitrogen deposition to the Baltic Sea area has decreased about 25 %, but somewhat less in the transition area, mainly due to reduced production in eastern Europe. No changes have been seen in the wet deposition of nitrogen to the North Sea.

Results for state and impact
The present state of eutrophication in coastal waters is assessed in terms of winter nutrient concentrations, chlorophyll-a and bottom oxygen concentrations. Analysis of the relationship between nutrients and salinity showed a consistent pattern of eutrophic conditions in areas receiving freshwater input from urban and agricultural catchments. Chlorophyll-a concentrations were positively correlated with winter concentrations of both nitrogen nutrients and phosphate. Oxygen concentrations in the bottom water were not correlated with any of the other variables and the geographical pattern in hypoxia/anoxia could only be explained by the vertical stratification of the water column.

Long-term development (1964–95) of winter concentrations (mid-January to mid-April) of phosphate and nitrate and nitrate in the surface layer (0–10 m) of the open Baltic Proper (East-Gotland Basin)	Figure 1
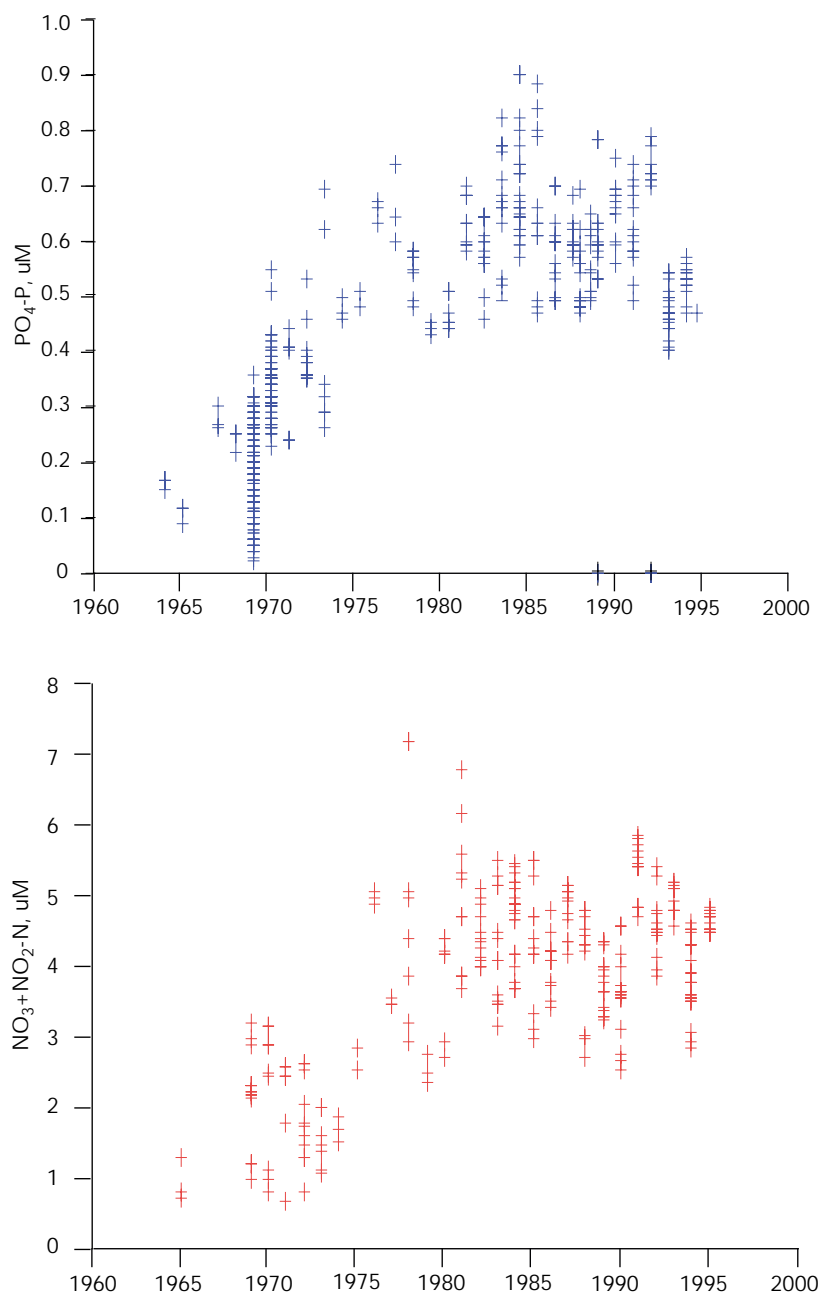
Source: ICES and Helcom.

In agreement with the development in nutrient load, the nitrogen and phosphorus concentrations in the Baltic Sea area (Figure 1) and the German Bight have generally doubled from the late 1960s to the middle of the 1980s. Phytoplankton production and frequency of algal blooms have increased, and consequently the transparency, and in stratified areas the bottom oxygen concentrations have decreased. Since the middle of the 1980s the phosphorus concentrations have decreased in many estuaries and coastal areas. However, the nitrogen concentrations have remained constant or slightly decreased due to variations in run-off. General improvements in biological eutrophication variables are nearly absent or very local. Table 3 is summarising the status and impact of eutrophication in different European sea areas.

Table 3	Status and impact of eutrophication in different European sea areas

Sea area	Status and impact of eutrophication
Arctic Ocean	In the Arctic waters with very sparsely populated drainage areas, eutrophication from fish farming in sill fjords is the major local threat. Eutrophication is not an issue of general concern in European Arctic waters.
Baltic Sea	The whole coastal as well as open Baltic Sea is affected by eutrophication with enhanced nutrient concentrations and related problems. The anthropogenic nutrient load is at its lowest in the northern forested and sparsely populated regions. The highest load can be found in estuaries and coastal areas close to rivers that are draining agricultural and densely populated areas.
North Sea	In the Greater North Sea eutrophication primarily affects the coastal zone. In particular in estuaries and fjords, the Wadden Sea, the German Bight, the Kattegat and the eastern Skagerrak, nutrient related problems are widespread.
Celtic seas	In the Celtic seas eutrophication is restricted to the Irish Sea and many estuaries.
Bay of Biscay and Iberian coast	In the Bay of Biscay and at the Iberian coast eutrophication problems are restricted to estuaries and coastal lagoons.
Mediterranean Sea	In the Mediterranean Sea eutrophication is limited mainly to specific coastal and adjacent offshore areas. Discharge of untreated or poorly treated wastewater is a major eutrophication problem in the Mediterranean Sea, besides nutrient loads from agriculture and aquaculture.

Responses

The Baltic and North Sea countries have decided on a 50 % reduction of the nutrient load to areas affected by or likely to be affected by eutrophication. The OSPAR countries in the North-East Atlantic region have designated areas to which a comprehensive procedure should be applied in order to classify the maritime area in terms of problem areas, potential problem areas and non-problem areas with regard to eutrophication. Also the EU directives will reduce the eutrophication in European waters, and eutrophication-sensitive areas are identified by the Member States.

Conclusions and recommendations

- Nitrogen and phosphorus nutrients, chlorophyll-a and oxygen concentrations are the most general and widely used eutrophication variables. It is therefore recommended as a first step to focus on these 'best available' variables only in assessing the state and development of eutrophication at European level.
- However, all European national monitoring programs also include the other 'best needed' eutrophication variables included in the OSPAR comprehensive procedure in all eutrophication sensitive areas as appointed in the OSPAR common procedure and in the national reports to EC concerning eutrophication sensitive areas in the framework of the urban waste water treatment directive and the nitrate directive, as well as in future to the water framework directive. That is to include at least measurements of phytoplankton species composition, macrophyte biomass, species composition and depth distribution, and macrozoobenthos biomass and species composition.
- The NRCs should strive to report more data to international databases (ICES, Medpol or the EEA) to allow for a more coherent analysis of eutrophication in the coastal zones of Europe.
- All marine eutrophication data, including reporting under the EU directives, should be reported to the databases of the marine conventions (Helcom, OSPAR and Medpol) or to the EEA. This would facilitate the development of eutrophication indicators and assessment of eutrophication in European coastal zones. Finally, it is important that routines to assure the quality and completeness of contributed data are being developed.
- Aquaculture is expanding in many European countries. In the Arctic waters eutrophication from fish farming is the major thread, and in the Mediterranean the nutrient load from aquaculture is comparable to the load from agriculture. Therefore, it is further recommended that nutrients and organic matter load from aquaculture is included in future pollution load compilations.

2.4. Contribution by remote sensing to support evaluation of eutrophication in marine and coastal waters

Monitoring eutrophication in large marine and coastal areas is difficult, and the use of advanced monitoring tools as satellite remote sensing could hopefully provide additional qualitative and quantitative information. The satellite data could be an important tool to support the evaluation of the study of the eutrophication in European marine waters. The ETC/MCE has therefore produced a technical report in collaboration with the JRC on the use of remote sensing to evaluate eutrophication.

In order to evaluate the contribution of remote sensing, 'chlorophyll-a-like-pigments' from satellite data were evaluated using data obtained from the SeaWIFS sensor (sea-viewing wide field-of view sensor). Chlorophyll-a maps were controlled against in situ data from the Skagerrak, Kattegat and the North Sea for the period September 1997 to the end of 1999. Based on in situ data the chlorophyll-a maps were tuned to reflect a 'true surface concentrations' of 'chlorophyll-a-like-pigment'. The information and concentrations in the maps were locally compared with in situ data and the general knowledge of the area (Figure 2).

Comparison of cumulative in situ values of chlorophyll-a and the satellite chlorophyll-a values from a station at the west coast of Denmark (Station 1510009)	Figure 2
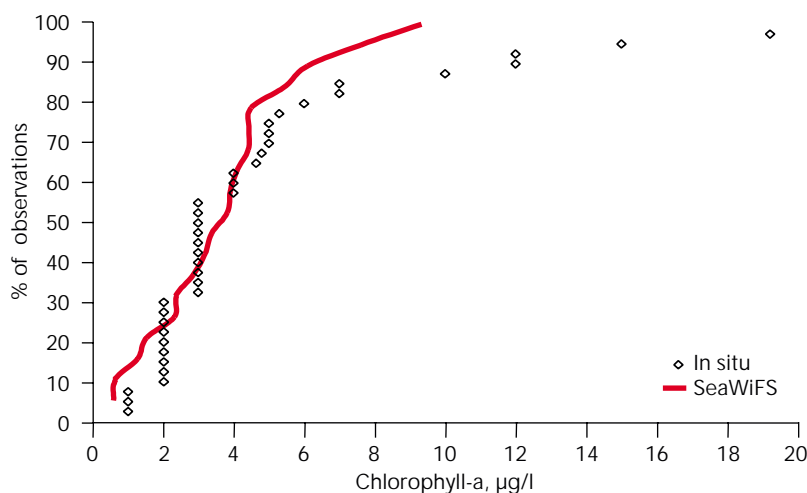
The algorithms to produce the chlorophyll-a-like-pigments from the water leaving radiance from SeaWIFS are presently overestimating the 'true' concentration (in open sea areas the overestimation is in the order of 60–70 %). However an investigation of scientific rationale behind these findings was not possible in this study as only in situ data from monitoring programmes where available and not, for example, information on the different optical quantities as suspended material and dissolved organic material; the information needed in term of atmospheric data was not available either.

The sampling frequency of the stations usually varies considerably: some stations are frequently monitored and others only occasionally. In situ data from Danish, Norwegian and Swedish waters are provided by different institutions (19) and counties around the areas. Therefore the analytical techniques for data collection vary.

The most severe problems retrieving the correct chlorophyll-a concentration was in the near coastal areas, where chlorophyll-a concentration seems to increase when approaching more low saline water as at the Norwegian coast. The deviation between in situ chlorophyll-a and SeaWIFS chlorophyll-a was increasing towards the area influenced by river input. The water masses in this area have normally high concentrations of dissolved organic material that influences the retrieval algorithms for chlorophyll-a.

Satellite data gives good information of the relative phytoplankton distribution and also the concentration when the levels of concentration are locally tuned to the true values. Using month mean maps in the period May to August gives much information and is promising. The mean or median value in this period would be the best for the level of eutrophication.

Little or no data was available from the winter period November to February. This is not critical when mapping eutrophication, since this is a period where the phytoplankton is light limited, and is therefore not related to the nutrient input. The chlorophyll-a maps from the period March to April/May reflect realistically the magnitude and geographical distribution of the spring bloom, and therefore also the level of eutrophication. Since the spring bloom could reflect the magnitude of the available winter nutrient pool a chlorophyll-a map showing the maximum concentration in each pixel should be interesting for studying the eutrophication level.

The application of remote sensing techniques in monitoring marine and coastal waters have shown potential to provide synoptic spatial data/information for a number of physical and bio-geochemical parameters. In this context the possibility of measuring the biomass of phytoplankton as 'chlorophyll-a-like pigments' would be promising, since the remote sensing is thought to give a useful additional or complementary information to traditional in situ measurements to assess the state of the marine/coastal waters.

2.5. Indicators for the marine and coastal environment in Europe

2.5.1. *Testing of indicators for the marine and coastal environment in Europe — Part 3: Present state and development on eutrophication, hazardous substances, oil and ecological quality*

The aim of this report was to evaluate the data and information gathered over the past three years by the ETC/MCE and to assess how this information can support the development of a series of indicators (concise, reliable, quantitative information) which can provide information on a regular basis at the European level on the quality of coastal waters, marine waters, estuaries and fjords.

The third volume of the testing of indicators provides a comprehensive review of the present state and development of indicators for water quality, as well as recommendations for future work (the word 'testing' is used here with the meaning of 'evaluating appropriateness'). The aim of this integration report is to give insight into the progress made in developing indicators, which describe the interrelations between human activities and the state of marine and coastal environment as far as related to the inputs of substances.

The structure of the report is based on the DPSIR assessment framework. Driving forces (or human activities) lead to pressures (that is, emissions or inputs) on the environment. As a result, changes in the state of the environment may lead to impacts on the quality of the environment, and responses must be defined to reduce the adverse effects.

Indicators for eutrophication, hazardous substances, oil pollution, and biological quality were developed and tested following this structure. For each group of indicators data availability is discussed, some type of trend analysis is made and recommendations are given.

The report evaluates the indicators from best available data and knowledge and not particularly from the context of best-needed data. Best-needed data considering eutrophication, hazardous substances and oil at the European level is presently being identified through the implementation of the water framework directive (WFD) and discussed in international working groups. No effort has been made to use statistical trend detection methods or to add to ongoing scientific work within the marine conventions and ICES. The time series analysis has been presented graphically on a yearly basis, taking into account estimates where appropriate. However the report reflects on the need to envisage the statistical power of (future) data sets and indicators in relation to the wanted accuracy level to assess changes over a certain period of time for a particular region.

Indicators on eutrophication

Nutrients (mostly nitrogen and phosphate compounds, but also several other compounds) are present naturally in the marine and coastal water environment and are essential to support marine life. However, excess nutrients may lead to eutrophication. Eutrophication, according to the Directive 91/271/EEC on urban waste water treatment, is defined as the enrichment of water by nutrients, especially compounds of nitrogen and/or phosphorus, causing an accelerated growth of algae and higher forms of plant life to produce an undesirable disturbance to the balance of organisms present in the water and to the quality of the water concerned. Inputs, state, impacts and response indicators have been reviewed. In the case of the inputs to the marine environment (which are subdivided into direct, riverine and atmospheric inputs), Figure 3 shows the sum of direct and riverine inputs of total N and total P in the North-East Atlantic and North Sea, in addition to total river flow. One can see that over the eight years studied there have been fluctuations (high or low years), but not overall trends. An interesting feature is that marine nutrient inputs follow quite well the river total flow, increasing when it increases, and decreasing when it decreases.

| Change in loads (sum of direct and riverine inputs) of total N and total P into the North-East Atlantic inclusive the North Sea in the period 1990–98 (input in 1990 is 100 %)	Figure 3
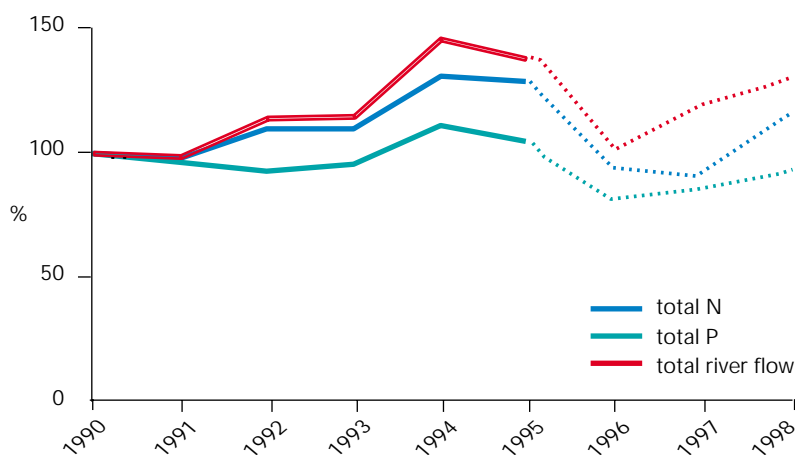
Note: Time series on direct and riverine input of Spain is far from complete; therefore all input data of Spain is omitted. Some data of 1996, 1997 and 1998 is lacking and these data is provided for by making estimates. For river flows, average data is used for the years for which data is available. For inputs, data of preceding years is used. Incomplete data and use of estimates is presented by dotted lines.

Changes in the inputs are not obviously mirrored by the State indicators, as can be seen in Figure 4. This figure shows also a decrease of average phosphate concentration in the Baltic and North Sea.

| Figure 4	Change in average winter phosphate concentration in the Baltic Sea and the North Sea in the period 1985–98
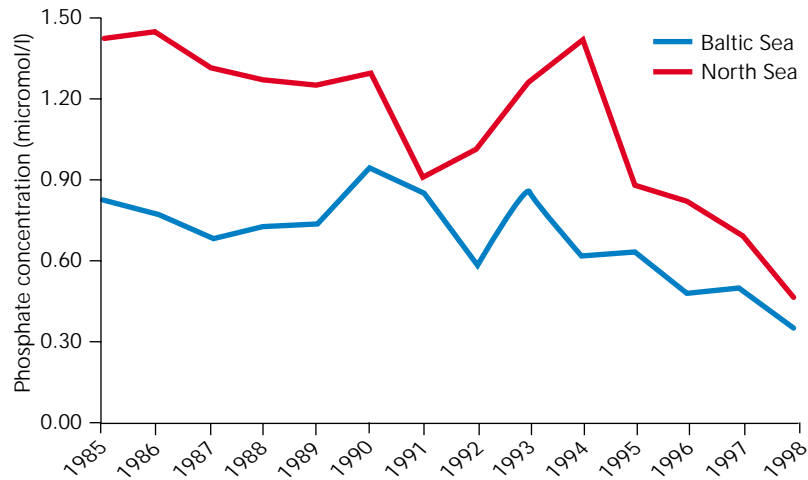
Note: The average values of 1998 are based on only a few data (for the Baltic Sea only one), meaning that the 1998 values are less reliable.

Indicators on hazardous substances

Hazardous substances are toxic, persistent and/or liable to bio-accumulate. The heavy metals cadmium, mercury, lead and zinc, the persistent organic pollutants lindane, and the sum parameter of PCB7, have been selected for indicator development. Figure 5 shows that there has been a substantial (50 %) reduction in the inputs in the period 1990–98.

Figure 5	Index of loads (direct and riverine input) of hazardous substances into the North-East Atlantic including the North Sea in the period 1990–98 (index value in 1990 is 100 %. The index is the average of the yearly river concentrations of six hazardous substances)
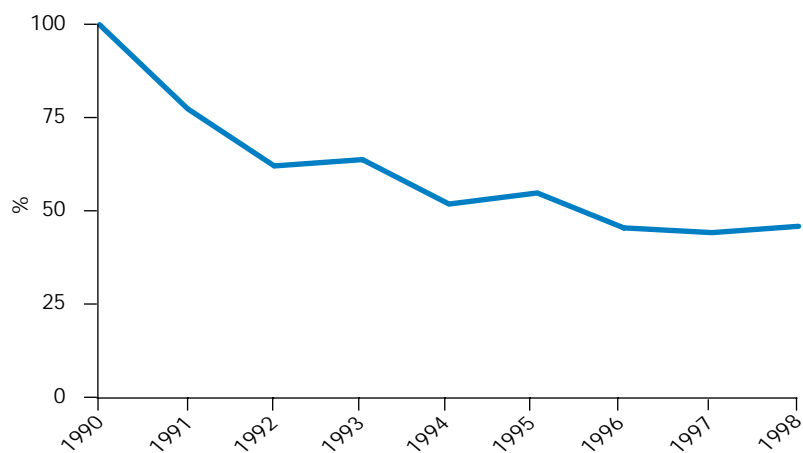
Also atmospheric inputs of hazardous substances has decreased over time (see Figure 6).

| Change in atmospheric inputs of cadmium, mercury and lead into the North Sea in the period 1987–95, based on data derived from deposition measurements in coastal stations surrounding the North Sea (atmospheric input of each metal in 1990 is 100 %)	Figure 6
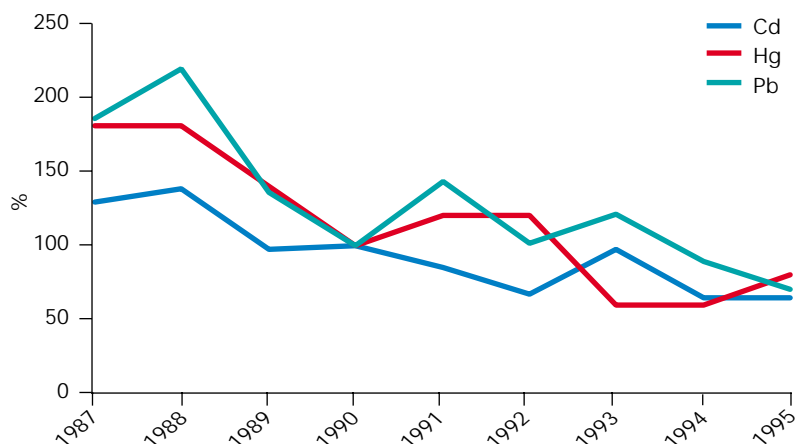
Such decreases in the inputs are hardly reflected by the 'state' indicators (see Figure 7, concentrations in blue mussel), but some degree of decrease is present in all parameters except for lead, and is certainly very high for lindane.

Change in concentrations of hazardous substances in the blue mussel in the North-East Atlantic including the North Sea in the period 1990–96 (concentration in 1990 is 100 %)	Figure 7
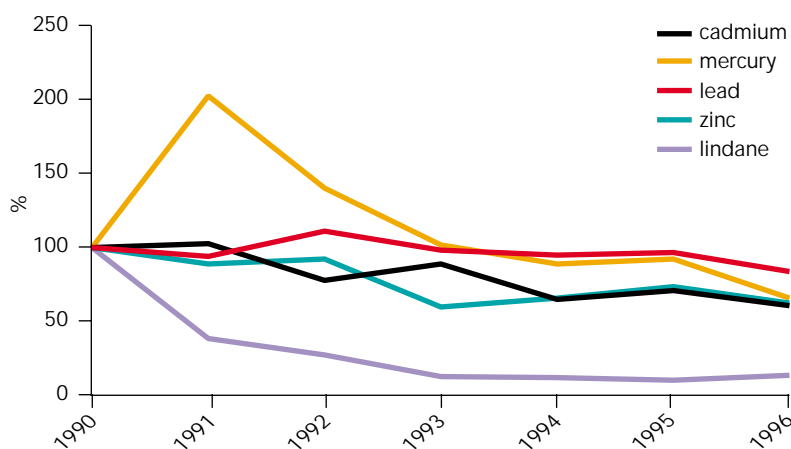
The above indicators on hazardous substances have been included into the *Environmental signals 2001* report.

Indicators on ecological quality
Integrated indicators describe the ecological quality of marine and coastal waters as a result of different disturbances (multi-stress). These ecological quality indicators are at an initial stage of development. Knowledge of, and experience with, the use of these indicators is limited and restricted to the local and regional level. Examples of indicators discussed in the report are zoobenthic indicators (species number, abundance, key species, community diversity), a trophic index indicator (called TRIX), phytoplankton and phytoxins indicators (see Figure 8).

Figure 8	Changes in amnesiac shellfish poisoning (ASP), diarrhetic shellfish poisoning (DSP), and paralytic shellfish poisoning (PSP) from 1989 to 1998. Shellfish poisoning events are presented for the coastal waters of the 15 European Member States. The number of events fluctuates between the years and no general trend is observed
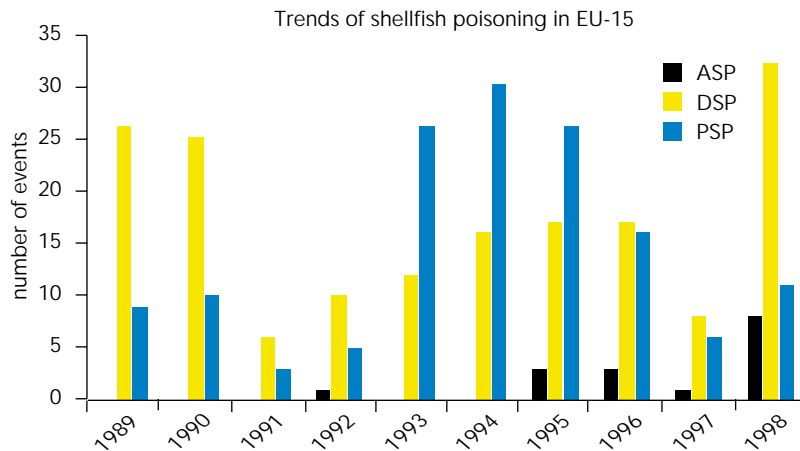
Indicators on oil pollution

The fate and ecosystem effects of mineral oil in marine and coastal waters differ from those of others hazardous substances. Oil slicks are most harmful to the coastal water environment (sea bird poisoning). These oil slicks develop when oil is spilled. Therefore, in developing indicators, mineral oil is dealt with separately from hazardous substances, focusing on oil slicks. The two main sources of oil pollution in the marine environment are from maritime transport and from refineries and offshore installations. Only maritime transport is considered for the present indicators.

Two indicators were proposed:
• the quantity in tonnes of all accidental oil spills larger than 7 tonnes
  as pressure indicator;
• the annual frequency of observed oil slicks evaluated as the ratio of the number of slicks
  per flight hour as from aerial surveillance in maritime areas in the EU as state indicator.

In Figure 9 the tonnes of oil spills above 7 tonnes per spill is reported. The majority of oil spills (70 %) above 7 tonnes in the world are caused by collisions, groundings or loading/discharging operations; it is noticeable that a few very large accidents are responsible for a high percentage of oil spilled. Consequently the total amount of oil spilled in European marine waters changes strongly between years; due to the large differences between the years longer time periods are needed to determine decreasing trends in the amounts of oils spilled in marine waters. For instance 10-year averages may be used.

Total amount of accidental oil spills in marine and coastal waters of the 15 EU countries in the period 1985–98 (only spills above 7 tonnes are accounted for)	Figure 9
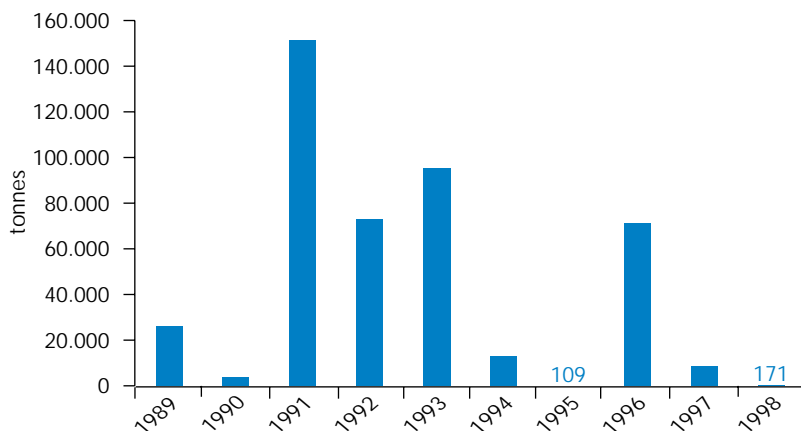
In Figure 10 the results of aerial surveillance in the North Sea and the Baltic Sea for the period 1992–96 are presented. Both the total number of oil slicks as well as the number of slicks observed per flight hour are presented. More flights may enforce keeping the rules, thereby decreasing the number of oil slicks. The number of oil slicks observed has been declining steadily and the high frequencies in 1997 and 1998 correspond to a methodological artefact due to the reporting of very small oil spills (less than 1 m^3) by one country. Thus an indicator of the area involved (km^2) could be useful for understanding possible impacts.

The indicators on oil spills have been included in TERM 2001 report, the indicator-based transport and environment reporting mechanism.

Number of observed oil slicks from aerial surveillance in the period 1990–98 for both the North Sea and the Baltic Sea	Figure 10
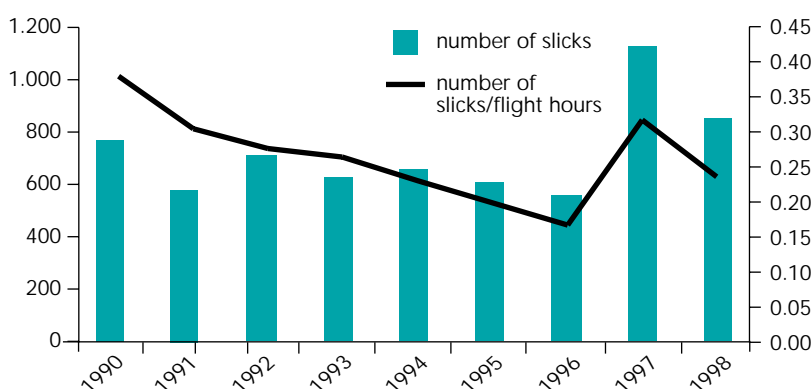
2.5.2. Conclusions and recommendations

The progress made in the development of indicators for eutrophication and hazardous substances is summarised in Figure 11.

Figure 11	Estimation of the present state of indicator development for the themes eutrophication and hazardous substances

The indicator potential is evaluated for the various indicators presented, for statistical and communicative power. Stat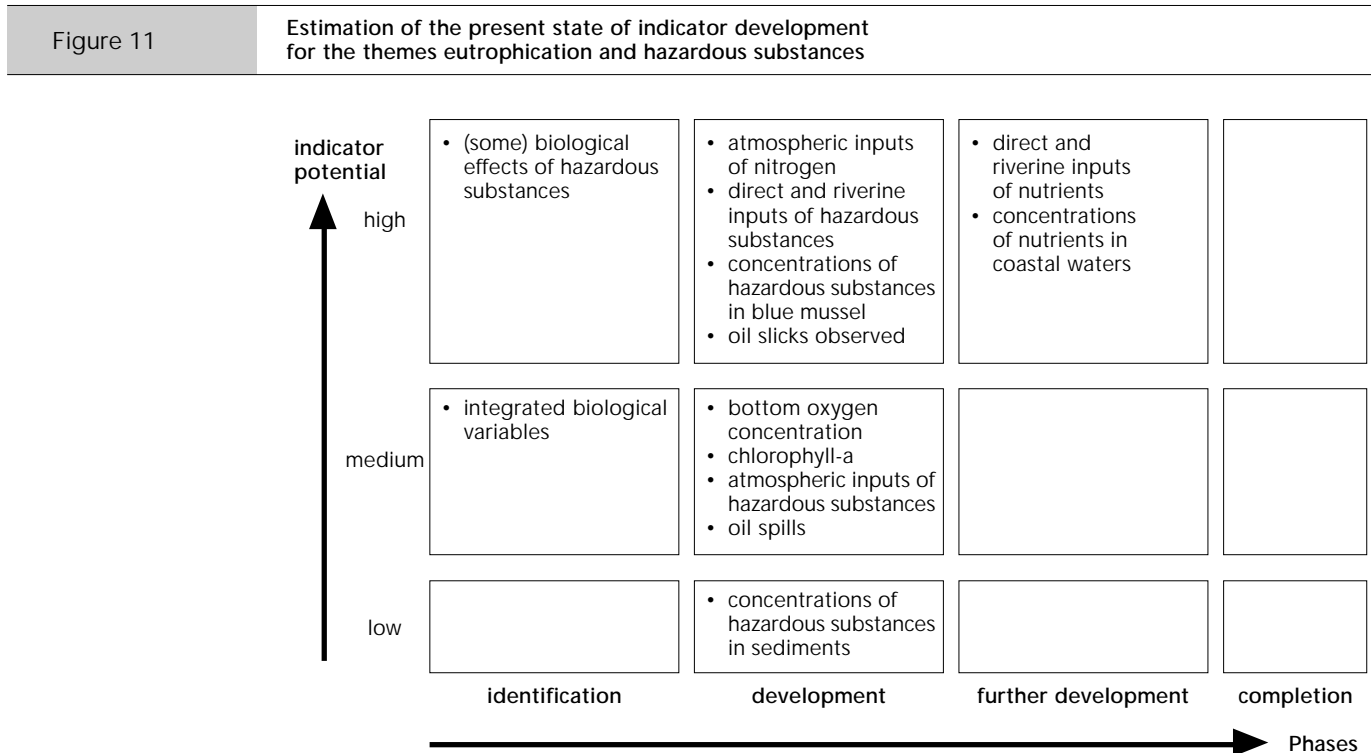istical power means that trends can be detected relatively easily minimising data processing (a definition not very comprehensible from a statistical point of view), while communicative power means that the meaning of the indicator is clear.

The study led to several recommendations for the future, some of which are reported here.
- The quality and completeness of the data that is used for trend analysis should get utmost attention. The value of data in trend analysis increases considerably when the data is reliable and complete. The time and geographic coverage of data collection should be increased to include all European regional seas and coastal waters.
- Developing an information strategy for describing the state of the marine and coastal environment is just in its initial phase. At present the information supplied does not meet the demand. Excessive amounts of data are gathered on subjects, which need analysis and insight and not just data. The data is not complete (geographical and time coverage) and the quality of many data is poor. Where there is an urgent policy need, relevant informa tion is not provided on a timely basis.
- Scientists may be of special help in clarifying cause and effect relations within the DPSIR assessment framework and they can advise on the development of information and monitoring strategies. To achieve the goals of effectiveness and efficiency, scientific help is really indispensable. For instance, the efforts put into: (a) model development; (b) direct measurements; and (c) remote sensing may be combined and attuned to each other.
- The development of monitoring and information strategies should be harmonised and standardised between European countries and new methods and technology should be implemented. Then data is comparable and exchangeable making aggregation of the data possible at any level wanted. Harmonising and standardising is needed not only between countries, but also on local level and between land and water environments.
- The supply of information should meet the demands at reasonable cost. A stronger

participation of policy-designers and the public in meetings to develop information and monitoring strategies is needed. More effort should be put into research and development of methodologies to specify information needs and the development of transparent meaningful indicators/indices, and into involving other (than the usual/ traditional) disciplines.

2.5.3. The potential core set of indicators for the marine and coastal environment

The ETC/MCE has also produced a report on a potential core set of indicators for the marine and coastal environment.

The scope is the identification and definition of the core set of indicators for environmental issues, which the EEA considers with first priority to be reported and elaborated further. At the European level for the state of the environment, the information is generated to fit the concept of a pyramid of indicators with three levels.

(1) Headline indicators. These are on top of the pyramid. The issues identified by the Expert Group on Indicators of the European Policy Review Group (EPRG) are: climate change, air quality, marine and inland water quality, water quantity, nature and biodiversity, land-use, chemicals, waste, resource-use, urban areas and fragile ecosystems;
(2) A core set of indicators is to be developed at the level of EEA topic centres. For the marine and coastal environment, the EEA, marine conventions/action plans and JRC are cooperating in the Inter-Regional Forum Working Group.
(3) Base layer information concerns data necessary for a better understanding of the relation ship between indicators, which drive the existing patterns of production and consumption and the interactions in terms of ecosystem functioning and sustainability. Data gathering and supporting indicator development at this level is ongoing nationally and internation ally.

The headline indicators on marine water quality, resource-use (theme 'Fisheries') and fragile ecosystems have been used as headings for the proposed core set of marine and coastal indicators.

It is stressed that the lists presented here (Tables 4, 5, 6) are still to be seen as a potential set, serving the process of common development.

Table 4	Potential core set of indicators for marine and coastal water quality.		
	Driving forces	Type (¹)	Time frame (²)
1	Economic value (³) of oil and gas industry at sea versus emission of hazardous substances	C	L
2	Economic value of fisheries versus implementation of precautionary approach	C	L
3	Economic value of shipping versus emission of hazardous substances	C	L
4	Economic value of agriculture versus emissions of nitrogen	C	L
	Pressure		
5	Loads (riverine and direct) of nutrients/nitrogen and phosporous to coastal waters	A	A
6	Loads of hazardous substances/heavy metals to coastal waters	A	A
7	Deposition of NO_x, NH_3, and total nitrogen to marine and coastal waters	A	A/I
8	Emissions of persistent organic pollutants (POPs)	A	A/I
	State	A	A
9	Nutrients nitrate and phosphate in coastal waters per regional sea	A	A
10	Nutrients nitrate and phosphate in coastal waters per class/type	B	I
11	Nitrogen/phosphorous ratio in coastal waters	A	A
12	Trophic index (TRIX) for the Mediterranean sea regions	A	L
13	Hazardous substances by size class/type of rivers and lakes	A	I
14	Hazardous substances in coastal and marine sediments	A	L
15	Levels of hazardous substances in marine organisms (mussels)	A	A/I
16	Ecological risk index for hazardous substances in organisms	A	A
	Impact		
17	Biological and physical-chemical classification of coastal zones less than 'good' quality in national classifications	B	A
18	Numbers and proportion of bathing waters failing to comply with bathing water directive microbiological standards	B	A
19	Total number of oil slicks	A	A
20	Number of slicks observed per flight hour are presented	A	A
21	Frequency of low bottom oxygen in sensitive coastal waters	A	A/I
	Response		
22	Progress in the implementation of the water framework directive	A	A/I

(¹) Type of indicators:
Type A: 'What is happening to the environment and to humans?' — Descriptive.
Type B: 'Does it matter?' — Performance indicators.
Type C: 'Are we improving?' — Efficiency indicators.
Type D: 'Are we on the whole better off?' — Total welfare indicators.

(²) Time frame.
A = available for 2002 environmental signals report.'
I = intermediate, data available by 2003.
L = long term, data available.

(³) Economic value is a function of the indicators production value, added value and employment.

Potential core set indicators for environmental integration in fisheries and mariculture (M) (³)		Table 5

Driving forces	Type (¹)	Time frame (²)
1 Economic value (⁴)of fisheries versus implementation of precautionary approach	C	L
2 Employment	B	A
3 Landings	B	I/L
Pressure		
4 Fishing mortality	A	L
5 Fleet size	B	L
6 Fishing effort (horsepower/day or categories per gear)	B	L
7 Ratio of fishing effort versus maximum yield	B	L
8 Percentage of stocks outside safe biological limits	A	I/L
9 Production (catch) (F and M)	B	I
10 Quality of effluent water (M)	B	I
11 Number and total size (ha) of fish farms (M)	B	I
State		
12 Biomass of commercial fish species	A	L
13 Structure of fish population	A	L
14 Catch per unit effort	A	L
Impact		
15 Physical damage to habitats and species (benthos changes)	A/B	
16 Discards	A/B	L
17 Relative abundance of juveniles versus adults	A/B	L
18 Bird population changes (food changes)	A/B	L
19 Non-commercial fish stocks changes	A/B	L
20 Bycatch (unwanted) of mammals	A/B	L
Response		
21 Percentage of fisheries reflecting environmental integration	C	L
22 Percentage of mariculture complying to fish farms code of conduct	C	L

(¹) Type of indicators:
Type A: 'What is happening to the environment and to humans?' — Descriptive.
Type B: 'Does it matter?' — Performance indicators.
Type C: 'Are we improving?' — Efficiency indicators.
Type D: 'Are we on the whole better off?' — Total welfare indicators.

(²) Time frame.
A = available for 2002 environmental signals report.
I = intermediate, data available by 2003.
L = long term, data available.

(³) (M) is indicated where the indicator is relevant also, or only, for mariculture.
(⁴) Economic value is a function of the indicators production value, added value and employment.

Table 6	Potential core set of indicators for marine and coastal ecosystems		
	DPSIR	Type (^{1})	Time frame (^{2})
	Ecological quality		
	Plankton		
S	*Occurence of nuisance algae*	A	L
S	*Species composition*	A	L
S	*Diversity*	A	L
	Fish (non commercial species)		
S	*Biomass of threatened species*	*A*	*L*
	Zoobenthos		
S	*Community species diversity*	A	L
S	*Community structure and function*	A	L
	Habitats		
S	*Surface versus potential surface*	A	L
	Marine mammals		
S	*Biodiversity / numbers of threatened species*	A	L
	Marine birds		
S	*Biodiversity/ numbers of affected species*	A	L
	Natural variability		
S	NAO	A	A
	Sustainable development of regional seas	D	I
R	*under development in UNEP/MAP*		
	Integrated coastal zone management (ICZM)	C	I
R	*Progress in national strategies to ICZM*		

(^{1}) Type of indicators:
Type A: 'What is happening to the environment and to humans?' — Descriptive.
Type B: 'Does it matter?' — Performance indicators.
Type C: 'Are we improving?' — Efficiency indicators.
Type D: 'Are we on the whole better off?' — Total welfare indicators.

(^{2}) Time frame.
A = available for 2002 environmental signals report.
I = intermediate, data available by 2003.
L = long term, data available.

2.6.   Biodiversity of the seas around Europe

ETC/MCE has produced the marine part (covering Europe's seven seas) of the EEA report entitled 'Europe's biodiversity', to be published in 2001/2002.

Each sea is addressed in a chapter structured according to the following headings.
*   What are the characteristics of the sea including general characteristics, main influences, main political instruments of relevance for biodiversity, present biodiversity status.
*   What is happening to biodiversity: the main influences and the trends in biodiversity.
*   What policies are at work in the Sea including nature protection, protection of marine resources by restrictions in fishing and hunting, research and monitoring programmes.

The main political instruments of relevance for marine biodiversity in Europe are the marine conventions that is: Helcom (Baltic Sea), OSPAR (Atlantic Ocean, North Sea, part of Arctic Ocean), AMAP and CAFF (Arctic), UNEP/MAP (Mediterranean Sea), BSEP (Black Sea), Accobams, Ascobans and Ramsar.

The present biodiversity status has been addressed at all possible levels of the food web starting from primary production and phytoplankton to fish and birds and the results are presented synoptically in tables and/or maps. The main influences have been pinpointed and trends in biodiversity are shown mostly through case studies. Finally, the policies at work in the seas, whether ministerial laws (the national level) or international agreements such as Accobams, Ascobans, or even establishment of marine parks and research programmes, have been summarised.

The main results on marine biodiversity in the seven European seas is summarised below, with special focus on the main threats and the policies in place.

2.6.1. North-East Atlantic Ocean

The North-East Atlantic Ocean is dominated by deep ocean basins, except the Celtic seas, the shelf along the Bay of Biscay and Iberian coast; the formation of the North Atlantic deep water is one of the driving forces for the thermohaline circulation of the world's oceans. The productivity in the open ocean is low, but is increasing from south to north and towards shore. The biodiversity is high, but several species in the area are threatened.

The main threats to marine biodiversity in the North-East Atlantic Ocean are:	
Celtic seas	• eutrophication • fishing • industry • shipping
Bay of Biscay and Iberian coast	• eutrophication • chemicals • fishing • tourism • shipping
Ocean areas	• fishing • shipping

Among the main threats listed, it is worth stressing the fisheries. Most of the commercially fished stocks are outside 'safe biological limits' in the Atlantic area (OSPAR, 2000) while over-fishing in southern Bay of Biscay has led to the virtual extinction of elasmobranchs (cartilaginous fish). In 1996, ICES indicated the need for a 40 % reduction in the fishing fleet to avoid over-fishing and match available fish resources.

Several legal instruments (conventions and directives) or collaborating bodies are in place to protect and conserve the marine life in the North-East Atlantic Ocean: OSPAR, ICES, Natura 2000, Bern Convention, Ramsar, Marpol 73/78 Convention and several NGOs such as the WWF.

2.6.2. Arctic Ocean

The Arctic Ocean covers a large area with harsh climatic conditions; there are strong seasonal and geographical variations in light, temperature and ice-cover. The European part of the Arctic Ocean covers only about 8 % of the total area of the Arctic Ocean, but due to its great depth it represents about 25 % of the total volume. The system of ocean currents induces an east-west temperature gradient with warmer conditions in the eastern part of the European Arctic Sea, strongly influenced by the warm Gulf Stream. This keeps the Norwegian Sea and a large part of the Barents Sea ice-free and favourable for the growth of a wide range of open-sea (pelagic) and bottom-living (benthic) species. This biological production sustains huge stocks of pelagic fish in these areas.

The main threats to marine biodiversity in the Arctic Ocean are:
- fisheries
- offshore oil and gas
- shipping
- discharges from industry.

As for fisheries, most fish stocks in remote areas of the open sea are being exploited, and fish catches doubled several times during the last century. The collapse in commercial fish stocks is due to the combined effects of poor recruitment, increased natural mortality, reduced growth and over-exploitation. The problems increase when the exploited species are food for other commercial species, as is the case for herring, cod and capelin, the three most important fish populations in the Barents Sea, which are biologically strongly linked.

As for the effects of contaminants on biological communities, although there is no evidence on the population level in the Arctic, recent investigations within the area indicate that PCB and TBT can cause several effects on some species; the bioaccumulation of contaminants in many Arctic animals by long lives and the important role that fat plays in animal metabolism in the Arctic region, increases the importance of biomagnification of fat-soluble contaminants.

The main political instruments covering the Arctic region are the Arctic Council, OSPAR, Nammco and the Bern Convention.

2.6.3. North Sea

The North Sea is a shallow and rather young ecosystem formed by the flooding of a landmass some 20 000 years ago. Its coasts and waters are still being colonised by new species from the Atlantic Ocean. The strong coupling between benthic and pelagic communities in the shallow parts of the sea makes it extremely productive. The North Sea is one of the most productive areas in the world, with a wide range of plankton, fish, seabirds and benthic communities. It is also one of the world's most important fishing grounds (the combined landings of fish amounted in 1995 to 3.47×10^6 tonnes) and it is rich in oil and gas.

The main threats to marine biodiversity in the North Sea are:
- eutrophication from agriculture
- industry
- offshore industry
- fishery
- shipping
- recreational use.

Fisheries have benefited for many centuries from the relatively shallow waters of the North Sea and, although they continue to do so, the species that are the focus of the fisheries have changed as landings and stocks have declined. The most important effects of fishing on North Sea ecosystems are:
- mortality of target and non-target species;
- organic input from discards and offal;
- physical damage of habitats.

All the major North Sea fish stocks are considered by ICES to be close to or below safe

biological limits:
- between 30 and 40 % of the biomass of these species is caught each year;
- about 70 % of two-year-old cod die before sexual maturity;
- fisheries cause 80 % of premature mortality.

Biodiversity in the North Sea is covered by a number of international agreements at different levels and with different scope. The following conventions/agreements are particularly relevant for biodiversity in the North Sea: OSPAR, ICES, Ascobans and the Bonn Convention, Trilateral Wadden Sea Cooperation, North Sea Conference, Natura 2000, Bern Convention.

2.6.4. Baltic Sea

The Baltic Sea is the largest brackish water system in the world. Its only connections to more open seas are the shallow sounds between Sweden and Denmark. In many respects the Baltic is similar to an inland lake or an estuary. It is unique in that there are areas where freshwater, brackish water and marine species are all present at one spot. Its salinity increases from east to west and from north to south. The sea is slowly shrinking because of geological uplifting of land after the last glaciations. The highest biodiversity is found in the south-west.

The main threats to biodiversity in the Baltic Sea are:
- eutrophication
- pollution of contaminants
- fishing
- construction (dredging and dumping of dredge material)
- recreational activities.

Eutrophication is one of the major environmental problems in the Baltic. A decrease in the concentrations of nitrogen and phosphorus was observed during the mid-1990s. Measurements during 1999 have not shown a continuation of this improvement — indeed, there is evidence of increasing levels of nitrate in near-bottom water in some areas (Helcom 1999). Effects of eutrophication in the Baltic include: increased amount of plankton algae, increased frequency of toxic algal blooms, a reduction of oxygen levels in the deep waters, decline or disappearance of larger perennial macroalgae such as bladder wrack.

As for fisheries, although the International Baltic Sea Fishery Commission regulates the offshore fishing efforts, over-exploitation is the common practice, even resulting in exploitation of stocks beyond safe biological limits. Fishery of the main target fish species such as cod, herring, salmon and eel is presently unsustainable due to over-exploitation and impairment of conditions for reproduction. By-catches of marine mammals, sea birds and non-target fish species are too high, thus threatening the ecological function and biodiversity of the Baltic marine area.

The main political instruments are Helcom, IBSFC, Accobans, Ramsar Convention, the Bern Convention, Natura 2000.

2.6.5. Caspian Sea

The Caspian Sea is the largest enclosed sea in the world. It is brackish with salinity up to 13.7.

Significant changes in water levels occur. These, combined with the presence of large shallow areas, constitute a potential threat to biodiversity and especially to the many endemic species.

Because of its relative stability over time, its salinity regime (consistently brackish), and its central location, almost all autochthonous species are found in the Middle Caspian Sea, and consequently, the highest number of endemic species are found there. Conversely, the North Caspian has the greatest diversity of both habitat and biota. This diversity is due to the existence of big rivers, such as the Volga and the Ural, which for the mixing of marine and freshwater fauna. The most important fauna of the Caspian Sea is the Sturgeon fish, which constitutes 85 % of the standing stock of the world's sturgeon population.

The main threats to the biodiversity in the Caspian Sea are:
- sea level fluctuation
- regulation of river flow
- oil and gas exploitation
- desertification
- contamination
- habitat changes
- fishing including poaching for sturgeon
- introduction of non-indigenous species.

The rise in sea level causes alteration of valuable habitats due to inundation of the vast coastal areas (deltas of Ural and Volga). Dam construction has altered the hydrology and ecosystem of the Caspian causing altered volume and timing of river flow, salinity variations, reduced input of inorganic nutrients, increased input of organic substances, reduced sediment delivery, reduced access to spawning grounds for certain fishes, reductions in spawning area and eutrophication.

Poaching is also one of the major threats as illegal catch accounted for about 90 % of all sturgeon caught (1995).

The Caspian environment programme is the main international political instrument, as the level of ratification of global biodiversity-related conventions varies from country to country. The Framework Convention for the protection of the Caspian Sea among all Caspian countries is now under final negotiations.

2.6.6. Mediterranean Sea

The Mediterranean Sea is the largest semi-enclosed European sea. It has a narrow shelf and in the north is mostly bordered by mountain chains sloping deeply into the sea resulting in a small drainage basin. The Mediterranean Sea is oligotrophic: it is rich in oxygen and poor in nutrients. Oligotrophy increases from west to east. The fauna and flora is very varied and there is a high rate of endemism. Biodiversity in the eastern basin is increasing (through the introduction of exotic species).

The main threats to marine biodiversity in the Mediterranean Sea are:
- eutrophication
- microbial contamination
- fishery
- mariculture
- industrial and oil pollution
- shipping
- recreational activities (especially tourism)
- introduction of exotic species.

Fishing has increased by about 12 % in the past decade, with high exploitation of both bottom-living (demersal) and big pelagic (tuna and swordfish) stocks. Over-exploitation (other than by fishing) has led to a serious decline in the red coral, the date mussel and many invertebrates.

One of the most endangered habitats in the Mediterranean Sea are the Posidonia beds or meadows, which have regressed considerably, in particular near the large urban centres: Athens, Naples, Genoa, Toulon, Marseilles, and Barcelona. The time required for recolonisation of the lost beds is estimated at about 3 000 years.

The Mediterranean monk seal has been classified as endangered by the IUCN (World Conservation Union) since 1966. Population numbers have continued to decline (dropping to about 300–400 individuals from about 1 000 in the 1970s. Although protection measures have been established since 1977, according to the latest studies only two of the 42 animals recorded in the 1987–94 period, remain alive. Mortality is mostly associated with fishing.

The legal framework for the conservation of natural habitats and species is provided through

the Barcelona Convention, the Bonn Convention, Bern Convention and the Tamsar Convention.

2.6.7. Black Sea

Once a lake connected to the Caspian Sea, the Black Sea became connected to the Mediterranean after the opening of the Dardanelles in the interglacial period (100 000 to 150 000 years ago). Then it was again isolated, and only about 6 000 years ago was reconnected to the Sea of Marmara and the Mediterranean Sea. As the result of past geological events, its morphometry and specific water balance, (high degree of isolation from the world ocean, deep water depression with a depth of 2 000 to 2 200 m in the centre of the sea, the extensive drainage basin and the large number of incoming rivers), nearly 87 % of the Black Sea water volume is entirely anoxic (without oxygen) and contains high levels of hydrogen sulphide.

Deep pelagic and benthic organisms are largely absent; the wide diversity of biotopes has made the Black Sea very susceptible to exotic species. The composition and structure of the marine communities is constantly changing with the destruction of certain species and expansion of others.

The main threats to marine biodiversity in the Black Sea are:
- eutrophication
- contamination and oil pollution
- fishery
- construction
- regulation of river flow
- introduction of non-indigenous species
- bacterial pollution in coastal marine areas.

Deterioration of some marine habitats and lack of law regulating the introduction of exotic species i.e. via ballast waters, allowed the invasion of exotic species. These have produced mass populations, which have changed the equilibrium of the native marine ecosystems. Growing concern for the fate of the Azov-Black Sea basin has stimulated a search for efficient countermeasures to combat unwanted alien settlers because today the dominant species across the food web are exotics.

Large-scale constructions of cascade dams on major rivers has led to the loss of spawning areas for the sturgeon and other valuable fish species. Moreover, drastic decrease of river discharges has resulted in apparent hydro-chemical and biochemical changes with catastrophic effects for the low salinity basins.

As for fisheries, over-exploitation has affected fish stocks. Commercial fishing in the Dnieper and Dniester estuaries has been reduced. Some valuable species such as mackerel, bonito, horse mackerel in the Black Sea and pike, perch, roach, bream in the Sea of Azov have practically disappeared. Of the 26 commercial fish species in the period 1960–70, only five were left by 1980. Importation of species for aquaculture has induced severe alterations at the ecosystem level.

The main political instruments are the Bucharest Convention, Odessa Ministry Declaration, Black Sea environment programme (BSEP).

3. Reports/outputs produced by ETC/MCE in 2000/early 2001

The following reports and products were delivered to the EEA in 2000/early 2001:

1. *Annual topic update 1999*, EEA Topic report No 11/2000
2. Contribution to *Environmental signals 2001*: chapter on hazardous substances and oil
3. Contribution to TERM 2001: chapter on oil spills
4. Report on Europe's biodiversity: Seas around Europe: the North-East Atlantic Ocean, the Arctic Ocean, the North Sea, the Caspian Sea, the Baltic Sea, the Mediterranean Sea; the Black Sea
5. *Eutrophication in Europe's coastal waters,* EEA Topic report No 7/2001
6. *Testing of indicators for the marine and coastal environment in Europe: Part 2: hazardous substances,* EEA technical report to be published in 2001
7. *Testing of indicators for the marine and coastal environment in Europe: Part 3: present state and development on eutrophication, hazardous substances, oil and ecological quality,* EEA technical report to be published in 2001
8. 'The potential core set of indicators for the marine and coastal environment', identification study, internal report
9. 'Eumaris GIS prototype' (CD-ROM and report), internal report
10. 'EEA topic status report on the establishment of EIONET', internal report

References

Baan, P. J. A. (WL/Delft Hydraulics) and van Buuren, J. T. (RIKZ), *Testing of indicators for the marine and coastal environment in Europe: Part 3: present state and development on eutrophication, hazardous substances, oil and ecological quality,* EEA technical report.

van Buuren, J. T. (RIKZ) and Baan, P. J. A. (WL/Delft Hydraulics), *The potential core set of indicators for the marine and coastal environment*, identification study, internal report.

Conversi, A. (ENEA), 'EEA topic status report on the establishment of EIONET', internal report.

Cryan, S. (EEA), Peronaci, M., Caiaffa, E., Creo, C. and De Cassan, M. (ENEA), 'European marine information system', internal report.

Nygaard, K. and Walday, M. (NIVA), *Report on Europe's biodiversity: Seas around Europe: the North-East Atlantic Ocean, the Arctic Ocean, the Caspian Sea, the Baltic Sea, the North Sea.*

Peronaci, M., *Marine and coastal environment: Annual topic update 1999*, EEA topic report.

Peronaci, M., Creo, C. and Mannarino, T. (ENEA), 'Marine and coastal environment: EIONET workshop, 30 November to 1 December 2000', internal report.

Sàlama, A. M. (ENEA), 'The Inter-Regional Forum Steering Group meeting, Copenhagen, December 14–15, 2000', internal report.

Zenetos, A., (NCMR): *Report on Europe's Biodiversity the Mediterranean Sea, the Black Sea.*

Ærtebjerg, G., Carstensen, J., Dahl, K., Hansen, J. (NERI), Nygaard, K., Rygg, B., Sørensen, K., Severinsen, G. (NIVA), Casartelli, S. and Schrimpf, W. (JRC-SAI), *Eutrophication in Europe's coastal waters*, EEA topic report.