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Report of the Study Group on Baltic Ecosystem Health Issues in support of BSRP (SGEH)

9–12 November 2003
Gdynia, Poland

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1 OPENING AND WELCOME

The Study Group on Baltic Ecosystem Health Issues in support of BSRP (SGEH) held its first meeting at the Sea Fisheries Institute (SFI), Gdynia, Poland, from 9–12 November 2003 in accordance with the Terms of Reference provided by the ICES Baltic Committee. Eugeniusz Andrulewicz, the SGEH Chair, opened the meeting, and Tomasz Linkowski, the meeting's host and Director of the Sea Fisheries Institute, delivered the welcome address. Mr. Linkowski stressed the importance of the meeting's success and emphasised that the achievements of this meeting are of great importance to the SFI.

1.1 Adoption of Agenda

The meeting agenda (Annex 2) was adopted without modification, although the participants decided that the approach to the agenda items should be flexible.

Representatives from Denmark, Estonia, Finland, Latvia, Lithuania, Poland, Russia and Sweden attended the meeting. Germany participated by correspondence. Representatives from the ICES, HELCOM, Baltic21, and HEED MD Program (USA) international commissions also attended the meeting (Annex 1).

Sebastian Valanko (Finland) and Benjamin Sherman (USA), with assistance from Elzbieta Lysiak-Pastuszak (Poland), were appointed Rapporteurs for the meeting.

1.2 Terms of Reference

The Study Group on Baltic Ecosystem Health Issues in Support of the BSRP (SGEH) (Chair: Eugeniusz Andrulewicz, Poland) will be established and will meet in Gdynia, Poland on 10–13 November 2003. The goals of the Study Group were defined as follows:

1) Prepare a review of developments regarding ecosystem-based approaches to the monitoring, assessment and management of fisheries and the marine environment, with particular reference to progress in ICES, HELCOM, OSPAR and the North Sea Conference process, keeping in mind the aim of establishing and implementing the ecosystem approach in the Baltic Sea.
2) Further develop the concept of an ecosystem approach particularly adapted to Baltic Sea needs and applications, including at the coastal sub-systems levels, as appropriate for the aims of the BSRP and taking into account work already done in ICES.
3) Elaborate a scheme for the delivery of research and scientific advice for ecosystem-based management in the Baltic Sea area, that is timely and user friendly:
    i) involving: the development and application of a system of ecological indicators and related reference points reflecting the objectives, constraints and state of key elements of the ecosystem in a coherent picture;
    ii) supported by the application of appropriate conservation measures necessary to protect threatened or vulnerable species and habitats.
4) Prepare a workplan, including a schedule for deliverables and a description on how the group will address the human dimension related to these issues, in cooperation with other BSRP groups and including considerations of potential contributions to 2006 Theme Session on Regional Integrated Assessments.
5) Discuss and propose a strategy for implementing the development of a habitat classification framework and habitat maps for the Baltic Sea (in collaboration with WGMHM) (HELCOM 2004).

1.3 Introduction by the BSRP Coordinator

Jan Thulin, the BSRP Coordinator, presented the history of the project and outlined its internal structure. He also stressed that the work within the project is not purely scientific and involves all the Baltic Sea commissions and conventions, which requires a great deal of diplomacy. The objective of the SGEH Study Group is to expand the context and scope of assessment and management approaches within the Baltic Region to accommodate impacts and quality conditions which are overlooked within the current monitoring programmes. The SGEH should define the structure and function of the Baltic Sea ecosystems as well as the ecosystem health criteria of this basin. The goal of the SGEH is to further develop the concept of the Baltic Sea as a multi sub-system basin and to create the appropriate scientific tools that will characterise the health of this system.

As a starting point, the following thematic areas are subject to SGEH consideration:

1 The Baltic Sea Region should be described as a distinct system comprised of natural sub-systems that share a similar open ocean context. Within these subsystems the following outcomes are anticipated:

1.1 Management and protection plans for nature conservation areas should be drafted that appreciate distinctive location as representative of the conservation values within the larger system;

1.2 Environmental Reference System can be calibrated (sharing some common characteristics among subsystems) yet should utilise specific reference values, historical reference points (possibly time-series) and a selection of reference areas that best reflect the subsystem;

1.3 The ICES Working Group of Marine Habitat Mapping on habitat classification for each sub-region should continue collaboration with the BSRP, while the development and evolution of the classification system that includes ecosystem health variables is an anticipated outcome.

2 The ICES/BSRP Study Group on Ecosystem Health should clarify the term "Baltic Sea Ecosystem Health."

2.1 Identify Ecological Quality Criteria (EcoQCs) for assessing ecosystem health;

2.2 Recover and synthesise data supportive of a relative baseline for health.

3 The past, present, and anticipated future impacts upon ecosystem health should be articulated.

3.1 Develop classification lists of endangered and threatened species for different Baltic sub-regions;

3.2 Include biodiversity descriptions that take into particular consideration the context of xenodiversity and invasive species;

3.3 Monitor the biological effects of eutrophication, contamination, and fisheries;

3.4 Monitor the effects of pollution on the functioning and structure of the ecosystem;

3.5 Monitor Multiple Marine Ecological Disturbances (MMEDs) as a spatially and temporally explicit integrated indicator status index.

4 The implementation of the ecosystem concept within the Baltic Sea Region will require decision-maker-friendly tools including decision-maker-friendly assessments. It will be necessary to develop a scheme for providing timely and user-friendly advice to management bodies. This should be done through developments of Driving Force-Pressure-State-Impact-Response (DPSIR) indicators.

5 The ecosystem-based approach concept as well as appropriate management tools should be developed and offered to decision-makers.

1.4 Introduction by BSRP Assistant Coordinator

Andris Andrushaitis of the Marine Monitoring Center (Latvia) and Assistant Coordinator of BSRP, presented practical information on how to assure participation and good products from the SGEH. He underlined the need for cooperation between BSRP study groups and further offered a brief review of discussions from the first SGPROD meeting in Riga, held on 28–31 October 2003.

The SGPROD meeting considered productivity on different levels of the food chain, starting from the flux of organic carbon and ending with the productivity of fish. There is a need for more measurements on flux parameters as the amount of available data is insufficient for the comprehensive analysis of matter flows within the ecosystem. Retention and recycling of nutrients, net production of phytoplankton, production of zooplankton and fish is not sufficiently described or understood. The net production of fish should be compared to fish landings.

Regarding technology, particular attention will be paid to improving automated measurement methodology, e.g., expanded use of ships of opportunity, CPR ondulators and the possible deployment and use of moored buoys. The meeting emphasised that, apart from improving measurements by ships of opportunity, there is a need to launch a sufficiently large CPR project. Further, the use of ship of opportunity samples should also be improved, including addressing the issue of how they relate to traditional vertical sampling.

1.5 Introduction by SGEH Chair

The SGEH Chair, Eugeniusz Andrulewicz, welcomed the participants to the first SGEH meeting in Gdynia. He expressed satisfaction with the positive response from most of the invited experts and the good attendance at the meeting. This should be seen as a sign of the scientific community's great interest in ecosystem health issues and the ecosystem-based management of the Baltic Sea. In particular, he welcomed the participation of experts who had not previously been involved in the activities of ICES, e.g., university lecturers, experts from national academies of sciences, representative of Baltic 21, and an expert from the USA. He hoped that such a diverse group of experts would be a good platform for the sharing of different experiences and approaches to ecosystem health and ecosystem-based management, recognising that marine ecosystem health is a relatively new, very complex and challenging issue. Good results are expected not only by ICES and BSRP, but also by HELCOM and other management bodies.

The Chair expressed the opinion that the range of issues to be addressed by the Study Group on Baltic Ecosystem Health Issues reflects the complexity of ecosystem health approaches and that it might not be possible to cover all the issues, simply due to a lack of expertise in certain fields.

He further emphasised that, due to delayed appointments of national members to the BSRP SGEH from several countries, he had taken the initiative of inviting the most qualified experts from Baltic countries. Nevertheless, formalities regarding appointments must be fulfilled, and the invited experts were urged to approach their ICES National Delegates at their earliest convenience to obtain formal nomination to the SGEH. This formality will also help in obtaining relevant funds for future SGEH meetings. Unfortunately, according to the rules given to BSRP, the participation of experts from western countries should be financed from their national sources. The Chair hoped that this would not prevent western experts from participating in SGEH meetings.

2 A REVIEW OF DEVELOPMENTS ON ECOSYSTEM-BASED APPROACHES TO MONITORING ASSESSMENTS AND MANAGEMENT (TOR 1)

The term "ecosystem-based policy" was clearly defined within the sustainable development policy formulated at the highest political level during the Rio Summit in 1992. It was later adopted by the EU (e.g., WFD 2000, EU Marine Strategy), ICES (e.g., ICES Strategic Plan 2002), OSPAR (e.g., Bergen Declaration 2002), HELCOM (e.g., HELCOM-OSPAR Ministerial Declaration 2003), and has now been adopted as the foundation for the work of the ICES BSRP.

No special review on the work of HELCOM, OSPAR or the EU was prepared for the SGEH meeting. However, it is generally understood that ecosystem-based policy for the management of the marine environment has a solid political base. Selected pre-existing developments should be considered by the SGEH, and, in some instances, they can serve as good examples for SGEH work.

2.1 Progress at HELCOM

HELCOM has been improving its environmental protection policy since the Helsinki Convention was signed by Baltic Sea countries in 1974. This is reflected in the frequent revisions and developments of the Baltic Monitoring Programme as well as in improvements in the Periodic Assessments. This is evidenced by the shift in the Baltic monitoring activities from physico-chemical parameters to biological variables, the biological impact of human activities and nature conservation approaches.In his presentation entitled What is going on in HELCOM?, Juha-Markku Leppänen, the Professional Secretary of the Helsinki Commission, informed participants of the most recent developments of ecosystem-based approaches to monitoring, assessment and management of the Baltic Sea, including:

- revision of future priorities; revision of working structure;
- implementation of the ecosystem approach;
- development of quality objectives (EcoQOs);
- development of indicators;
- revision of monitoring programmes;
- new assessment products;
- Baltic Sea Regional Project.

Elżbieta Łysiak-Pastuszak, a senior scientist from the Institute of Meteorology and Water Management, Maritime Branch in Gdynia and the Chair of SGQAC, presented information on the most recent HELCOM MONAS meeting in Gdynia regarding the main issues related to ecosystem health matters, i.e., establishing the MONAS-PRO (for the revision of COMBINE), PLC and MORS programmes; new assessment products - indicator reports. She also described the scope of the Pilot Study Group for the Development of Ecological Quality Objectives for the Baltic Sea.

During the discussion on the current status of implementing HELCOM COMBINE, some gaps in the monitoring programme were identified, e.g., inadequate phytobenthos monitoring, the lack of coastal fish monitoring and the general absence of biological effects monitoring. Marine birds and algal toxins in molluscs and benthic fish were proposed as possible new variables for monitoring ecosystem health.

2.2 Progress at ICES

ICES has been developing environmental advice since the 1970s; however, purely ecosystem-based advice was not initiated until the late 1990s. This advice, and associated policy considerations, is specifically developed through advisory committees. These include the Advisory Committee on the Marine Environment (ACME) and the Advisory Committee on Ecosystems (ACE), which often utilize the work of working groups under the Marine Habitat Committee. Development is greatly facilitated by the work performed by various environmental and fishery working groups, oarticularly the Working Group on Ecosystem Effects of Fishing Activities (WGECO), the Working Group on Seabird Ecology (WGSE), the Working Group on Marine Mammal Ecology (WGMME), and the Working Group on Marine Habitat Mapping (WGMHM). The most recent initiative was the creation of the Study Group on Information Needs for Coastal Zone Management (SGINC) and four ICES/BSRP Study Groups, including the SGEH.

A major ecosystem-related activity for the past few years has been the scientific development of ecological quality elements and objectives, based on initial work under OSPAR workshops. Scientific information and advice concerning ecological quality objectives has been published in ACE reports.

ICES developments and advice are described in advisory committee reports (available as part of the *ICES Cooperative Research Report* series) and ICES working and study group reports (available as hard copies and through the ICES web site (www.ices.dk)). ICES environmental policy and strategy is described in the ICES Strategic Plan (2002).

2.3 Progress at OSPAR

The ecosystem-based policy developed at OSPAR for the North Atlantic (including the North Sea) can serve as a very good example for similar development regarding the Baltic Sea. OSPAR had already organised a number of workshops concerning the development of EcoQOs (e.g., Workshop on the Ecosystem Approach to the Management and Protection of the North Sea. Oslo, 1998) by the 1990s. However, the most significant of its recent achievements include the Bergen Declaration 2000, in which ecosystem-based policy is clearly defined, and documents from the Joint Ministerial Meeting of the Helsinki and OSPAR Commissions, Bremen 2003, available at www.ospar.org

2.4 Progress in the EU

The EU not only supports, but also initiates, ecosystem-based policy through its directives (e.g., Habitat Directive, Birds Directive, Water Framework Directive 2000) and policy documents, such as the document on European marine strategy *Towards a strategy to protect and conserve the marine environment*, EU COM 539. 2002). It also participates by financing various research projects related to the implementation of sustainable and ecosystem-based policy. The European Environment Agency (EEA) runs various activities related to the development of tools for this policy. Hopefully, the EU will fully recognise the experience already gained by international advisory bodies and regional commissions.

3 DEVELOPING THE CONCEPT OF AN ECOSYSTEM-BASED APPROACH FOR THE BALTIC SEA (TOR 2)

The Baltic is known as a “sea of many environments”, and it is defined variously, however all the definitions identify several Baltic sub-regions that can also be regarded as ecological systems.

Multibasin topography of the Baltic Sea, coupled with salt-water inflow and freshwater runoff has created a specific circulation system which serves as a basis for differentiation of large and relatively autonomous units of the Baltic Sea ecosystem. These sub-units are bounded by hydrographic constraints and separated by transition areas. The sub-units differ both in the abiotic (e.g., salinity, temperature, oxygen content) and biotic (species composition, richness and abundance) variables.

HELCOM adopted sub-basin approach in its Periodic Assessments: (1) Baltic Proper, (2) Gulf of Bothnia, (3) Gulf of Finland, (4) Gulf of Riga, (5) Kattegat and the Belt Sea, e.g., Environment of the Baltic Sea Area 1994–1998, Baltic Sea Environment. Proceedings No. 82 B. However, even HELCOM at the Report, for some other purposes recognises nine sub-regions : (1) Bothnian Bay, (2) Bothnian Sea,(3) Archipelago Sea, (4) Gulf of Finland, (5) Gulf of Riga, (6) Baltic Proper, (7) Western Baltic, (8) The Sound, and (9) Kattegat.

The following scheme for separation of the regional sub-systems of the Baltic Sea LME was proposed by Ojaveer and Elken (1997): (1) Kattegat, (2) Belts, the Sound, the Kiel and Mecklenburg Bights, (3) Arkona Sea, (4) Bornholm Sea, (5) Sotheastern Baltic (Gdansk Deep area), (6) Eastern Gotland Sea , (7) Western Gotland Sea, (8) Northern Baltic Proper, (9) Gulf of Riga, (10) Gulf of Finland, (11) Bothnian Sea, and (12) Bothnian Bay.

Division of the Baltic Sea into the regional subsystems should reach considerable attention and needs to be further discussed and developed within the BSRP project as it forms the scientific basis for management of the Baltic Sea resources. In addition, this issue is the joint umbrella for the three ICES BSRP Study Groups (SGEH, SGPROD, and SGBFFI).

Natural driving forces make this sea vulnerable and sensitive to pollution and other stressors. Unfortunately, anthropogenic pressure occurs on such a scale that it should be recognised as one of the driving forces in the Baltic Sea. The pressure stems from the fact that the large Baltic catchment area is inhabited by 85 million people, with the most significant pressure resulting from the heavy loads of nutrients and toxic substances from agriculture, industry, transport, and households. Humans are strongly influencing the quality of the Baltic ecosystem. Developing a new ecosystem-based policy for the management of human activities can assist in the sustainable development of the Baltic Region and in improving the health of the Baltic ecosystem.

The participants presented several views on the topic of Baltic Sea ecosystem health.

Josianne Støttrup of the Danish Institute of Fisheries Research, Charlottenlund, Denmark, *What is ecosystem health?*

The author of this presentation discussed several basic issues relevant to SGEH, including how to define “health” in terms of the structure and function of a system and its ability to withstand stress and disease. She then discussed the need to develop knowledge of environmental systems, including identifying how they behave and changes that occur in them. She also emphasised the need for indicators and criteria for healthy systems.

Ben Sherman, representing the Health Ecological and Economic Dimensions of Major Disturbances Program (HEED MD), USA, presented some views regarding ecosystem health. The marine ecosystem is described as a “... dynamic complex of plant, animal and micro-organism communities and their non-living environment interacting as a function unit”. This concept of ecosystem is already recognised by similar regional efforts in the North Sea, throughout the European Union and in the United States and Australia and should be adapted to the Baltic Sea. No particular spatial unit of scale is included in this definition; rather the scale of the ecosystem is defined depending upon the problems addressed.

Humans are included explicitly in the marine ecosystem as a driving force of changes within the system and as an element that is impacted by these changes. The decision was taken to avoid ethically and spiritually value-laden terms associated with the ecosystem in preference for empirically defensible concepts supported by scientific methodologies.

Since changes in the Baltic Sea Ecosystem are measurable, the approach to describing status change in the SGEH has concentrated on indicators and variables that best describe the transitional state of an ecosystem from a reference point to the present condition. In order ensure the sufficiently general level of specificity required to encompass the 1 700 000 km^2 area known as the Baltic drainage area, the selection of parameters is biased toward those that have high predictive value and are repeatable.

Our definitions recognise that the ecosystem approach is desirable and the same approach should be applied to adjacent ecosystems. This approach is defined as "...the comprehensive integrated management of human activities based upon the best available scientific knowledge about the ecosystem and its dynamics in order to identify and take action on influences which are critical to the health of the marine ecosystem, thereby achieving sustainable use of ecosystem goods and services and maintenance of ecosystem integrity"

(Bergen Declaration, 2002/ EC European Marine Strategy / HELCOM / OSPAR).

While there is general consensus on what constitutes an ecosystem approach, definitions vary as to what the health of an ecosystem comprises. A common sense definition is one that incorporates a medical analogy. Medicine and epidemiology recognise that environmental contexts and factors provide diagnostic clues as to the origin of poor health in human populations. Conversely, ecologists have borrowed the medical analogy to describe unexpected conditions within ecosystems due to larger scale and generally unidentified forces. To address the aforementioned Terms of Reference, the SGEH will evaluate several similar ecosystem health definitions that differ in detail and that have already been applied to discussions of the Baltic Sea.

Applying the ecosystem approach requires developing the measures necessary to implement an ecosystem approach**,** in order to make firm commitments and help to maintain and, when practicable, restore ecosystem health and the integrity of ecosystem services.

Ecological quality is an "...overall expression of the structure and function of the marine ecosystem taking into account the biological community and natural physiographical, geographic and climatic factors as well as physical and chemical conditions including those resulting from human activities." Ecological Quality Elements are the individual aspects of overall ecological quality. Ecological Quality Objectives are the desired level of ecological quality. This level can be set in relation to a reference level. (5th North Sea Conference, Bergen Declaration 2002, HELCOM MONAS 6/2003 for the Baltic Sea).

One goal is to maintain ecosystem health and integrity which means:

- maintain viable populations of species;
- protect representative examples of all native ecosystem types across their natural range of variation;
- maintain evolutionary and ecological processes;
- manage landscape and species in response to both short- and long-term environmental change;
- accommodate human activities within these constraints (Grumbine, 1994).

Robert Costanza *et al.* (1992) one of the more prolific authors in the area of marine ecosystem health, provides the following definition of ecosystem health: **"**To be healthy and sustainable, an ecosystem must maintain its metabolic activity level and its internal structure and organisation, and must resist external stress over time and space scales relevant to the ecosystem."

There are two main distinctions that can be applied to concepts of ecosystem health, and the SGEH chose to adopt both approaches:

- Forward Looking - A healthy or sustainable state is defined *a priori*, and it is the aim of the Baltic Sea Regional Projects to work toward attaining this goal of a healthy state. Progress reports and lessons learned will be provided periodically.
- Backward Looking - A particular healthy state is not defined explicitly. Rather, by re-examining past changes in environmental conditions relative to currently monitored conditions, early warning signs of ill health (unexpected conditions) are detected and work is focused on defining thresholds of change in chronic conditions. BSRP pollution and ecosystem health objectives are met in this approach by observing the occurrence or non-occurrence of changes. These will be supported by real-time reporting. Over time, thresholds of change in baseline conditions

will be established and will define structural and functional ecosystem health. Summary reports will be provided on the changing state of the Baltic Sea ecosystem when mechanisms and/or predictions of changes have been validated.

Both approaches are required to integrate findings and, in turn, support the productivity indicator, fish/fisheries indicator and the governance and socio-economic indicators of the BSRP modules.

The structure, functioning and dynamics of the Baltic Sea ecosystem should be understood in relation to environmental driving forces, i.e., climate and meteorological conditions and human impact. The SGEH will concentrate on the effects of human impact, which can be influenced by ecosystem-based policy:

- eutrophication;
- overexploitation of marine living resources (mainly fishing);
- chemical contamination;
- oil pollution;
- introduction of alien species;
- physical disturbance of habitats.

3.1 Biological effects of eutrophication

Enhanced eutrophication is a major environmental problem in the Baltic Sea. As a result of changes in land use, loss of wetlands, the application of mineral fertilisers, increased urban and industrial sewage load and fossil fuel combustion, nutrient input into the sea have increased significantly over the last sixty years. The present load of nitrogen is three-fold higher than that in 1940, while that of phosphorous has increased five-fold since 1940. As a consequence, biological production has increased (resulting in eutrophication); water transparency has decreased; the abundance and biomass of brown seaweed (Bladder wrack) has fallen and changes have occurred in the species composition and abundance of planktivorous fish and bottom-dwelling organisms. Since 1900, primary production has increased by 30–70%, zooplankton biomass by 25%, and sedimentation by 70–190% (SGBEAB 2000). Higher fish catches (four- to five-fold) are the result of increased fishing effort. In parallel to increased production, there are many evidences showing that irreversible changes have taken place in communities at various trophic levels, both pelagic and benthic, where species tolerant to eutrophication have increased in abundance, and clean water requiring species have decreased in population size and retreated from more eutrophied areas.

Several papers related to eutrophication and the biological effects of eutrophication were presented at the SGEH meeting. Below are short reviews of some of the presentations.

Maija Balode, Institute of Aquatic Ecology, University of Latvia Riga, Latvia
Harmful algal blooms and algal toxins as indicators of ecosystem health in the Baltic Sea

The importance of harmful algal blooms (HAB) in the monitoring of the World Ocean, including the Baltic Sea, was discussed. The list of potential HAB species and their toxic influence was presented. The importance of HAB for both ecosystem and human health was discussed.

A number of bloom-forming cyanobacteria, dinoflagellates, haptophytes and diatoms are known to be causative agents of harmful effects and potential toxin producers. Acute and chronic poisoning from algal toxins (hepatotoxins, neurotoxins, diahrretic shellfish poisons - DSP, paralytic shellfish poisons - PSP, neurotoxic shellfish toxins - NSP, amnesic shellfish poisons – ASP, etc.) are observed worldwide and constitute a menace for aquatic organisms, birds, domestic and wild animals, as well as for human health. Incidents attributed to algal toxins (recorded in Brazil, the USA, China, Australia, England, Sweden and other countries) call for further investigations of harmful algal blooms and related toxic effects.

Cyanobacterial toxins (microcystins and nodularin) are known to inhibit protein phosphatase, cause hepatic necrosis and promote tumours. Contamination with DSP toxins (also protein phosphatase inhibitors) is manifested in acute gastrointestinal symptoms – diarrhoea, nausea, vomiting, chills, and abdominal cramps. In addition to these symptoms, exposure to PSP toxins (Na+ channel blockers) can cause respiratory problems and paraesthesias. NSP toxins (Na+ channel activators) can cause bronchoconstriction and the reversal of temperature sensation. Harmful diatoms and haptophytes can result in fish mortality by causing gill damage and osmoregulatory problems (*Chrysochromulina* spp., *Prymnesium* spp) or cause mechanical irritation of gill tissue due to the thickness or length of setae (*Chaetoceros danicus*).

In recent decades, regular or occasional blooms of harmful cyanobacteria, dinoflagellates, haptophytes and diatoms have also occurred in the Baltic Sea. They have contaminated aquatic organisms causing mortality and allergic and gastrointestinal problems in animals and humans. The monitoring of the impact of HAB and the bioaccumulation of algal toxins in shellfish and benthic fish are considered to be good indicators of the fate of algal toxins in the Baltic Sea. Focusing on hepatotoxins, neurotoxins and DSP toxins was suggested. The criteria recommended for water quality control for HAB were the occurrence of HAB species and bloom intensity; presence of algal toxins; bioaccumulation of toxins in shellfish and benthic fish; species diversity and abundance of other aquatic organisms during HAB; toxic effects on mortality, reproductive capacities – egg production, hatching, etc.

Elmira Boikova, Institute of Aquatic Ecology, Riga, Latvia
The coastal zone threats of the Baltic Sea - are they unique?

Approaches for the healthy development of the coastal zone based on scientific data obtained in the Gulf of Riga, especially in the littoral zone, indicate that marine biodiversity is comparatively high here. This buffers the influence from the land to sea, especially with regard to microbial food elements (bacteria, picocyanobacteria, nanoplankton and protozooplankton).

In order to understand the self-purification processes, it was strongly recommended that the trophic cascade model of benthos, plankton, fish and birds and changes in it (like the introduction of invasive species, etc.) be used. Adequate measurements for water quality assessments, such as indices based on the ecosystem approach, are required.

Georg Martin, Estonian Marine Institute, University of Tartu, Tallinn, Estonia
Phytobenthos as an indicator of ecosystem health of the Baltic Sea

Phytobenthos is a very important part of the ecosystem. In coastal areas, it can contribute up to 30% of the total biological production and has several other features which render it one of the most important elements in the coastal ecosystem. Phytobenthic communities have a high level of biodioversity; they also serve as a temporary sink for nutrients and hazardous substances coming from the terrestrial environment.

Light availability and substrate quality are among the most important factors affecting phytobenthic communities in the Baltic Sea. In the northern part of the sea, ice is also considered to be one of the most important factors. Biotic interactions such as grazing and competition are considered to be of minor importance in the Baltic Sea. The phytobenthos is affected by several environmental gradients on both the horizontal (or geographical) and vertical (depth gradient) scales. Both contribute to the spatial variability of phytobenthic parameters that can be used as eutrophication indicators.

At the same time, the phytobenthos has been proposed as a valuable environmental bioindicator, since it has certain predictable responses to changes in eutrophication level and, being a stable component of the marine environment, has the ability to integrate responses to environmental conditions over time.

The main difficulties in using phytobenthos as an environmental indicator are related to its high spatial (large- and small-scale) and temporal (seasonal and interannual) variability and technical problems with sampling and observation.

Currently, marine phytobenthos monitoring is conducted at the national level only in Denmark, Sweden, Estonia and Poland. At the same time, phytobenthos monitoring is included in the HELCOM COMBINE programme and is required for EU member states as part of the monitoring programme of the Water Framework Directive (WFD). The reasons for the lack of similar programmes in many countries differ slightly from country to country, but frequently it is for a lack of scuba-diving biologists and the high expenses of equipment and operational costs.

3.2 Biological effects of contamination and fish diseases

The concentration of contaminants in marine waters and the foodweb pose a potential threat to the health of marine organisms (including fish) and that of consumers of marine products.

Baltic Fish and Contaminants – Following many years of declining concentrations in fish tissues of classic organic contaminants (ΣDDT, ΣPCB, HCH, HCB, PAHs) (HELCOM Third Periodic Assessment), concentrations have ceased to decline. Knowledge regarding the concentrations of other organic contaminants in Baltic fish is sparse. The same applies to the biological effects of contaminants in the Baltic Sea. Nevertheless, some techniques for measuring biological effects are well developed and are already being applied in the monitoring of other seas, e.g., the North Sea.

The Study Group noted differences in the capabilities of measuring biological effects in fish and other species and the expanding range of chemical analyses of hazardous substances in fish tissues (dioxins, furans, brominated flame retardants, co-planar CB_s, TBT compounds) in the more developed countries. These compounds are of concern due to their input into the marine environment, their persistence and their toxic effects.

Recommendations for the biological effects monitoring programme for the Baltic Sea are:

- concentration of organic contaminants, e.g. PCBs, DDTs, TBT, dioxins, pesticides, algal toxins, in selected fish, shellfish and seabird eggs (bioaccumulation);
- endocrine disruption – imposex, intersex, vitellogenin, embryo sex ratio, reproductive success, chromosomal aberrations in the gonads;
- biomarkers – AChE, MT, EROD, lysosomal stability, PAH metabolites, micronuclei, oxidative stress biomarkers;
- changes in abundance, biomass and the distribution of native species.

Several papers related to biological effects of contaminants were presented by the SGEH participants.

Janina Baršienė, Institute of Ecology of Vilnius University, Lithuania
The Relevance of Genotoxicity Markers in Baltic Sea Ecosystem Studies

The assessment of environmental genotoxicity was included in EU BEEP project as a biomarker of cytogenetic damage which can arise after exposure to both DNA reactive and non-reactive compounds. A brief overview was presented on micronuclei studies in three fish species and blue mussels inhabiting 18 stations in the Baltic Sea (coastal areas of Sweden, Lithuania, Poland and Germany). The elaboration and further development of the micronucleus test was performed in experimental studies on fish and mussels. Deep concern was expressed regarding oil genotoxicity in marine organisms and the consequences of the oil spill at the Butinge oil terminal (Baltic Sea) and in the Bleivik area of the North Sea. It was suggested that the evaluation of chromosomal aberrations in gonads should be used as a marker of environmental pollution in the assessment of disturbances in the reproduction of marine organisms. In summary, the micronuclei test was proposed as very simple, cost-effective, fast, sensitive tool to monitor the status of ecosystem health.

Kari Lehtonen, Finnish Institute of Marine Research, Helsinki, Finland
The use of biomarkers for the ecosystem health assessment of the Baltic Sea (Annex 3)

Kari Lehtonen gave a short review on special features of the Baltic Sea in relation to chemical pollution. Than he reviewed the status of development of measuring biological effects of chemical pollution in the Baltic Sea including results of WP 2 “Biomonitoring of the Baltic Sea” of the EU BEEP (Biological Effects of Environmental Pollution on Marine Coastal Ecosystems) project. Finally he has proposed a strategy for including biomarkers in the monitoring of ecosystem health in the Baltic Sea (Annex 3).

Janusz Pempkowiak, Institute of Oceanology, Polish Academy of Sciences, Sopot, Poland
Contaminants in the southern Baltic Sea

This contribution presented recent results from the Institute of Oceanology Polish Academy of Sciences from studies on contaminants in sediments and marine organisms in the Polish marine areas of the southern Baltic Sea. The overall conclusion is that contamination is area-dependent, and can be considered “limited” in the scale “lack-limited-moderate-clearly contaminated”. The results are considered to be useful in the evaluation of the biological effects of pollutants and can be included in the database for biological effects studies.

Brita Sundelin, Institute of Applied Environmental Research, Stockholm University, Sweden
The possible crash of Monoporeia affinis *populations in the Gulf of Bothnia*

This contribution, presented by Kari Lehtonen, focused on a seven-year environmental monitoring programme in Sweden regarding reproductive biomarkers, e.g., embryo malformations and delays in sexual development, in the benthic amphipod *Monoporeia affinis*. Although it indicated interannual variability, it is difficult to differentiate between the possible effects of contaminants and the effects of natural variables. The observed "crash" in population densities and biomass of *M. affinis* in the Bothnian Sea in recent years might have occurred following long-term (5–7 years) cycles observed in this area. Continuous monitoring of perch in Kvädöfjärden (Baltic Proper, Sweden) since 1988 shows a decreasing trend in gonadosomatic index (GSI) coupled with an increasing trend in liver EROD activity. This illustrates the usefulness of biomarker monitoring programmes, which are currently very rare worldwide, to detect slowly occurring changes in the marine environment.

Thomas Lang, Institute of Fishery Ecology, Cuxhaven, Germany
Study on diseases and parasites of Baltic fish as part of an ecosystem approach to the assessment and management of the environment and the fisheries in the Baltic Sea (Annex 4)

This contribution, presented by J. Stottrup, suggests future activities as part of the remits of BSRP, as follows:

- enhance coordinated fish disease monitoring conducted by Baltic countries;
- combine fish disease monitoring with that of the biological effects of contaminants (biomarker approach) and, if feasible, ideally fish stock assessment surveys, too;
- intensify inter-calibration between Baltic institutes by organising joint sea-going workshops (this can be done aboard the German research vessel *Walther Herwig III* in December 2004;
- combine and statistically analyse data from long-term fish disease surveys (cod, flounder) with stock assessment and reproduction data in order to increase knowledge on the effects of diseases on fish stocks and the effects of fish stock performance on diseases (particularly for infectious diseases);
- enhance integrated assessment by utilising data from various sources (hydrography, geography, contaminants, diseases/parasites, biomarkers, fish stock parameters, biodiversity, etc.). In this context, the ICES Marine Data Centre plays a crucial role and can be utilised to a great extent.

3.3 Biological effects of fishing

Fishery and fishing causes various effects on fish communities such as changes in the size distribution of target fish, changes in fish community structure and the bycatch of birds, mammals and non-target fish species. Heavy trawling also affects bottom biotopes (e.g., Ojaveer, 2002).

In recent decades, overfishing and the lack of favourable conditions for reproduction have reduced populations and caused a dramatic reduction in the area of occurrence of cod. In areas where cod has traditionally been caught by coastal fisheries, fisherman and anglers now have problems catching any cod.

The ecological effects of the removal of predatory fish are not restricted to cod. There are examples that reducing the overfishing of pikeperch has resulted in a drastic increase in one of their prey species, the three-spined stickleback, e.g., in Pärnu Bay in the Gulf of Riga (E. Ojaveer, pers. comm.) and the Puck Bay in the Gulf of Gdansk.

Fishery does not only influence target species; the bycatch of other fish species, harbour porpoises, seals and seabirds also carries an impact. This is considered to be a particular problem for the very small population of the Baltic Sea harbour porpoise (ICES CM 2000/ACME:02).

It has also been suggested (Hjerne, 2000) that fishery is an important factor in eutrophication. By sequestering large quantities of phosphorus from the water column during summer, fish can possibly compete for phosphorus with cyanobacteria and influence the occurrence of blue-green algal blooms.

Fishery has had a strong impact on the Baltic Sea ecosystems. An ecosystem management approach has to include a combination of sustainable and properly managed fishery and effective measures to reduce eutrophication and concentrations of toxic substances. Healthy populations of ecologically and economically important fish stocks will increase our possibility to maintain commercial fisheries, while new fisheries can be developed. This includes fishing tourism as an important component. With the central role that fish play in the food web, dominating two of the five trophic levels from phytoplankton to mammals and birds, fishery management is also likely to influence other ecosystem components, e.g., algal blooms (see above) and experiences from lakes (Carpenter and Kitchell, 1993). Our management goals are not only an issue for fishery, but should be determined through a political process that involves various stakeholders. The critical questions to be asked are what we would like the Baltic Sea ecosystem to look like, and to what extent can fishery management influence this.

The following presentations were prepared regarding this topic.

Chris Hopkins, AquaMarine Advisers, Åstorp, Sweden
Recommended targeted actions/measures-fishery (received by correspondence)

The definition of the ecosystem approach emphasizes the need for integrated management of human activities to achieve sustainability of ecosystem goods and services and maintenance of ecosystem integrity. Accordingly, there is a need to identify and rank the particular human pressures and inappropriate practices that cause specific, substantial impacts, i.e., elucidate cause and effect, on Baltic Sea ecosystems and their key components (see OSPAR QSR 2000).

Further, clear targets and a comprehensive 'tool-box' of effective management measures and actions have to be established for fisheries. These must be supported by easily understandable indicators and quality objectives for assessing changing status and trends. This will permit redressing the 'root-causes' of the problems and achieving the recovery and restoration of key impacted ecosystem components. For fisheries, these measures include the following:

a) reduced fishing effort and fleet capacity regarding deployment of inappropriate gear;
b) gear modification and substitution, e.g., towards passive and non-mobile gear that does not seriously impact seabed habitats or cause substantial bycatch and discards;
c) propose appropriate networks of marine protected areas (MPAs) of significant size, with clearly defined management goals, including undisturbed areas with no-take and no trawl zones to enhance the protection of juvenile fish, spawning areas and vulnerable benthic species and habitats;
d) develop recovery plans and restoration schemes;
e) identify and make proposals for the implementation of major changes in governance that will promote sustainable fisheries in sustainable ecosystems;
f) the focus should be on 'where, how many and why' and the cost vs. benefit should be justified.

Henn Ojaveer, Estonian Marine Institute, University of Tartu, Tallinn, Estonia
Exploitation of marine living resources

The main exploitable living resources of the Baltic Sea are fish. Currently, several commercial fish stocks, which are managed both nationally and internationally, are outside of safe biological limits, e.g., herring in the open Baltic, eastern Baltic cod, or evidence suggests that overexploitation is severe, e.g., several coastal species such as perch and pikeperch. Due to high commercial interest, signs of improvement in the conditions of these fish stocks are either too low or not evident.

The internationally managed fish species are cod, herring, sprat and salmon. The management of the first three species is based on the application of single-species stock assessment models where ecosystem-related information is generally not used. In the assessment of the stocks, and partly in their management, the fish population structure is not always taken into account.

As management decisions for nationally managed fish are taken by the Baltic countries separately and the justifications and backgrounds of these decisions are unavailable to the group, a more comprehensive overview of this topic should be requested from the ICES/BSRP.

The future development on the topic of the biological effects of fishing will be developed jointly with the BSRP SG BFF and linked to HELCOM MONAS Coastal Fish Monitoring.

3.4 Effects of non-indigenous species

It is documented that over 100 alien species have been recorded to the Baltic Sea. Although there are case studies available for selected species (e.g., the polychaete *Marenzelleria viridis*, the zebra mussel *Dreissena polymorpha*, the cladoceran *Cercopagis pengoi*) showing that significant ecological changes have been taken place after these invasions in the Baltic Sea, the large-scale effects of alien species on native organisms and local ecosystems are generally unknown in the Baltic. However, knowledge from other areas/ecosystems of the World suggests that impact of alien species is in general unpredictable and irreversible. Therefore, BSRP expressed the opinion that the topic of alien species should be included in the Ecosystem Health module of the project. This issue, although usually taken separately, is clearly related to ecosystem health.

Several papers were presented on this topic.

Elena Ezhova, Atlantic Branch of the P. P. Shirshov Institute of Oceanology, Kaliningrad, Russia

Ms. Ezhova presented results of current scientific projects carried out in the Vistula Lagoon and Russian marine areas in the Kaliningrad region, with an emphasis on alien species in this region of the Baltic Sea.

Sergej Olenin, Coastal Research and Planning Institute, Klaipeda University, Lithuania
Perspectives of the Baltic Sea Alien Species Database in relation to ICES/BSRP

This contribution (presented by Zita Gasiunaite) made an overview of the Baltic Sea alien species database which was developed through the cooperation within the BMB WG30 NEMO and with support from HELCOM in 1999–2000. It described plans for further development of the Database. It emphasised that the Coastal Research and Planning Institute (Klaipeda, Lithuania) is willing to cooperate with the BSRP in the filed of invasive alien species.

Vadim Panov, Zoological Institute of the Russian Academy of Sciences, St. Petersburg, Russia
Monitoring and studies of ecosystem impacts of alien species in the Baltic Sea coastal waters in Russia
(received by correspondence)

At present, the Zoological Institute of the Russian Academy of Sciences (ZIN RAS) is involved in a number of national projects focused on the research of invasive alien species in Baltic Sea coastal ecosystems. These projects are funded by the Russian government as part of national efforts to implement relevant international agreements regarding invasive alien species (particularly Decision VI/23 COP6 of the Convention on Biological Diversity).

In 2002, the Ministry of Industry, Science and Technology of the Russian Federation launched a federal program entitled *Research on Priority Directions in Development of Science and Technologies* for the 2002–2006 period. Within the framework of this Program, ZIN RAS is conducting a three-year (2002–2004) project to assess the impact of alien species on the ecosystem in the Baltic Sea Basin. This is under the auspices of the national project on the assessment of the impact of alien species on the structure, productivity and biodiversity of ecosystems in Russia (http://www.zin.ru/rbic/projects/impabalt/). In cooperation with two sub-contracting institutions in Kaliningrad, the P.P. Shirshov Institute of Oceanology RAS and AtlantNIRO, ZIN RAS is focusing on field and experimental studies of alien species for the ecosystem impact assessment, predictions of new invasions, the development of a national alien species information system (http://www.zin.ru/rbic/projects/iasnwrussia/), and the development of a scientific basis for state policy regarding biological invasions.

Since early 2003, ZIN RAS has been involved in a new national project on biosecurity and the monitoring of biological invasions in aquatic ecosystems of the European part of Russia, funded by the Ministry of Industry, Science and Technology of the Russian Federation. The main goal of the project includes monitoring biological invasions in the eastern Gulf of Finland and the timely incorporation of monitoring data in the open information system with GIS-applications. Currently, this project serves as the main source of funding of the online GIS *Invasive Species of the Baltic Sea* (http://www.zin.ru/rbic/projects/invader/), part of the HELCOM project on development of open information resources on the invasive alien species in the Baltic Sea.

Since early 2003, ZIN RAS has also been involved in a project of the Presidium of the Russian Academy of Sciences Program on Biodiversity Conservation (2003–2005), which deals with biological invasions in Baltic Sea coastal waters and includes studies of the diversity of marine coastal ecosystems under the influence of biotic factors. The main objectives of this project include assessing the impact of alien species on biodiversity and the structural-functional organisation of coastal ecosystems of the Baltic Sea, and the evaluation of the resistance of coastal ecosystems to the impact of invasive alien species.

3.5 Oil pollution

A total of 119 shipping accidents occurred in the Baltic Sea during the 2000–2002 period, and 344 illegal oil discharges were recorded in 2002 (by the HELCOM aerial surveillance programme). The actual number of oil spills may be as high as 700 per year (S. Wilhelms, BSH). The rapid development of oil shipping lines, the construction of refineries and oil terminals are all anticipated. The potential threat from oil spillage is a growing concern.

Although the issue of oil pollution was not discussed during the meeting, it was recognised that the Baltic Sea, due to its characteristics, is particularly vulnerable to oil pollution. This and other issues related to the effects of marine transport could be considered at the next SGEH meeting.

3.6 EcoQOs for the Baltic Sea

The first meeting of the SGEH was not able to consider explicitly the assessment and management techniques that will be necessary to achieve the desired EcoQs (Ecological Qualities) described. It was generally agreed that assessment activities must integrate all of the information contained in Table 1 and Figure 2 in Annex 5 (S.Valanko, *A Pilot Study into the development of a roadmap for the establishment of ecological quality objectives (EcoQOs) within HELCOM for the Baltic Sea*). Moreover, the management strategies used to attain objectives related to the described qualities (EcoQOs) should be adaptive and flexible enough to take into account both realistic impediments and an ecosystem unable to return to reference condition.

Both the top-down and bottom-up processes are essential in building a foundation of understanding surrounding the ecosystem approach (in Table 1 and Figure 2 in Annex 5). This shift from traditional resource management is aimed at long-term sustainability. It has a multi-species framework, integrating human activities and the conservation of nature, including political, economic and social values, and proposes solutions which are socially acceptable.

It must also be recognised that within the framework of the ecosystem approach, emphasis must be placed on issues that present the greatest risk to long-term sustainability. These issues need also to be viewed with consideration to the underlying criteria of what constitutes good EcoQOs.

As the study group consisted only of scientists, the so-called bottom-up approach (Figure 2, Annex 3) was applied in terms of the EcoQOs suggested. As this table is developed further, it is important to note that regional diversity will require careful consideration of the specific needs of all stakeholders, and our efforts to establish EcoQOs should reflect this. We cannot risk alienating key players within this regionally interlinked system. In order to have as wide as possible stakeholder understanding and participation (political ownership), we need to express EcoQOs in terms of a “public ecology”, where overall the public is aware of the aims, implementation, potential benefits, and the governance of marine conservation with regard to their anthropogenic activity.

Establishing EcoQOs and deciding on management action will be the result of intense debate. If we only choose scientific certainty and political objectives as our criteria for EcoQOs, it will risk alienating the public and many key stakeholders. Simplification may risk scientific uncertainty, but we need to ask ourselves if we are willing to continue denying stakeholders the know-how to conserve our marine environment.

When applying the ecosystem approach there needs to be a shift towards the ecosystem itself, which will be at the centre of a causal chain continuum of cause and effect. Once developed, EcoQOs should ideally reflect the core of information on the ecosystem, with a balance between the basic ecosystem properties on one hand and human influences on the other. It has been recognised that biological effect variables can provide a useful link between effects and human influence on the marine environment. Therefore, specific long-term visions of the state of the Baltic Sea environment were identified with regard to some priority issues: eutrophication; hazardous and harmful substances; fisheries and mariculture; biodiversity and habitats. These so-called visions will provide a useful step towards developing specific EcoQOs that will have sustainability at their core.

Sebastian Valanko, Helsinki Commission, Finland
Pilot study into the development of a road map for the establishment of ecological quality objectives (EcoQOs) within HELCOM for the Baltic Sea (Annex 5)

This presentation offered an extended discussion on Ecological Quality Objectives (EcoQOs) for a regional ecosystem approach in the Baltic Sea.It was followed by a thorough discussion including a questionnaire for the participants regarding the quality objectives within different Baltic Sea ecological problems (eutrophication, contamination, biodiversity). The issue of EcoQOs will be developed further in co-operation with HELCOM and taking into consideration the developments in OSPAR and ICES. Reference points and conditions will be developed along with the EcoQOs.

3.7 Multiple marine ecological disturbances – MMED

Healthy and balanced marine ecosystems are commonly associated with unpolluted water and the existence of natural communities of marine invertebrates, fish, birds and mammals desired by society and supporting and sustaining human health. Unanticipated disturbances impacting wildlife, coastal populations, tourists and tourism influence perception of marine ecosystem health. Tourism and the marketability of seafood rely upon a collective perception of high quality and healthy coastal waters. In the Baltic, beaches and coastal waters suffer from toxic phytoplankton blooms and concentrations of dangerous and harmful compounds in the seawater. Invasive species and disease events also significantly impact fisheries and damage the viability of aquaculture operations. Anticipating or accounting for these events serves two purposes 1) helps determine causality by carefully investigating co-occurring indicators of change and 2) builds a capacity to buffer or ameliorate the harm from events. Disturbance indicators or proxy indicators can take many forms. The objective of a Baltic Sea MMED approach is to select for monitoring the best oceanographic, biological, climatic, and economic indicators of disturbance. MMED projects in the Gulf of Mexico, Caribbean Sea, and Northwestern Atlantic Ocean have determined that the best indicators are those already monitored by informal networks of researchers and governments concerned with marine environmental quality and human health. Where informal networks are absent, journalists have historically reported the minimum information required to evaluate changes over time: e.g., what happened, where, and when.

Benjamin H. Sherman, HEED MD Program, Teaneck, New Jersey, USA

This presentation was an extended introduction to the concept of ecosystem health. Three papers related to the MMED Approach were delivered.

MMED Indicator Methodology and Applications

Data mining both peer review scientific publications and public media accounts of disturbance has been found an effective tool to develop lists of keywords associated with disturbances in a marine ecosystem. The keywords can in turn be used to survey source publications by time period and spatial area to determine whom has studied what and where and when logical gaps in monitoring effort exist. Data mining requires a central database and a geographic information system to conduct queries into co-occurring disturbance indicators. Because no single indicator measures precisely the same conditions even when sampled in the same general location and time period, disturbance causality can be teased apart by pattern analysis and reconstruction of time-series. Some indicators it has been found, serve as suitable proxies for each other and can reduce the need to monitor all parts of an ecosystem. Predictive models can be created with historical meta-data (regarding what, where, when) using neural network algorithms to determine if conditions are present for return occurrence – even if the disturbance forcing factors are unknown.

Multi-indicator Coastal and Marine Health Characterisation

The MMED approach has been shown in a partial global survey of all marine systems (Sherman 2000) to statistically associate thousands of different marine disturbance types into the following eight general types of ecosystem disturbance:

- Biotoxin/Exposure (e.g., toxic algae blooms, human gastroenteritis);
- Anoxic/Hypoxic (e.g., nuisance blooms, Baltic cod/hypoxia);
- Trophic Magnification (e.g., tainted shellfish, piscavore tumors);
- Mass Mortality (e.g., M74 Salmon aquaculture losses, flatfish mortalities);
- Climate Forcing (e.g., North Atlantic Oscillation and storm damage);

- Disease (e.g., herring lymphocystis, morbillivirus, phocine distemper virus);
- Novel and Invasive Disturbances (e.g., Ballast water discharge);
- Keystone and Chronic disturbances (e.g., colonial water bird mortality, seasonal eutrophication).

These eight disturbance types are indices integrating the research of tens of thousands of references in the pollution and ecosystem health supporting literature.

In Baltic assessments, biotoxin/exposure, mass mortalities, climate forcing, disease, and keystone chronic disturbances are deemed important. However, the research and management communities and policy makers have deemed anoxic/hypoxic conditions, invasive disturbances, fisheries and anthropogenic pollution, which have not yet been inventoried in the formative MMED work, as proof of the concept of ecosystem health parameters. Their semantic equivalents, nonetheless, integrate the thousands of data elements inherent in the eight objectively defined MMED disturbance types.

Brief history of the ecosystem health concept, some cautions, and recommendations in evaluating the extension of the concept

The International Society for Ecosystem Health began to formalize the ecosystem health concept between 1992 and 2002. The general consensus after ten years of debate is to drop definitions that dwell on extended metaphors and substantiate changes in condition using time series and indicators. Many governments have embraced the goal of large area multijurisdictional management and called that ecosystem management. Management questions and measures of success rely upon identifying sufficiently large disturbance forcing factors impacting the system. In the case of the U.S. Greater Yellowstone Ecosystem fire was identified. The International Joint Commission concerned with air-sheds (US and Canada) includes humans as part of the system. Recently groups like those in conservation medicine have developed cross training programs to get veterinarians and public health specialists to share epidemiological techniques and apply them jointly to marine ecosystem problems. Marine epidemiology as a consequence offers a forum for the exploration of both chemical contamination and natural ecological impacts upon species. Importantly, public health and economic motivations are the primary drivers for environmental or ecological decisions so it is expedient to include these variables in any study. **One missing element in the 1st SGEH was the lack of public health representation (hence no indicators were offered). To effectively address the concept of Baltic marine ecosystem health, human epidemiology should be included as humans are the best and if not the best always the most compelling indicators of lapses in environmental quality.**

All of these papers presented views on how to implement the MMED approach in the Baltic Sea LME. The proposed MMED approach solicits keyword contributions from stakeholders and compiles meta-data regarding all types of disturbances related to the Baltic ecosystem and marine related human health. Initial success of the effort will come from 1) soliciting contributions from a sufficiently wide range of disciplines and sectors tracking disturbances associated with the marine environment 2) making sure the source material is geographically representative and historically worthy of survey 3) the SGEH group's ability extract meta-data from disturbance reports and then compile into a database the where, when, how, what information for later analysis. To begin, the SGEH will need to create a Baltic Sea bibliography, if not, reprint collection of disturbance reports. It is incumbent upon each SGEH member to provide the bibliography and reprints that will get this project started.

The SGEH meeting participants expressed a desire to invite Mr. Sherman to lead a group of selected experts to elaborate and develop the proposal for applying the MMED approach to the Baltic Sea region.

4 SCIENTIFIC ADVICE FOR ECOSYSTEM-BASED MANAGEMENT OF THE BALTIC SEA (TOR 3)

4.1 Ecological indicators (ToR 3i)

Indicators are an indispensable tool for management. A number of other international organisations and commissions, such as Baltic 21, EU-EEA, GIWA, HELCOM, OSPAR and WWF, began to expand the lists of indicators in order to be able to produce indicator-based assessments and provide them to decision makers. BSRP SGEH should contribute to these developments by proposing strategy for the development of an indictor set which could be adopted by the Baltic states.

Eugeniusz Andrulewicz, Sea Fisheries Institute, Gdynia, Poland
Strategy for developing environmental indicators for the Baltic Sea (Annex 6)

The aim of this paper was to contribute to the development of indicators as an indispensable tool for the marine environmental assessment and the management of the Baltic Sea. It proposes a step-by-step approach to achieve the full D-P-S-I-R framework of indicators beginning with State-Impact (S-I) indicators, which should be developed by an "environmental group" of experts, and Driving force-Pressure (D-P) indicators, which should be developed in "socio-economic" groups of experts. These two developments should be merged in a joint group of experts to elaborate the full D-P-S-I-R framework including societal and governmental "Response" (R) indicators.

Illustrative examples of indicators include eutrophication, chemical contamination, fishing, oil pollution, invasion of non-indigenous species, sanitary conditions of coastal waters, dumping of dredge spoils, extraction of sand and gravel, offshore oil and gas production and contamination by artificial radionuclides.

Marek Maciejowski, General Secretary of Baltic 21, Stockholm, Sweden
A new perspective of Baltic21

This presentation on the work of Baltic 21 focused on sustainable development of the Baltic Region. Within baltic 21 the three dimensions of sustainable development are addressed, namely environmental, social and economic aspects. The focus is on eight sectors of crucial importance to sustainable development in the Baltic Sea Region: Agriculture, Energy, Fisheries, Forests, Industry, Tourism, Transport and Education as well as on Spatial Planning. Baltic 21 develops periodic reports based on 111 sustainable development indicators (both sector and overall), in which it assesses the region's progress toward agreed sustainable development goals. Mr Maciejowski stressed the importance and relevance of the BSRP to Baltic 21. Especially the indicator work planned for by this Study Group is of relevance to the indicator work of Baltic 21. Therefore, synergy should be sought wherever possible between these two. Mr. Maciejowski also provided the participants with publications and informational materials - Newsletters 2003, Baltic 21 Report 2000-2002: Towards Sustainable Development in the Baltic Sea Region, and a compact disk entitled "An Agenda 21 for the Baltic Sea Region".

Zita Gasiunaite, Coastal Research and Planning Institute, Klaipeda University, Lithuania
Indicators of Ecosystem Health – possible links with the ongoing EU

This paper by Zita Gasiunaite, Sergej Olenin and Arturas Razinkovas presented work that is currently under development within the EU project on the Characterisation of Baltic Sea Ecosystem: Dynamics and Function of Coastal Types.

4.2 Nature conservation measures and biodiversity (ToR 3ii)

Nature conservation issues regarding the Baltic Sea were not discussed during the meeting due to the lack of time and expertise, but the Chair stressed the need to address them at the next SGEH meeting. This is particularly important with regard to the need of preparing protection and management plans for 62 coastal Baltic Sea Protected Areas (HELCOM BSPA) and 24 proposed offshore HELCOM BSPAs. This work should be closely linked to the European Union network for the protection of European fauna and flora, so-called NATURA 2000. Associated protective measures should also be discussed in light of the recent proposal of the Baltic Sea countries (excluding Russia) to designate the Baltic Sea area as a Particularly Sensitive Sea Area (PSSA).

Important aspects of biodiversity, namely lists of endangered and declining Baltic Sea species were not discussed either. These issues are extremely important for the environmental management of the region and should be discussed at the next SGEH meeting.

Jan Marcin Weslawski, Institute of Oceanology Polish Academy of Sciences, Sopot, Poland
Biodiversity as a tool in the assessment the health of the Sea

The ideas presented in this paper were based on discussions held by the author and some other participants of the meeting during international meetings and seminars of the Biodiversity Feasibility Study Group ESF 1997–1998, BIOMARE project of the EU Fifth Framework Programme (FP5), MARBENA FP5, MARBEF FP5 and SCOPE Sediments Study Group 1998–2002. Biodiversity was measured and defined separately as:

1) species richness;
2) species turnover;
3) habitat heterogeneity can be used as a complex tool for the assessment of biological effects of the health of the ecosystem.

Over 300 papers have been published recently regarding bioindicators of biodiversity, but most of them focus on insects and birds in tropical areas. In marine sciences, the idea of using Peracarida (a higher crustacean) as a bioindicator for marine macrobenthos biodiversity is under consideration. These are large, conspicuous species, which are widely known, relatively easily identifiable brooders.

There are also multi-species indicators of environmental health like log normal distribution, Caswell's neutral mode, the ratio of pollution-sensitive to pollution-insensitive taxa and phylum level meta analysis. All of them have strong and weak points and require further testing under natural conditions.

Thus far, there is a general lack of confirmed, functional links between the functioning of natural ecosystems and their biodiversity level.

The Co-operative Baltic Monitoring Programme (COMBINE) should extend its scope of work to include the monitoring of plant and animal communities, such as vascular plants and macroalgae, sea mammals and avifauna. The meeting participants learned that HELCOM HABITAT decided in 2002 to conduct a pilot project to evaluate the available data and draw conclusions on necessary follow-up activities. DHI Water & Environment in Denmark is coordinating the pilot project and submitted a progress report to HELCOM HABITAT in 2003 regarding the status of ongoing monitoring programmes and trends in waterbird breeding and wintering and data on beached oiled waterbirds in the Baltic. A proposal for the monitoring of avifauna was available at the meeting from

Henrik Skov, DHI Water and Environment, Hørsholm
The HELCOM Waterbird Monitoring Plan (Annex 7)

The participants expressed the opinion that this paper should be considered within the revised HELCOM COMBINE. The following recommendations concerning bird monitoring and birds as indicators of healthy systems were formulated:

- waterbirds are excellent ecosystem indicators as the top predators in the trophodynamic chain in the Baltic sea, they provide information about ecosystem health;
- waterbirds, especially those which live and breed in sea coastal areas, are an attractive subject for the education of society regarding biodiversity and species protection;
- the Baltic Sea region is inhabited by bird populations which are partially protected by the Bern and Bonn conventions;
- it is necessary to enlarge key bird monitoring areas – like Latvian birds surveys on beaches during winter and data collection from ships of opportunity (defence vessels);
- bycatch phenomena monitoring should be included as one of the tasks of fishery.

5 WORKPLAN FOR POTENTIAL CONTRIBUTIONS TO ICES (TOR 4)

Although there is much room for scientific papers that address major Baltic concerns, the need remains for conceptual papers on Baltic Ecosystem Health, particularly in relation to ecological indicators, quality references, EcoQOs and MMEDs. Participants were encouraged to submit contributions to the ICES ASC 2004 (Vigo, Spain), and, in particular, to the 2006 Theme Session on Regional Integrated Assessment. Nevertheless, there have been no clear proposals for the 2004 ICES ASC, as yet.

6 STRATEGY FOR THE DEVELOPMENT OF HABITAT CLASSIFICATION AND HABITAT MAPS FOR THE BALTIC SEA (TOR 5)

No experts on marine habitat mapping attended the first SGEH meeting. This issue will be considered by the SGEH at later stages. The SGEH Chair, in cooperation with the Project Co-ordinator and the Project Assistant, will contact the Chair of the ICES Working Group on Marine Habitat Mapping (WGMHM) regarding the development of Baltic habitat classification issues and further discussions on the developments of habitat classification for the Baltic Sea. The most recent developments by ICES, EEA and HELCOM and those formulated at the national level should be taken into consideration and proposed at the next SGEH meeting. Information on the present status of habitat classification should be collected and further developments harmonised.

Sergej Olenin, Zita Gasiunaite, Arturas Razinkowas, Coastal Research and Planning Institute, Klaipeda University, Lithuania
Habitat classification and application of the EUNIS/HELCOM systems in Lithuania

The aim of this project, presented by Zita Gasiunaite, is to develop habitat classification in Lithuanian marine areas.
Characterisation of the Baltic Sea Ecosystem: Dynamics and Function of Coastal Types

Developments by Lithuanian experts (presented by Zita Gasiunaite) could serve as a good example of habitat classification in the Baltic Sea, although this has to be considered in combination with other proposals (EEA, ICES). Although meeting participants were aware of the HELCOM Developments on Red List of Marine and Coastal Biotopes and Biotope Complexes of the Baltic Sea, Belt Sea and Kattegat (HELCOM BSEP No. 75) and about national developments in Germany, Finland and Sweden, no updated information was available.

Lena Kautsky, Stockholm Marine Research Centre, and Department of Botany, Stockholm University, Sweden
The development of typology and Ecological Quality Ratios (EQR) for the biological parameter macrovegetation for Swedish coastal waters.

This presentation outlines the Swedish experience so far in developing a typology of Swedish coastal waters to meet the requirements of the EU Water Framework Directive (WFD 2000). A revised and further developed classification system adapted to the Water Framework Directive for EU and for the environmental goal in the Directive appendix V was presented. The Swedish Metrological Hydrological Institute, SMHI as been responsible for the work with dividing the Swedish coastal water into 23 types, each defined by a set of criteria, i.e., depth, salinity, water exchange , stratification and number of ice days. The last factor is not obligatory.

The aim of the ongoing project is to develop a classification system, using an Ecological Quality Ratio (EQR) index constructed as the ratio between observed value/reference value. To do this values for reference conditions for shallow vegetated bottoms in each of the 23 types are needed. As far as possible historical data will be used if available, secondly correlations between the maximum distribution of macroalgae and Secchi depth and lastly if nothing else is available expert judgment.

In each of the 23 areas at least 5–6 perennial structurally important macroalgal and/or phanerogam species, occurring over a large part of the coastal areas were selected. Maximum depth occurrence of these species may be determined from different older investigations or from areas regarded as having reference conditions. At references conditions/high ecological status the maximum depth of the included species might be even higher than noted in old inventories. For very shallow where light is not limiting the depth distribution of vegetation the proportion of perennial/annual species will be used together with the % cover. Which species that are included in each type will depend on the salinity and wave exposure of the area, all factors used in defining the typology of the coastal waters. For areas where the amount of data have been sufficient, a classification of Ecological Quality Ratio values, divided into five classes – i.e., high, good, fair, poor, and bad – have been proposed following the criteria presented in the Water Framework Directive, appendix V. However, it should be pointed out that a set of environmental conditions need to be fulfilled to be able to use the suggested method and to calculate an EQR-value for an area/type using maximum depth of a selected number of benthic plant species. Those environmental conditions are:

- underwater profile must basically be placed on hard substrate
- depth of the profile must be larger than the depth of the reference condition of the actual species
- investigations should take place in July–September
- wave exposure needs to be moderate

To be able to develop the suggested classification system further it will be important to document presence and maximum depth and possibly also the maximum development of the belt of a large set of common perennial macroalgal and phanerogam species. Today we totally lack or have very limited data about the depth distribution of macrovegetation a very useful indicator of the ecological status and health of shallow coastal Baltic ecosystems specifically in relation to eutrophication. Thus, efforts should be put into improving the information about our knowledge of distribution and patterns in different types of macrovegetation as well as improving methods to monitor changes, e.g., by air photography and GIS.

7 RECOMMENDATIONS

1) The proposed location of the next SGEH meeting is Vilnius, Lithuania. The proposed date is to be set.
2) Develop the Baltic Ecosystem Health concept in relation to the main ecological problems of eutrophication, hazardous substances, overfishing, invasive species, biodiversity, and habitat destruction.
3) Initiate reference level/baseline work on a set of ecological quality (EcoQ) elements that reflect associated ecological quality objectives (EcoQOs), as follows:
   - Secchi depth or other proxy measure for light attenuation;
   - oxygen depletion in shallow waters;
   - phytobenthos (e.g., Bladder wrack – *Fucus vesiculosus*);
   - organic contaminant concentration (e.g., PCBs, DDts, TBT, dioxins, pesticides, algal toxins) in selected fish, shellfish and seabird eggs (bioaccumulation);
   - endocrine disruption (imposex, intersex, vitellogenin, embryo sex ratio, reproductive success, chromosomal aberrations in gonads);
   - biomarkers (AChE, MT, EROD, lysosomal stability, PAH metabolites, oxidative stress biomarkers);
   - changes in the size distribution of fish;
   - CPUE (catch-per-unit-effort) of non-assessed fish;
   - changes in fish community structure;
   - changes in abundance, biomass and distribution of native and alien species;
   - physical disturbance of the shoreline and coastal water zone (e.g., habitat destruction, nesting sites disturbed or disappearing, obstruction of migratory corridors, habitat fragmentation, shoreline disturbance, stagnation, turbidity).
4) Develop a Baltic MMED indicator system with the support of NOAA.
5) Review the COMBINE Programme, including methodology, especially coastal fish monitoring in cooperation with HELCOM MON-PRO including workshops already set by HELCOM MONAS 6/2003.
6) Evaluate the value of large projects being conducted in the Baltic Sea area, e.g., CHARM, BEEP, which deal with ecosystem health issues.

8 CLOSING OF THE MEETING

The Chair closed the meeting at noon on 12 November 2003 and wished everyone a safe journey home.

Recommended papers and reports

Anon. 1998. Workshop on the Ecosystem Approach to the Management and Protection of the North Sea. Oslo, Norway, 15–17 June ThemaNord 1998: 579, 100 pp.

Bergen Declaration 2002. Ministerial declaration of the fifth international conference on the protection of the North Sea. Bergen, Norway 20–21 March 2002.

Commission of the European Communities. 2002. Communication from the Commission to the Council and the European Parliament. Towards a strategy to protect and conserve the marine environment. COM (2002) 539 final.

Costanza, R., B. Norton, B. Haskell (eds.) 1992. Ecosystem Health: New Goals for Environmental Management. Island Press, Washington, D.C.

EEA 1999a. EEA Technical Report, No. 17. Integration of information on Europe's marine environment. Ed. By T. Bokn and H.R. Skjoldal. pp. 41.

HELCOM Ministerial Declaration (HELCOM Bremen declaration) adopted on 25 June 2003 in Bremen by the HELCOM Ministerial Meeting.

ICES 1999. Developing ICES ecosystem advice test case – Baltic and North Seas. ACME June 1999.

ICES 2000. Report of the Study Group on the Scientific Basis for Ecosystem (SGBEAB).

ICES. 2001. Report of the ICES Advisory Committee on Ecosystems, 2001. ICES Cooperative Research Report, 249: 15–59.

ICES. 2002. Report of the ICES Advisory Committee on Ecosystems, 2002. ICES Cooperative Research Report, 254: 60–77.

ICES. 2003. Report of the ICES Advisory Committee on Ecosystems, 2003. ICES Cooperative Research Report, 262: 40–116.

ICES 2000. Report of the ICES Working Group on Ecosystem Effects of Fishing Activities.

ICES CM 2000/ACME:02.

ICES 2000. ICES Study Group Report: Ecosystem Assessment and Monitoring ICES 2000/E:09.

ICES-ACMP 1991. ICES Co-operative Research Report No. 177.

ICES-ACMP 1992. ICES Co-operative Research Report No. 190. pp. 2.

Ojaveer, H. 2002. Environmental impacts on fish and ecosystem effects of fishing in the Baltic Sea. Estonian Marine Institute Report Series No.11, Tallinn.

Ojaveer, E. and Elken, J. 1997. On regional subunits in the ecosystem of the Baltic Sea. In: (E. Ojaveer, editor) Proceedings of the 14th Baltic Marine Biologists Symposium, Pärnu, Estonia, 5–8 August, 1995. Estonian Academy Publishers, Tallinn, pp. 156–169.

Poutanen, E., Valanko, S., Leppänen, J. 2003. Pilot Study into the Development of a road map for the establishment of ecological quality objectives (EcoQOs) within HELCOM for the Baltic Sea. Final report, in collaboration with HELCOM-MONAS and the Ministry of the Environment Finland.

Rice, J. 2000. Evaluating fishery impacts using metrics of community structure. ICES Journal of Marine Science, 57: 682–688.

Rice, J. 2003. Environmental health indicators. Ocean and coastal management, 46: 235–259.

Skjoldal, H.R. 1998. Overview report on Ecological Quality (EcoQ) and Ecological Quality Objectives (EcoQOs). Institute of Marine Research, Bergen, Norway.

Valanko S. A Pilot Study into the development of a road map for the establishment of ecological quality objectives (EcoQOs) within HELCOM for the Baltic Sea. HELCOM-MONAS, doc. 5.5 6/2003.

9 ANNEXES

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Annex 2 Agenda

1. Welcome
2. Introduction to Ecosystem Health module: aims and objectives
3. Review of participant's scientific activities relevant to BSRP SGEH
4. Review of developments regarding ecosystem-based approaches to the monitoring, assessment and management of fisheries and the marine environment
5. The development and application of a system of ecological indicators and related reference points reflecting the objectives, constraints and state of key elements of the ecosystem
6. The development of ecological quality objectives(EcoQOs) for the Baltic ecosystem
7. The application of appropriate conservation measures necessary to protect threatened or vulnerable species and habitats
8. Strategy for implementing the development of a habitat classification framework and habitat maps for the Baltic Sea
9. Status of development of list of sensitive and endangered species
10. Development of Baltic concept of Multiple Marine Environmental Disturbances (MMED)
11. Potential contributions to 2006 ICES Theme Session on Regional Integrated Assessments in relation to the human dimension
12. Preparation of a workplan for description of human dimensions related to integrated ecosystem assessment
13. SGEH Terms of References proposed for the next meeting/recommendations
14. Next meeting
15. Any other business

Annex 3 The use of Biomarkers for the Ecosystem Health Assessment of the Baltic Sea

Kari Lehtonen, Finnish Institute of Marine Research

In marine coastal ecosystems, measuring the concentrations of certain pollutants in sediments, water and biota may give information regarding their level and distribution patterns but still there is no information on their biological effects. Without this information the evaluation of “safe” pollutant concentrations in the environment is, with current knowledge, practically impossible. Therefore, it is rational to study the effects of environmental pollutants at molecular, cell, tissue as well physiological functions levels where the adaptive or toxic responses occur and are rapidly displayed.

In the Baltic Sea, eutrophication has been classified as the greatest threat to the marine environment. The studies and monitoring of pollutants and, particularly, their effects have received much less attention. According to the prevailing view, eutrophication usually masks the effects of pollution. This belief may remain valid if one uses indicators that are related to changes observed at population or community levels where they can usually be directly related to increased concentrations of nutrients and the resulting pathways of biological processes.

However, there exists a large suite of methods developed to indicate biological effects of pollutants, some of which are general stress indicators and some indicate exposure to specific groups of pollutants. Examining the health of organisms has many advantages. Physiological effects of environmental pollutants are often rapidly manifested, and the observations on disturbances during a health check may be quickly used to direct more detailed chemical analytical work to the potential problem area. Although many of the effects of toxins are reversible, causing no permanent damage to the organisms or reduce their fitness or reproductive capacity, a great number of them do have potential links to genotoxicity, diseases and reproductive disorders which are features that may strongly affect populations and communities. The current concept for developing Ecological Quality Objectives (EcoQOs) criteria for the Baltic Sea, aiming at assessing environmental health in an integrative mode, lacks such an approach - looking at the health of organisms that form the ecosystem and resolving which factors are causing the problems.

Bioavailability of different chemical compounds varies remarkably under different environmental conditions, depending on, e.g., oxygen level, pH, temperature, and, naturally, also on the specific biological characteristics of the organism itself. Eventually, the stress syndrome is an integrated response of an organism to various factors. It should be recognised that similar environmental levels of specific pollutants may cause different effects in organisms, depending on forcing exhibited by other relevant factors in the environments in question.

Toxic concentrations established in the laboratory seldom realistically reflect the effects under natural conditions, where the response of the organism consists of the integrated effects of all stress factors. The presently assumed risk assessment approach, i.e., concluding from laboratory toxicity data obtained with one contaminant on safety limits in the environment, is bound to be invalid because of the presence of a mixture of various pollutants, in addition to all other natural stress factors. Seasonal variability influences the exposure of marine organisms to pollutants, e.g., even temporal oxygen deficiency may lead to the release of various sediment-bound pollutants and increases exposure. In spring, an increase in riverine runoff elevates the concentrations of pesticides and herbicides used in agriculture. Furthermore, the behaviour of organisms is dependent on, e.g., seasonal variability in temperature, nutritional conditions and reproductive cycle.

The EU Water Framework Directive requires the application of biological effects methods over chemistry-based ones in the monitoring of the state of marine coastal ecosystems. This has generally been interpreted as methods that describe changes at population or community levels, measured as changes in abundance and biomass of species, and interspecies relations. To apply successfully this approach, requires (1) time series long enough to catch the natural internal fluctuations often occurring in populations, as well as (2) “undisturbed” reference areas. Of these, the former takes a considerable period of time to be obtained, while the identification of the latter in the Baltic Sea has been proven to be a difficult and even an unrealistic task. Even if the monitoring strategy described above would eventually reveal some changes in populations or communities, it is rather doubtful that these changes could be attributed to specific factors with an acceptable degree of certainty. This is explicit in situations observed in most coastal marine environments where relatively low concentrations of various environmental pollutants affect organisms in concert with disadvantageous environmental factors.

Recommendations for the BSRP:

- The biomarker approach should be implemented to the BSRP.
- Results, experiences and deliverables (database, SOPs, recommendations, network) obtained from the EU project BEEP (especially the WP related to Baltic Sea Biomonitoring) should be taken advantage of when planning the detailed implementation of biomarkers to the BSRP.
- As a preliminary suggestion, the so-called core biomarkers of the BEEP project (acetylcholinesterase inhibition, metallothionein induction, lysosomal stability, EROD activity and PAH metabolites in fish bile) could be adopted by the BSRP. In addition, methods of which previous experience in some Eastern Baltic Sea laboratories already exists (e.g., genotoxicity biomarkers, glutathione-S-transferase, catalase, etc.) could be implemented.
- A clarification in the aims of the biological effects monitoring should be made, i.e., to use “early warning” and “higher level” biomarkers (i.e., reproductive disorders).
- The dissemination of selected biomarker methods to Eastern Baltic Sea laboratories by consultant Western expert laboratories should be a target.
- Active cooperation between the Eastern and Western laboratories should be established through BSRP to (1) launch a common project for the further validation of biomarkers in the Baltic Sea area, and (2) harmonise a common biological effects monitoring strategy in the future.

Annex 4 Studies on diseases and parasites of Baltic fish as part of an ecosystem-based approach to the assessment and management of the environment and the fisheries in the Baltic Sea

Thomas Lang, Federal Research Centre for Fishery, Germany

Introduction

When discussing environmental indicators to be incorporated into ecosystem health programmes aiming at an assessment of the state of the marine environment of the Baltic Sea, it is very obvious that the health status of the marine organisms inhabiting the ecosystem under study is being considered in this context.

If this environmental assessment is part of a more generic ecosystem-based approach, integrating the assessment, monitoring and management of the environment and the fishery, it is further obvious that it would be advisable to use target organisms for such studies that are both of ecological and economical significance. For the Baltic Sea, some fish species are appropriate candidates that are abundant, have a wide-spread geographical distribution, and that are fished regularly (also in fish stock assessment surveys): cod (*Gadus morhua*), flounder (*Platichthys flesus*), herring (*Clupea harengus*) and sprat (*Sprattus sprattus*).

The usefulness of studies of fish diseases in environmental monitoring has intensively been discussed in fora such as ICES for decades. Today there is general consensus that studies of fish diseases may provide information on the occurrence of environmental stress and are, therefore, considered as an important component of national and international monitoring programmes. One of the major advantages fish disease surveys offer is that diseases are ecologically (some even economically) relevant and integrative endpoints of chronic exposure to stressors including contaminants (Lang, 2002). Some more strengths of fish disease monitoring are given in Table 1.

In the following, a brief overview is provided on present and past activities carried out in the Baltic Sea that are related to the above strategic considerations. The role of ICES and BMB as initiators and coordinators is highlighted. Some current data are presented and a few suggestions are made for future activities within the framework of the BSRP ecosystem health module.

Fish disease monitoring in the Baltic Sea

The regular and systematic monitoring of diseases and parasites of Baltic fish started in the late 1970s. Depending on the availability of funding and experts, most of the Baltic Sea countries have been carrying out more or less regular fish disease surveys (Lang 2002). At present, most activities are being done by Germany and Poland and cover large parts of the southern Baltic Sea.

Methodologies applied in fish disease surveys in the Baltic Sea have been developed by the ICES Working Group on Pathology and Diseases of Marine Organisms (WGPDMO, present Chair: T. Lang) and have been intercalibrated repeatedly between institutes involved. Two sea-going workshops were organised, the first one under the auspices of the Baltic Marine Biologists (BMB) Working Group 25 'Fish Disease and Parasites in the Baltic', held in 1991 on board RV ‘Alkor’. The second one took place in 1994 on board RV 'Walther Herwig III' under the co-sponsorship of BMB and ICES (Lang and Mellergaard, 1999). Based on the objectives of these practical workshops, baseline data on the prevalence and spatial distribution of diseases and parasites of cod, flounder, herring and sprat have been obtained and standardised methodologies have been established. Another milestone was the BMB Symposium “Diseases and Parasites of flounder (*Platichthys flesus*) in the Baltic Sea” held in Turku, Finland, in 1994 (Bylund and Lönnstrom, 1994)

At its annual meetings, the ICES WGPDMO regularly reviews new information on disease trends in Baltic Sea fish submitted by Baltic Sea countries as part of their national reports. Disease prevalence data generated based on the standardised ICES methodology are submitted by ICES Member Countries to the fish disease databank of the ICES Marine Data Centre and standard operating procedures for data submission, validation and statistical analysis have been developed by ICES WGPDMO in close collaboration with the ICES Secretariat (Wosniok *et al*., 1999; Lang and Wosniok, 2000).

Information on diseases and parasites of Baltic fish have been incorporated in the HELCOM Period Assessments of the State of the Marine Environment of the Baltic Sea (HELCOM, 1996, 2002) and are part of the present EU-funded project 'Biological Effects of Environmental Pollution in Marine Coastal Ecosystems, BEEP'

Diseases and parasites of Baltic fish monitored on a regular basis

Most fish disease surveys in the Baltic Sea are focused on cod and flounder, which are, based on the experience made in long-term monitoring, the most appropriate species for large-scale monitoring in the Baltic Sea. In addition, data from regular monitoring is available on diseases and parasites of dab (*Limanda limanda*; available only in the western Baltic Sea), herring and sprat. It has to be mentioned here that studies have also been carried out on diseases and parasites of other Baltic fish species, which, however, were more research-oriented and restricted to smaller geographical regions and shorter time periods (HELCOM 1996).

In most cases, the regular surveys are focused on the inspection of fish for grossly and externally visible infectious and non-infectious diseases and parasites. Exceptions are the surveys for the occurrence of neoplastic liver lesions in flatfish species and of *Ichthyophonus hoferi* in herring (see Table 2). While some of the diseases/parasites were recommended by ICES for fish disease surveys, others were added to the national programmes in additions because of their prevalence and relevance. The selection of diseases is largely based either on the known or suspected responsiveness of the diseases/parasites to environmental factors (including pollution) (e.g., neoplastic liver lesions) or on their potential impact on fish stocks (e.g., skin ulcerations in cod, *Ichthyophonus* in herring).

In recent years, fish diseases studies were extended to studies on liver histopathology, encompassing a quantification of early and late neoplastic and non-neoplastic liver lesions (Feist *et al.*, in press).

Some current results from the German fish disease monitoring in the Baltic Sea

Systematic fish disease surveys started in Germany in the early 1980s. Since that time, annual winter surveys have been carried out in the south-western Baltic Sea from Kiel Bight to the Gdansk Deep. Since 1999, surveys have also been extended to cover a period in late summer.

In Tables 3 and 4, current data on disease prevalence in cod (Table 1) and flounder (Table 2) are provided obtained in a fish disease survey carried out in December 2002 as part of the regular German fish disease monitoring programme. The location of sampling sites can be seen in Figure 1. BEEP locations were sampled as part of the EU-funded project BEEP (to be detailed by SGEH member Kari Lehtonen, Finland).

From the tables, there is evidence that for both fish species marked spatial variation in the disease prevalence were recorded. These spatial patterns correspond well with previous long-term data and indicate a significant difference between areas regarding the environmental conditions having an impact on the diseases and parasite occurrence. From previous studies (e.g., Lang *et al.*, 1999; Mellergaard and Lang, 1999) there is evidence that the variation in prevalence is partly due to differences in the fish stock composition (e.g., as regards size, age, and gender ratio). However, there still are significant sampling site effects that cannot be attributed to host-specific factors.

The data furthermore reveal that some of the diseases occur at markedly high prevalence. This is particularly the case for acute/healing skin ulcerations in cod, a disease that seriously affects the general condition of the fish and is likely to be lethal if larger areas of the body surface of the fish are affected. Because of these characteristics and because of the fact that cod continuous to be the most significant Baltic fish species in terms of its economical importance, this diseases and its impact on the cod stock and fishery are certainly worth to be continuously monitored.

Suggestions for future activities as part of the remits of BSRP

- Enhance coordinated fish disease monitoring carried out by Baltic countries.
- Combine fish disease monitoring with monitoring of biological effects of contaminants (biomarker approach) (if feasible, ideally also with fish stock assessment surveys)
- Intensify intercalibration between Baltic institutes by organising joint sea-going workshops (this can be done on board the German RV "Walther Herwig III" in December 2004. **SGEH: Please regard this as a sincere invitation!**).
- Combine and statistically analyse data from long-term fish disease surveys (cod, flounder) with stock assessment and reproduction data in order to increase knowledge on effects of diseases on fish stocks and effects of fish stock performance on diseases (particularly for infectious diseases).
- Enhance integrated assessment by utilising data from various sources (hydrography, geography, contaminants, diseases/parasites, biomarkers, fish stock parameter, biodiversity etc.) In this context, the ICES Marine Data Centre plays a crucial role and can be utilised to a great extent.

Literature cited

Bylund, G., and Lönnström, L.-G. (eds.). 1994. Proceedings from Diseases and Parasites of Flounder (*Platichthys flesus*) in the Baltic Sea, 27–29 October, 1994, BioCity, Åbo Akademi University Turku/Abo, Finland, BMB Publication No. 15, 147 pp.

Feist, S.W., Lang, T., Stentiford, G., and Köhler, A. 2003. The use of liver pathology of flatfish for monitoring biological effects of contaminants. ICES Techniques in Marine Environmental Sciences, in press.

HELCOM. 1996. Third Periodic Assessment of the State of the Marine Environment of the Baltic Sea, 1989–1993. Balt. Sea Environ. Proc. No. 64, 252 pp.

HELCOM. 2002. Environment of the Baltic Sea Area 1994–1998. Balt. Sea Environ. Proc. No. 82B, 215 pp.

Lang, T. 2000. Diseases and parasites of Baltic fish. In: ICES 2000, Report of the ICES Advisory Committee on the Marine Environment, 2000. ICES Cooperative Research Report, 241: 201–213.

Lang, T. 2002. Fish disease surveys in environmental monitoring: the role of ICES. ICES Marine Science Symposia, 215: 202–212.

Lang, T., and Mellergaard, S. 1999. The BMB/ICES Sea-Going Workshop. Fish Diseases and Parasites in the Baltic Sea – introduction and conclusions. ICES Journal of Marine Science, 56: 129–133.

Lang, T., and Wosniok, W. 2000. ICES data for a holistic analysis of fish disease prevalence. *In* ICES 2000, Report of the ICES Advisory Committee on the Marine Environment, 1999. ICES Cooperative Research Report, 239: 193–209.

Lang, T., Mellergaard, S., Wosniok, W., Kadakas, V., and Neumann, K. 1999. Spatial distribution of grossly visible diseases and parasites in flounder (*Platichthys flesus*) from the Baltic Sea: a synoptic study. ICES Journal of Marine Science 56: 138–147.

Mellergaard, S., Lang, T. 1999. Diseases and parasites of Baltic cod (*Gadus morhua*) from the Mecklenburg Bight to the Estonian coast. ICES Journal of Marine Science, 56: 164–168.

Wosniok, W., Lang, T., Vethaak, A.D., des Clers, S., Mellergaard, S. (1999). Statistical analysis of fish disease prevalence data from the ICES Environmental Data Centre. In: ICES 1999, Report of the ICES Advisory Committee on the Marine Environment 1998, ICES Coop. Res. Rep. 233: 297–327.

Table 1. Some strengths of fish disease monitoring (Lang, 2002)

- Diseases are an overt and integrative biological endpoint of physiological changes at different levels of biological organisation affecting the organism’s homeostasis that are associated with environmental change.
- In concert with more specific early-warning biological effects techniques, e.g., biomarkers of contaminant exposure and contaminant-induced damage, fish diseases can be used more specifically as indicator of effects of contaminants.
- Significant changes in disease prevalence are a biologically and ecologically relevant warning sign for adverse environmental changes, since diseases may affect growth, reproduction, and survival of affected individuals and may, therefore, have implications on the population level.
- Data on the prevalence and spatial distribution of diseases (including parasites) of commercial fish species are of direct use for quality controls of fish as food resource for human consumption.
- Fish disease monitoring is cost-effective since it can be carried out directly on board research or even commercial vessels, possibly in combination with stock assessment surveys, without involving subsequent laboratory work (except histopathology).
- Externally visible target diseases identified are, with a certain degree of training, easy to recognise.
- A large number of fish and large geographical areas can be screened and results are immediately available.
- Methodologies for fish disease surveys have been established and repeatedly intercalibrated.
- Standard procedures for data submission and validation, statistical analysis, and data presentation have recently been developed by ICES.
- A large ICES database with long-term fish disease data from the North Sea and adjacent areas submitted by ICES Member Countries has been built up and can be used as baseline information for future monitoring programmes.

Table 2. Diseases and parasites commonly monitored in Baltic fish species.

Fish species	**Disease/parasite**	**Remarks**	**Recommended by ICES for fish disease surveys**
Cod (*Gadus morhua*)	Acute/healing skin ulcerations	Bacterial disease	+
	Skeletal deformities	Various causes	+
	Fin rot/erosion	Bacterial disease	-
	Pseudobranchial swelling (X cell disease)	Likely to be caused by parasites	+
	Lernaeocera branchialis	Parasite (copepode)	-
	Cryptocotyle lingua	Parasite (Digenea)	+
Flounder (*Platichthys flesus*)	Lymphocystis	Viral disease	+
	Acute/healing skin ulcerations	(See above)	+
	Fin rot/erosion	(See above)	-
	Skeletal deformities	(See above)	-
	Cryptocotyle sp.	(See above)	-
	Hyperpigmentation	Causes yet unknown	-
	Neoplastic liver lesions (tumours)	Likely to be caused by carcinogenic contaminants	+
Herring (*Clupea harengus*)	Lymphocystis	(See above)	-
	Acute/healing skin ulcerations	(See above)	-
	Skeletal deformities	(See above)	-
	Ichthyophonus hoferi	Parasite (Fungi)	-
Sprat (*Sprattus sprattus*)	Lymphocystis	(See above)	-
	Acute/healing skin ulcerations	(See above)	-
	Skeletal deformities	(See above)	-
Dab (*Limanda limanda*)	Lymphocystis	(See above)	+
	Epidermal hyperplasia/papilloma	(See above)	+
	Acute/healing skin ulcerations	(See above)	+
	Fin rot/erosion	(See above)	-
	Skeletal deformities	(See above)	-
	Hyperpigmentation	(See above)	+
	Neoplastic liver lesions (tumours)	(See above)	+

Table 3. Prevalence of grossly visible diseases of Baltic cod (*Gauds morgue*) recorded in December 2002.

(N ex.: Number examined; Ulf.: Acute/healing skin ulcerations; Scalded.: Skeletal deformities; PBT: Pseudobranchial swelling (X-cell-disease); Locera: *Lernaeocera branchialis*; Cryp.: *Cryptocotyle lingua*

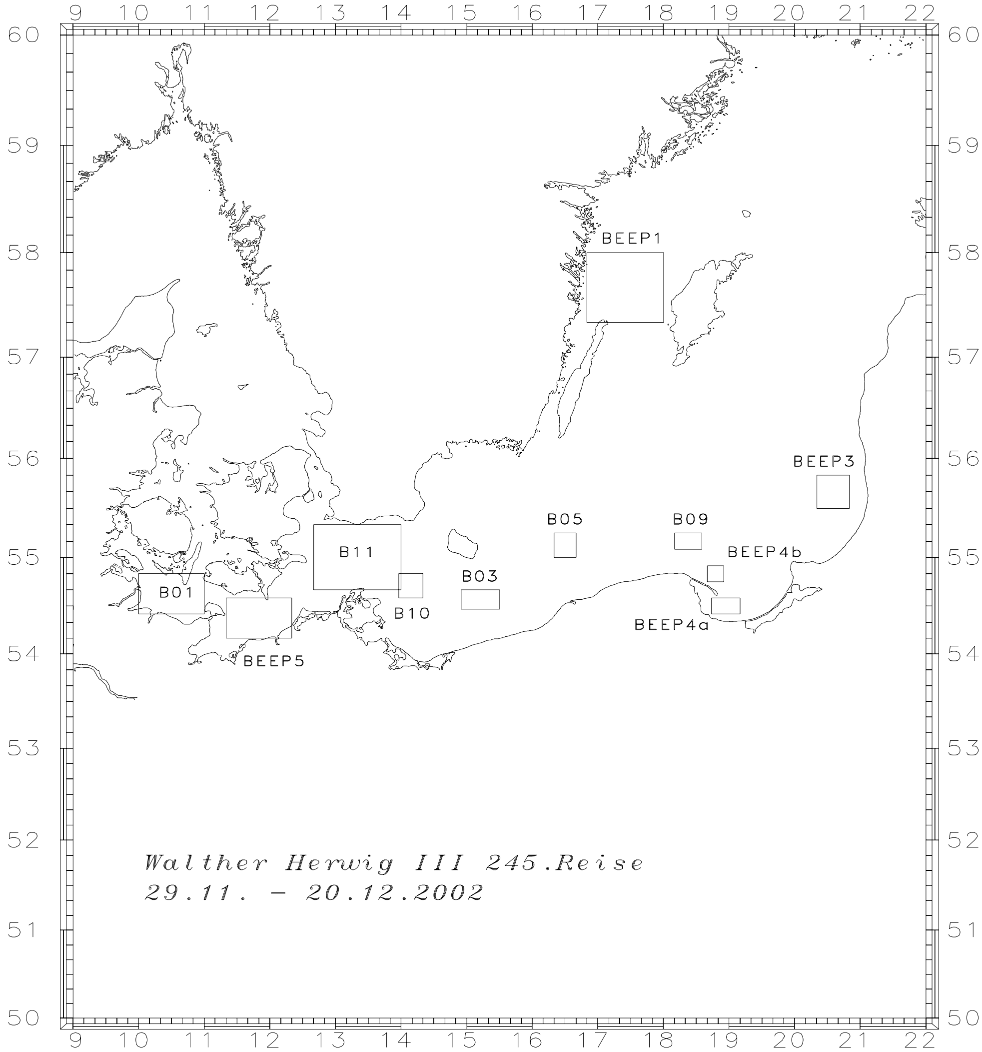
Area	N ex.	Prevalence (%)				
		Ulc.	Skel. Def.	PBT	Locera	Cryp
B01	101	5,0	4,0	0,0	4,0	86,1
BEEP 5	356	3,9	3,7	0,6	0,8	82,9
B11	727	5,1	2,8	0,1	0,8	12,0
B10	846	4,3	3,9	0,1	0,1	7,9
B03	534	12,4	4,7	0,0	0,0	0,6
B05	717	7,8	1,8	0,0	0,0	3,8
BEEP 1	18	16,7	0,0	0,0	0,0	0,0
B09	742	16,6	2,4	0,0	0,0	0,8
BEEP 4a	182	36,3	8,8	0,0	0,0	0,5
BEEP 4b	605	26,3	5,5	0,0	0,0	0,7
BEEP 3	421	5,0	1,7	0,0	0,0	3,1

Table 4. Prevalence of grossly visible diseases of Baltic flounder (*Platichthys flesus*) recorded in December 2002.

(N ex.: number examined; Ly: Lymphocystis; Ulc. Acute/healing skin ulcerations; Skel.Def.: skeletal deformities; Hyp.Pig: Hyperpigmentation; LN > 2: Liver nodules (tumours) > 2 mm)

Area	N ex.	Prevalence (%)					
		Ly	Ulc.	Fin Rot	Skel. Def.	Hyp. Pig.	LN > 2
B01	8	25,0	12,5	0,0	0,0	0,0	0,0
BEEP 5	57	17,5	0,0	0,0	1,8	0,0	0,0
B11	436	23,2	0,9	0,2	0,5	0,2	0,0
B10	433	15,5	1,2	0,0	0,0	0,0	0,0
B03	165	18,2	0,6	0,6	0,6	0,0	0,6
B05	24	29,2	0,0	4,2	4,2	0,0	0,0
BEEP 1	840	12,3	3,1	3,5	0,1	2,3	0,0
B09	2	0,0	0,0	0,0	0,0	0,0	0,0
BEEP 4a	115	16,5	7,0	0,0	1,7	0,0	0,0
BEEP 4b	36	16,7	8,3	0,0	0,0	0,0	0,0
BEEP 3	177	23,7	9,6	0,0	0,6	0,6	0,0

Figure 1.



Location of sampling sites for fish disease monitoring in December 2002.

Annex 5 A Pilot Study into the Development of a Road Map for the Establishment of Ecological Quality Objectives (EcoQOs) within HELCOM for the Baltic Sea

Sebastian Valanko, EcoQO Project Assistant, HELCOM

Introduction

A step toward the implementation of a regional Baltic Sea specific ecosystem approach to the management of human activity was made at the Joint OSPAR and HELCOM Ministerial Meeting in June 2003, where it was agreed that the ecosystem approach and setting of ecological quality objectives (EcoQOs) are key to improving the protection of the North-East Atlantic and the Baltic Sea (Declaration of the First Joint Ministerial Meeting of the Helsinki and OSPAR Commissions, Bremen, 25–26 June 2003). It was recognised that the ecosystem structure, process, functions and interactions (relevant to the development of policies) must be considered together in order to ensure the sustainable use of the seas, and the balance of interests between different sectors. The ecosystem approach was recognized as a key principle to maintain and restore ecosystem health, integrity and services.

The ecosystem approach is commonly defined as "the comprehensive integrated management of human activities based on the best available scientific knowledge about the ecosystem and its dynamics, in order to identify and take action on influences which are critical to the health of marine ecosystems, thereby achieving sustainable use of ecosystem goods and services and maintenance of ecosystem integrity".

When ecosystem approach is discussed several other terms are also commonly used. The definitions, as agreed by the 5th North Sea Conference (Bergen Declaration 2002), are the following:

Ecological Quality (EcoQ) is "An overall expression of the structure and function of the marine ecosystem taking into account the biological community and natural physiographic, geographic and climatic factors as well as physical and chemical conditions including those resulting from human activities"

Ecological Quality Elements are the individual aspects of overall Ecological Quality.

Ecological Quality Objective (EcoQO) is the desired level of an ecological quality (EcoQ). Such a level may be set in relation to a reference level.

Understanding fully how the ecosystem functions is challenging, as it is a very complex and complicated issue. In order to be able to explain to the general public and to gain the necessary political and public support, it is important to keep the concept simple.

A management strategy based on the sustainable utilization of coastal and marine resources will have at its core reaching a set of EcoQOs in order to maintaining functional diversity and ecosystem integrity, i.e., the maintenance of system components, interactions among them and resultant dynamic behaviour of the system. By incorporating EcoQOs to the D-P-S-I-R framework (**D**riving force – **P**ressure - **S**tate – **I**mpact – **R**esponse) a set of environmental **I**mpacts and **S**tate changes (EcoQOs) can be identified. By working back through the D-P-S-I-R framework it will allow for an effective means to identify the environmental **P**ressures and related socioeconomic **D**rivers that need to be addressed by policy **R**esponse in order to achieve positive environmental impacts for society. It can further provide a means to link processes, composition, and functions with output of goods and services, allowing ultimately the assignment of monetary economic and/ or other value on reaching a set of EcoQOs.

For more detailed background material please refer to attached scientific document.*

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* Thesis: "*Establishment of ecological quality objectives (EcoQOs) for a regional ecosystem approach in the Baltic Sea*". Note that this attached document was not considered at the workshop and is the work of Mr. Sebastian Valanko.

Initial ecosystem roadmap for the Baltic Sea

Ecological quality can be used at different levels when defining environmental strategies and objectives:

- Strategic vision
- Strategic goals
- Ecological quality objectives
- Indicators
- Variables to be monitored

From the beginning it is important to formulate a commonly accepted vision. For this purpose there are already several Baltic and European agreements which could be used for common visions, inter alia:

- The Helsinki Convention: to restore and preserve the ecological balance of the Baltic Sea (Article 3 of the 1992 Convention),
- the EU Water Framework Directive: good status for all waters,
- the EU Habitats Directive: restore and maintain favourable conservation status, natural habitats and wild species,
- the European Marine Strategy: healthy seas and oceans and their ecosystems as well as a sustainable exploitation of their resources,
- the Swedish national quality objectives: a balanced marine environment, sustainable coastal areas and archipelagos, a non-toxic environment and zero eutrophication,
- the Finnish national Baltic Sea Programme: good ecological state of the Baltic Sea.
- The Johannesburg declaration requests to halt biodiversity decline by 2010.

Based on the above few examples the vision for the Baltic Sea could be formulated as

“A healthy and balanced Baltic marine ecosystem, where resources are exploited sustainably”.

To facilitate the process of delivering an ecosystem approach fundamental principles and strategic goals should be established. According to the Køge outcome principles are simple and clear “things we believe in” whereas strategic goals are what the ideal world would look like if the principles were all followed; “places we want to get to”.

The initial development and establishment of the ecosystem approach and the setting of EcoQOs require the logical development of a strategic roadmap that is based on a reasoned, holistic and multisectoral consideration of the problems associated with the state of the threats within the Baltic Sea area. Throughout this development cycle, one needs to be sufficiently inclusive of the interactive process between all stakeholders, especially between scientists and managers. The proposed roadmap (Figure 1) will serve as an initial diagrammatic simplification introducing the general process to be taken within the Baltic Sea. The elements that this roadmap emphasises are:

- characterized by simplicity;
- set out the principle route to be taken;
- broad and non-limiting.

In order to identify the issues that need to be addressed, two different processes can be employed, the ”top-down” process, where issues are identified by managers or policy makers, and the ”bottom-up” process, where essential components or issues are identified by scientists.

The top-down process leads to the establishment of EcoQOs in a relatively short time frame. Science can provide a bottom-up or the foundation for a management plan through the advancing of knowledge about ecosystem functioning and behaviour. Both of these processes also need to incorporate societal values and public perception when arriving at a consensus on the issues that need to be addressed to achieving improved ecosystem or simply maintaining a healthy ecosystem.

Arriving at a consensus, using both the top-down and bottom up process, on how human activity should be managed will allow for realistic management goals to be set. These goals can be considered as product of a ”socially desirable mix” of marine ecosystem states. Managing human activities will have as its primary goal to maintaining the ecosystem health[1] – which serves as the source to maintain the socio-economic activities that rely on the goods and services it provides.

Our aim is to consider the necessary steps for the regional implementation of this approach.

Regional diversity requires careful consideration to the specific needs of all stakeholders and our efforts to establish EcoQOs should reflect this. We cannot risk alienating key players within this regionally interlinked system. In order to have as wide as possible stakeholders understanding and participation (political ownership), we need to express EcoQOs in terms of a “public ecology”, where overall the public is aware of the aims, implementation, potential benefits, and the governance of marine conservation with regard to their anthropogenic activity.

Establishing EcoQO and deciding on management action will be the result of intense debate. If we only choose scientific certainty and political objectives as our criteria for EcoQOs it will risk alienating the public and many key stakeholders.

Simplification may risk scientific uncertainty, but we need to ask ourselves if we are willing to continue denying stakeholders the know-how to conserve our marine environment?

[1] or balances as in the Helsinki Convention: “…to restore and preserve the ecological balance of the Baltic Sea”

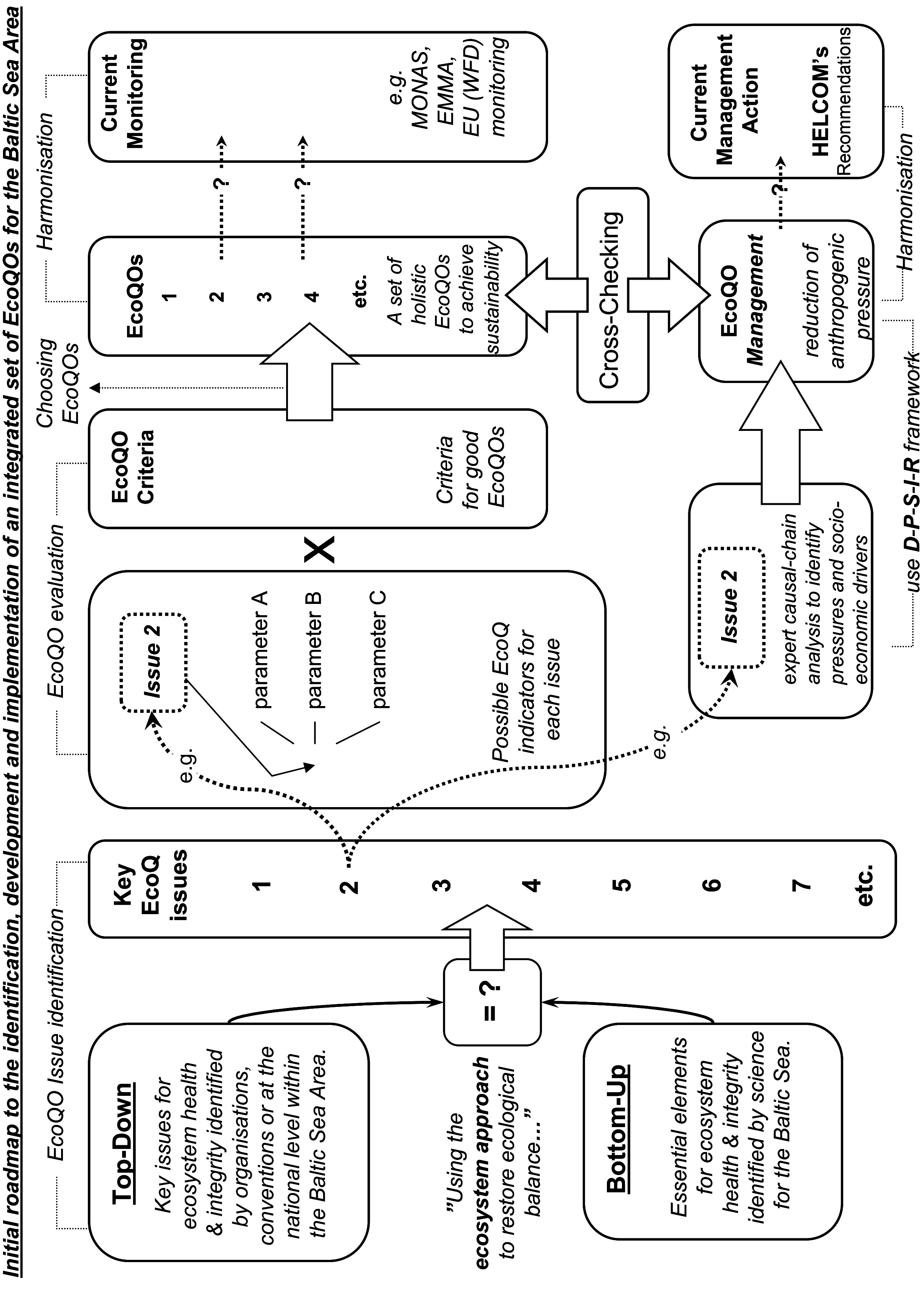

Figure 1. A roadmap showing the main route to be taken in the identification, development and implementation of an integrated set of EcoQOs for the Baltic Sea Area.

"Ideal" criteria for EcoQOs

According to the Report of the ICES Advisory Committee on Ecosystems, 2001, EcoQOs should be:

- relatively easy to understand by non-scientists and those who will decide on their use;
- sensitive to a manageable human activity;
- relatively tightly linked in time to that activity;
- easily and accurately measured, with a low error rate;
- responsive primarily to a human activity, with low responsiveness to other causes of change;
- measurable over a large proportion of the area to which the EcoQ element is to apply;
- based on an existing body or time series of data to allow a realistic setting of objectives.

In addition, an EcoQ element may:

- relate to a state of wider environmental conditions.

Note that these criteria reflect the ideal situation and all criteria may not be applicable in practise. Therefore the criteria that will be used for the Baltic Sea need to be discussed further.

Issues for Baltic EcoQOs

Both the top-down and bottom-up processes are essential in building a foundation of understanding surrounding the ecosystem approach. This shift from traditional resource management is aimed at long-term sustainability, has a multi-species framework, integrating human activities and conservation of nature, including political, economic and social values, and proposes solutions, which are socially acceptable.

In doing so, the approach needs to build on

- the framework of an existing management plan,
- develop desired future conditions and
- needs to incorporate current existing data with new research to develop ecologically based concepts and techniques to achieve the desired conditions.

The process will include the selection of issues within the region to be considered. It must also be recognised that within the framework of the ecosystem approach, emphasis must be placed on issues that present the greatest risk to long-term sustainability. These issues need also to be viewed with consideration to the underlying criteria of what constitutes a good EcoQO. The workshop[*] approached this process by identifying desired future conditions, in terms of visions, with regard to some priority issues.

Scientists have been given responsibility to deal with the complexity of the marine environment that includes hundreds of species and many different types of habitats and biotopes. With regard to regulating human activity, policy makers lack strong support from public opinion to preserve ecosystem health or demands for the wise use of the ecosystem. The development of EcoQOs is regarded as an important step in clarifying this picture.

HELCOM assessments have identified and prioritised threats and their causes. The latest assessment [*] identified the following concerns:

1. "Eutrophication still a widespread and persistent problem"
2. "More action still needed on hazardous substances"

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[*] Workshop on: "Pilot Study into the Development of a Road Map for the Establishment of Ecological Quality Objectives (EcoQOs) within HELCOM for the Baltic Sea", 26th September 2003, Helsinki, Finland.
[*]The Baltic Marine Environment 1999-2002, BSEP 87, 2003

3. “Increasingly crowded shipping lanes”
4. “Over-fishing a serious problem”
5. “Habitats and biodiversity at risk”.

These issues of concern should be used in developing EcoQOs.

When applying the ecosystem approach there needs to be a shift towards the ecosystem itself, which will be at the centre of a causal chain continuum of cause and effect. Where EcoQOs once developed should ideally reflect the core of information on the ecosystem, with a balance between the basic ecosystem properties on one hand and human influences on the other. It has been recognised that biological effect variables can provide a useful link between effects and human influence or use of the marine environment.

Therefore, specific long-term visions of the state of the Baltic Sea environment were identified with regard to some priority issues: eutrophication, hazardous substances, commercial fishing, biodiversity and habitats. These so called visions will provide a useful step towards developing specific EcoQOs that will have sustainability at its core.

Table 1. A provisional list of visions in terms of some priority issues, with their related ecological quality element and primary cause as the basis for discussion.

ISSUE(S)	Ecological quality objective	Ecological quality element	Primary cause
Eutrophication	**Vision:** Stop eutrophication in order to restore ecological balance within the Baltic Sea and to ensure a functioning marine ecosystem. • Water clarity restored to historical regional levels; • No oxygen-depleted areas in shallow coastal areas; • There should be no kills of benthic (bottom dwelling) organisms as a result of oxygen depletion2, where it should not occur naturally; • Depth range of water plants returned to regional historical levels; • No visible arrivals of opportunistic algae at reference beaches where it did not appear before the 1970s, e.g., green pin-cushion algae (*Cladophora*) or sea lettuce algae (*Enteromorpha*); • Bladder wrack (Fucus vesiculous) restored in areas where it has disappeared; • No exceptional massive algal blooms.	Phytoplankton biomass and species composition • Secchi depth ; • Phytoplankton chlorophyll *a* and percentage of silicous species. • Winter concentrations of nutrients Oxygen depletion • Hypoxia and hydrogen sulphide. Macrozoobenthos biomass and composition • Changes/kills in zoobenthos3 . Density of sensitive species Littoral community composition • Filamentous macro algal mats; • Bladder wrack (Fucus vesiculosus). Harmful algal blooms • Frequency and extent of algae and blue-green algae; especially toxic and potentially toxic blooms.	Waterborne inputs of nitrogen and phosphorus. Airborne inputs of nitrogen. Sources: • Agriculture; • Waste water from municipals and dispersed settlement; • Industry. Traffic (air, water, and land)
Hazardous substances	**Vision:** A marine environment which is not toxic to the organisms living in it or to humans. • Concentrations of hazardous substances in the Baltic Sea near background values for naturally occurring substances and close to zero for man-made substances4.; • Toxic substances shall neither cause sub-lethal effects, e.g., health/reproduction of marine mammals, birds, shellfish, and other organisms5 ;	• Organic contaminant (e.g., PCB and dioxin) content in fish • Heavy metal (e.g., Hg, Cd, Pb) concentrations in fish (e.g., herring and cod). • Organic contaminant concentration in seabird eggs (e.g., guillemot)6 • Imposex in coastal biota (red/common whelk)	Waterborne and airborne inputs of hazardous substances Sources: Industry Traffic (land and water) Agriculture

[2] "and/or toxic phytoplankton species (including blue-greens)"
[3] "…due to eutrophication"
[4] "…until 2020". (see HELCOM 1998)

ISSUE(S)	Ecological quality objective	Ecological quality element	Primary cause
Hazardous substances (continued)	• All fish caught in the Baltic Sea shall be suitable7 for human consumption; • Good knowledge about hazardous substances, their sources and effects; • Concentrations of man-made radioactivity in the Baltic Sea ecosystem as low as possible and causing risk neither to humans nor the nature.	• Reproductive disturbances effecting populations of seals and white-tailed sea eagle.8 • Levels of radioactive substances in seawater, sediment and the biota.	
Fisheries and Mariculture	**Vision:** Ensure exploitation of living aquatic resources that provide sustainable economic, environmental and social conditions. • The Baltic Sea will be a region where fisheries and aquaculture activities is practiced sustainably and managed responsibly to ensure a health marine ecosystem; • All stocks managed under a long term management plan and well within safe biological limits; • Fishing practices shall not threaten non-target species populations (e.g., bycatch of marine mammals & sea birds).9 ; • Healthy fish communities e.g., herring, sprat, cod, salmon, eel, and local coastal fish populations; • The production of wild salmon should gradually increase to attain at least 50% of naturally production capacity of every individual river before the year 2010, this in order to achieve a better balance between wild and reared salmon.	Over-fishing: Spawning stock biomass of commercial fish species Changes of the size of the fish (average weight and length) Fish production targets should be agreed to ensure ecosystem maximum sustainable yield, e.g., multi species F-target, including targets on sustainability Changes in fish community Maricuture: Genetic "pollution" of wild stocks Infections of parasites and disease	**Direct:** Over-fishing Fishing practices bycatch Aquaculture practice **Indirect:** Water quality – eutrophication & hazardous substances Reduced spawning success - habitat degradation

[5] Hard to monitor. The first objective is much stronger, where this objective on sub-lethal thresholds may not be necessary, if first objective is reached.
[6] delete
[7] "have no or negligible residues to be compatible"
[8] delete
[9] Objective could be strengthened by quota for by-catch and landing of by-catch.

ISSUE(S)	Ecological quality objective	Ecological quality element	Primary cause
Habitats and Biodiversity • Habitats • Threatened/loss of biodiversity • Natural amenity • Coastal development	**Vision:** A Baltic Sea marine environment with maintained natural biodiversity at all levels, strengthening its natural integrity. • A sufficient number, size and network of coastal and marine BSPA (Baltic Sea Protected Areas) to ensure the preservation of: – natural coastal landscapes within the Baltic Sea; – natural ecosystems and processes ensuring long-term interconnectedness between areas; – protect declining/endangered species. • restored species supporting climax communities in areas where they have disappeared, e.g.: – Eel grass meadows (*Zostera*); – Bladder wrack beds (*Fucus*); – Mussel beds (*Mytilus edulis*). • EcoQOs are regionally integrated into the economic and cultural elements within coastal area in order to maintain habitats and their integrity. • Healthy viable populations of top-predators: mammal populations, seabirds, fish (salmon, trout, cod). • Minimize the introduction of non-native species, especially from ballast water and aquaculture activity.	Physical disturbance of: • Shoreline – Habitats disappear; – Nesting sites disturbed or disappear; – Obstruction of migratory corridors; – Fragmentation. • Coastal water zone – Shore line disturbance; – Stagnation; – Turbidity. Presence and extent of threatened biotopes and biotope complexes (cf. HELCOM Red Data Book) Lack of stakeholder involvement Management of coasts lacks vision and is based on a very limited understanding of coastal processes and dynamics, with scientific data isolated from end-users. (e.g., future ICZM programmes should make use of EcoQOs) Seal population trends Bycatch of seabirds, seals and harbor porpoises Invasive species	• Housing • Industry • Tourism • Traffic: shipping, ferries, and recreational boats • Bilge and ballast water release • Ports and marinas • Dredging and dumping of dredged spoil • Extraction of natural resources • Sand and gravel extraction

Future work

Developing and implementing an ecosystem approach and identifying appropriate EcoQ elements and EcoQO is a huge task that will be achieved in a series of smaller steps. Therefore, the proposed list of issues, visions, ecological quality objectives, elements, and primary cause given in Table 1 should be considered as the first step in this long process. The long experience in running HELCOM joint monitoring programmes and in making the assessments will offer a good basis for this work.

Some of the issues listed in Table 1 are more ready for "operational use", whereas others need research and further testing. It is proposed that the next stage of EcoQO work should be divided according to the "readiness" of the issues. Those issues and EcoQOs where a lot of data/knowledge exists already could be considered as short-term tasks. Medium-term tasks could be the ones where scientific information/data exists but where societal choices might hinder the progress. And finally long-term issues could be the ones where we have "empty hands".

With the incorporation of EcoQOs within a D-P-S-I-R framework, it was also noted that the development of spatially explicit models are needed to permit all stakeholders to view all likely outcomes of proposed management alternatives across the landscape of the Baltic Sea, with regard to reaching EcoQOs.

In order to continue the development of EcoQOs for HELCOM, the HELCOM Secretariat has made a project application to the EU. The duration of the project would be one year. The project would:

1. Develop initial EcoQOs for the chosen set of issues to be discussed by HELCOM MONAS 7/2004;
2. Involve Contracting Parties and stakeholders into the process;
3. Make proposal for a timeline and milestones for the further development of HELCOM EcoQOs.

Some key issues[10] are:

- Determination of reference levels for chosen EcoQOs. The work already done within HELCOM needs to be continued (Lead Countries Germany and Sweden).
- Determination of information requirements for the chosen EcoQOs. The aim is to have Lead Countries for the acquisition of information for each EcoQOs.
- Coordination with other international activities, especially with the development in European Marine Strategy (EMMA), Ecosystem Approach to the Management of Human Activities (EAM), EEA and the implementation of the EU WFD.
- Use the GEF Baltic Sea Regional Project to support and provide advice in the continued development of EcoQOs for the Baltic Sea, which includes the integral role of ICES

[10] Future work should specifically also consider:

- Identifying the most important properties of the ecosystem to protect.
- List human activities that have a potential impact on each EcoQO.
- Examine the relationship between EcoQOs, pressure, impact and human activities.
- Develop methods to relate specific human activities (by stakeholders) to potential impacts on each EcoQO.
- Review overall framework, show overlaps, gaps.
- Study the effects on all EcoQOs of measures in place to achieve each of the individual EcoQOs.
- Propose indicators to be developed.
- Elaboration of a timetable for undertaking future work on the development and application of EcoQOs.

Annex 6 Strategy for Developing Environmental Indicators for the Baltic Sea

Eugeniusz Andrulewicz, Sea Fisheries Institute, Gdynia, Poland

1 Introduction

The rapid urbanisation, industrial development and intensification of agricultural based on mineral fertilisers and chemical pest control that followed World War II placed significant anthropogenic pressure on the Baltic Sea. This pressure was so strong that the ecological status of some sea areas was transformed from oligotrophic to eutrophic (Jansson, 1980; Ojaveer, 2002), and the whole ecosystem became contaminated with hazardous substances. More recently, resources of commercial fish have become seriously depleted as the result of intense fishing.

Environmental pressures can be ranked according to their impact on the Baltic ecosystem as follows:

- Eutrophication;
- Chemical contamination/Harmful substances;
- (Over)Fishing;
- Invasive species;
- Oil spills;
- Disruption or degradation of natural habitats;
- Other.

The disruption and degradation of natural habitats is caused by bottom trawling and various technical activities such as dredge spoils dumping, sand and gravel extraction and the construction of new ports and oil terminals. More recently, plans have been developed for the construction of large windmill-parks, oil and gas pipelines and for the laying of cables.

Other anthropogenic effects such as coastal tourism, the effects of crude oil exploitation and the microbial contamination of swimming waters can be important on a local scale. The Chernobyl disaster, which resulted in elevated levels of some artificial radionuclides, is a special case in the Baltic Sea.

The aim of this paper is to contribute to the development of anthropogenic pressure indicators, environmental status and societal response to this pressure. These indicators should be delivered to managers and laymen as tools for the management of anthropogenic activity. Their development should also help in understanding the Baltic ecosystem, which functions under an additional driving force – that of anthropogenic pressure.

2 Developing Baltic Environmental Assessments

This paper is primarily based on a review of HELCOM *Periodical Assessments* and the author's experience gained from HELCOM working groups involved in the preparation of these assessments. Other assessments, such as North Sea QSRs, Arctic Monitoring and Assessment Programme and the developments of EEA for European seas and the Global International Water Assessment (GIWA) for the Baltic Sea, were also taken into account.

The Helsinki Commission (HELCOM) initiated the monitoring and assessment of the quality of the Baltic Sea environment in 1979. In 1981, the commission published the *"0" Assessment* (HELCOM 1981) followed by four *Periodical Assessments* (HELCOM 1985, 1993, 1996, 2002). Although of significant scientific value, none of them were of substantial value for decision-makers. They were criticised for the time-consuming preparations they required and for the difficulties non-scientists had in digesting the scientific nature of the contents of the publications. In an effort to improve the assessments, HELCOM recently began preparing indicator-based assessments with the hope that they will be more useful for managers and laymen. A number of other international organisations, such as EU-EEA, GIWA, OSPAR and WWF, have begun to present assessments as evaluations of environmental indicators in order to produce decision-maker-friendly assessments and to improve marine management.

A few carefully selected indicators were proposed initially by HELCIOM MONAS:

- to assess eutrophication: surface concentration of inorganic nutrients in winter, mainly oxidised nitrogen forms and phosphate; the riverine load of total N and total P; mean chlorophyll concentrations in summer, changes in the depth range and distribution of bladder wreck (*Fucus vesiculosus*) and eel grass (*Zostera marina*);
- to assess contamination: waterborne load of Hg, Pb, Cd (and time series for 1994-2000); atmospheric load of Hg, Pb, Cd based on model calculations; Hg, Pb, Cd, CBs (7 congeneers) in Baltic herring (HELCOM 2001).

3 The conceptual frameworks of environmental quality indicators

The term "indicator" has been given various definitions, but generally it refers to a measure of some environmental property or state. The OECD definition of an indicator reads:

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

The relationship between indicators and the information on which they are based is illustrated in Hammond's information pyramid (Hammond, 1995) (Figure.1). Basically, raw data are processed, and then published in the form of papers or scientific assessments. They are usually of high scientific quality; however, even "Processed Data" as such, are not very useful for laymen or decision-makers. Therefore, it is necessary to go further up the information pyramid to the level of indicators.

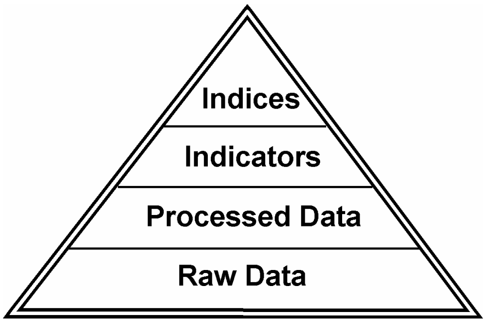

Figure 1. The information pyramid. (Hammond, 1995)

Already, following the demand of various international organisations dealing with assessments global (e.g., GIWA) and those dealing with assessments of large-scale European seas (e.g., EEA), a request has been issued to develop a simple scoring system of indices that will help to compare the status of different seas and/or regions. The indices are developed in order to limit the amount of information that decision-makers and other interested parties have to absorb. By nature, the indices are less informative than their indicator components, since the process of agglomeration attenuates the impact of individual indicators. The indices represent the most integrated information with the least amount of detail. They are usually expressed as classes (e.g., "very good", "good", "sufficient", "bad" (EU WFD 2000), or from "no impact" to "slight", "moderate" and "severe" impact (GIWA 2001). They will be useful in comparing the quality of many aquatic and marine systems, e.g., on a Pan-European and/or global scale. However, their development should obviously be preceded by the development of indicators.

3.1 PSR framework of indicators

The OECD (Organisation for Economic Co-operation and Development) developed a systematic P-S-R framework of indicators commonly referred to as "**P**ressure-**S**tate-**R**esponse" (OECD, 1993) which is based on the following causality chain:

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

Indicators of pressure (P) can also be called indicators of stressors. For example, pollution load can be regarded as a primary pressure indicator.

State (S) indicators are needed to assess the state of the marine ecosystem properly. This knowledge comes through research and monitoring. This is why the establishment of appropriate monitoring and research programs is an important task. State indicators are measures of the state of the quality of the environment, such as concentrations of nutrients and contaminants. However, to describe the quality status of the marine environment, both state and effects have to be considered. Therefore, in most cases there is no need to distinguish between state and pressure indicators.

Response (R) indicators should aid the decision making process, the development of regulatory standards and the identification of needed actions. Response indicators include government policies and regulatory efforts, as well as societal responses through individual and collective actions. These response activities usually result in changes in pressure indicators, thus closing the loop.

3.2 DPSIR framework of indicators

The conceptualised PSR (Pressure-State-Response) indicator framework is a very good starting point towards the development of a full DPSIR (**D**riving force-**P**ressure-**S**tate-**I**mpact-**R**esponse) indicators system already adopted by the EEA. The EEA has already begun developing a DPSIR framework through a series of dedicated workshops.

The original cause of "Driving force-D" pressure is usually far from the sea. It might be poor governance, economic or social problems and/or lack of awareness. The identification of the original pressure requires knowledge of socio-economic forces within the catchment area.

According to the author, it will not be practicable and even difficult to develop a DPSIR framework in one stage. Developing "D" indicators will require the involvement of economists (preferably environmental economists) to perform so-called "casual-chain analyses" in which socio-economic forces behind different pressures are analysed in detail.

Currently, the cause-effect relationship is barely understood in many cases. Thus, a step-by-step approach is proposed to achieve the full DPSIR framework of indicators. PSR indicators could be developed in an "environmental" group of experts and Driving force - D (also including Response – R indicators) could be developed in "socio-economic" group of experts. These two frameworks would then be merged into the full DPSIR framework.

4 Illustrative examples of indicators

4.1 Eutrophication

Eutrophication is a particularly important problem in semi-enclosed seas (such as the Baltic Sea), coastal bays and lagoons and some coastal areas. Eutrophication has caused significant adverse biological effects over recent decades. These effects are complex and concern all components of the ecosystem, i.e., water, sediments and biota.

Eutrophication is primarily understood as nutrient enrichment in an aquatic system; it also signals a change in the trophic status of the system. Although a natural process, the eutrophication of the marine systems is generally regarded as a consequence of anthropogenic activity. Eutrophication is usually viewed as an undesirable effect, although it is worth remembering that enhanced productivity also means more food in the system and more fish, e.g., between the 1950s and 1970s herring biomass growth in the Baltic Sea accelerated two times (Ojaveer 2002).

There are different definitions of eutrophication. ICES-ACMP (1992) defines eutrophication simply as "nutrient enrichment". According to EEA (ETC, 1997):

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

Anthropogenic Pressure (P) Indicators	Environmental State and Impact (S) Indicators	Government/Society Response (R) Indicators
Amount of nutrients discharged from point sources Amount of nutrients discharged from diffuse sources Amount nitrogen deposited from the atmosphere	Winter concentrations of nitrogen and phosphorous Chlorophyll *a* concentration in surface waters Secchi-disk visibility Depth range of macrophytes Oxygen depletion (in historically oxygenated areas) Frequency and presence of potentially toxic algal species Increased biomass of fish above the halocline	Reduction of nutrient discharges from point sources Construction of wastewater treatment facilities Reduction of nutrient discharges from diffuse sources Reduction in the use of fertilisers and detergents containing phosphorous Buffer strips to trap nutrients to prevent eutrophication Adoption of better agricultural practices (sustainable agriculture)

A number of HELCOM Recommendations regarding the reduction of nutrient inputs to the Baltic Sea have been issued. This is also a hot issue on the political level and the subject of various research projects (e.g., BOING, MARE).

4.2 Chemical contamination/Harmful substances

Contamination and the adverse effects of it are caused by the presence of substances or group of substances that are toxic, persistent and prone to bioaccumulation. These include inorganic compounds (e.g., heavy metals), organic compounds (e.g., some biocides, industrial halogenated compounds and some polycyclic aromatic hydrocarbons) and organometallic compounds (e.g., organic compounds of mercury and tin). The Baltic Sea environment and its food chains are currently contaminated at all levels. The biological effects of this contamination are largely unknown.

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

Anthropogenic Pressure (P) Indicators	Environmental State (S) Indicators	Government/Society Response (R) Indicators
Quantity of toxic compounds discharged from land-based point sources Quantity of toxic compounds discharged from land-based diffused sources (e.g., pesticides) Quantity of discharges of toxic compounds from sea-based sources Amount of toxic compounds deposited via the atmosphere or fallout into the sea	Contamination (levels/concentrations in water sediments and biota) Long-term trends in concentration levels Bioaccumulation /bioconcentration (levels/rates) in organisms Biomagnification (rates) in the food chain	Improvement/construction of wastewater treatment facilities Ban on production of harmful substances (i.e., DDT) Significant reduction in the use of harmful substances Reduction of toxic emissions at sources

There is a need to monitor the marine environment for the biological effects of pollution since a pre-release ecological safety assessment is unable to define hazards from all agents of contamination. The ecosystem-approach should integrate monitoring of concentrations of harmful substances and their biological effects. Biological effects techniques have been increasingly used within marine monitoring and research programs and various biomarkers have been developed to measure these effects on different levels of biological organization:

- multiple stress factors (e.g., stress proteins);
- genotoxic effects (e.g., cytogenetic and DNA damage);
- immunosupression (e.g., lysosomal stability);
- reproductive disturbances (e.g., imposex/intersex);

- carcinogenic effects (e.g., liver neoplasm);
- changes in community structure (e.g., benthic community structure in the vicinity of point sources).

In some cases, there will be a need to identify the specific effects of a given harmful substance, e.g., in case of anti-fouling paints – vitellogenin, metallothioneins, intersex, imposex, and shell thickening. These biomarkers can be regarded as both S-State and I-impact indicators.

4.3 Fishery

Fish are practically the only living resource of market value in the Baltic Sea. The tradition of fishery management is well established within the Baltic region, and it is usually controlled by national and international regulations. However, there are still problems related to catch statistics, illegal catches and ineffective fishery control. Today, in many sea fishery areas, the main problem is the overexploitation of available commercial fish resources.

The International Baltic Sea Fishery Commission (IBSFC, 1998) has already adopted some indicators: sustainable stock biomass (SSB), fishing mortality, recruitment and socio-economic indicators, e.g., landings, number of vessels, engine power, fish consumption and the number of full-time fishermen. At present, they do not follow either the DPSIR or PSR frameworks. The proposed PSR scheme is presented below.

Anthropogenic Pressure (P) Indicators	Environmental State (S) Indicators	Government/Society Response (R) Indicators
Number of fishing vessels per country operating in the area under consideration Landings of fish per country (e.g., for the Baltic Sea total amount of landings in tons of cod, salmon, herring, sprat) Average engine power per country: total kilowatts of the fleet, divided by the number of vessels Number of full-time fishermen actively engaged in an area, by country	Spawning stock biomass (SSB) Fishing mortality rate Recruitment rate Ratio between yield and SSB	Regulation of landings (total allowable catches (TACs), per country) Technical measures (fishing gear, number and size of nets, etc.) Temporary closure of fishing (fishing grounds, protective periods, etc.) Reduction in the number of licensed commercial fishermen

For many years, assessments of the effects of fishery were focused on commercial fish stocks to ensure the renewal of the exploited resources. The new ecosystem-based policy should involve a number of new indicators which are related to the effects of fishing on the ecosystem, as follows:

Pressures (P-indicators) due to fishing

- amount and composition of the bycatch of non-commercial fish, birds and mammals;
- location and amount of dumped fish discards and fish offal;
- number and size of benthic habitats where bottom trawling is conducted.

State (S-indicators) due to fishing

- changes in the food web structure;
- changes in populations of keystone/dominating species;
- changes in species richness;
- changes in seabird and mammal community structure;
- evidence of bottom habitat destruction.

Regulatory **Response (R-indicators)**

- technical regulations on fishing gear, fishing practices in relation to bycatch;
- regulation of the dumping of fish offal and discards;
- areas excluded from fishery.

4.4 Invasion of non-indigenous species

Invasive species are becoming an issue of growing concern in the Baltic Sea. More than 100 alien plant and animal species have been recorded to date (Olenin and Leppakoski, 1999). The environmental and economic impacts of these species are largely unknown; however, in some lagoons and coastal areas they clearly change food web structures. In most scientific opinions this is a "potential danger", although it is classified from "insignificant" to "ecological bomb" within the wider scope of hazards.

Anthropogenic Pressure (P) Indicators	Environmental State (S) Indicators	Government/Society Response (R) Indicators
Marine transport (amount and type of ballast waters) Introduction programs	Number and abundance of alien species Nature of interaction with native species Economic losses from interaction with native species and costs of combat measures	Ballast water control and management technologies

4.5 Oil spills

The Baltic Sea is an area of busy cargo links. Approximately 2 000 cargo ships (among which 50 carry crude oil or crude oil products) and 50 ferries sail on fixed routes at any given time in the Baltic Sea. The number of cargo ships and oil tankers will grow rapidly in the next decade; therefore, it is expected that oil pollution will increase proportionally (HELCOM 2002). Currently, approximately 400 illegal oil spills are recorded every year, and a total of 119 ship accidents occurred in the Baltic between 2000–2002 (IMO MEPC 51/8). Oil pollution is mostly recognised as a great potential danger because of the vulnerability of the Baltic ecosystem and growing sea traffic.

After many years of studies on petroleum hydrocarbon pollution, there is still no consensus on the definition of oil pollution. Since authors define this issue in different ways, it is often difficult to compare the results of their studies. The following definition was adopted for this paper:

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

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

Anthropogenic Pressure (P) Indicators	Environmental State (S) Indicators	Government/Society Response (R) Indicators
Frequency and amount of transported crude oil and oil derivatives (number and amount of discharges) Number of accidents, collisions at sea, level of risk of spills Amount of land based discharges (sewage out-falls and river run-off) Amount of atmospheric deposition (from transport and the combustion of fossil fuels)	Levels of oil residues in sea water and sediments Number of oil slicks on the sea surface Concentrations of PAHs in water, sediments and some marine organisms PAH-related effects in marine organisms (e.g., mutagenic effects, liver neoplasmia) Number of oiled or beached birds	Regulations on transport (including ship requirements) Reception facilities in ports Inspections of marine transport activities (e.g., aerial surveillance) Oil combating facilities in ports and oil combating vessels Regulations on discharges (e.g., for the offshore oil and gas industry)

Additional information on the present level of petroleum hydrocarbons is needed in order to establish reference values for clean-up purposes, particularly in high-risk locations: ports, oil terminals, offshore oil rigs and shipping lanes.

With oil and petroleum hydrocarbon pollution, the most effective course of action is to prevent oil spills. Since preventive measures will not entirely eliminate oil spill events, an effective combat system, such as the one proposed by HELCOM, is still needed.

4.6 Dumping of dredge spoils

The dumping of dredged spoils from port and navigation channels is permitted by international law; however, this is regulated by national legislation as well as by international recommendations.

Anthropogenic Pressure (P) Indicators	Environmental State (S) Indicators	Government/Society Response (R) Indicators
Amount of dumped dredged spoils Quality of dredged spoils (e.g., concentration of harmful substances, amount of oxygen-consuming substances)	Fate of dredged material after dumping (dispersion/deposition rate) Biological effects on dumping site (e.g., number of damaged organisms, mutagenic and carcinogenic effects) Recovery rate of dumping sites	Complying with national and international regulations Monitoring effects of dumping Restricting the amount of dumped material Storage on land and in landfills

Although there are national and international quality standards for dredged material, they do not address dumping sites or the fate of material after dumping. Therefore, ecological criteria regarding the proper disposal of dredge spoils must be developed.

4.7 Extraction of sand and gravel

In addition to crude oil, sand and gravel are the other mineral resources from the Baltic Sea that are exploited.

Anthropogenic Pressure (P) Indicators	Environmental State (S) Indicators	Government/Society Response (R) Indicators
Number and size of extraction fields Amount of extracted material per year	Morphological changes on the bottom Effects of changes of the natural balance of currents Effects of changes in the structure of bottom fauna and flora communities Creation of suspended matter plumes affecting fish spawning grounds Creation of suspended matter plumes affecting marine vegetation	Environmental impact assessments Guidelines and /or code of practice for mineral exploitation Licensing/permission Monitoring the efficacy of national or international surveillance activities

The environmental policy regarding sand and gravel exploitation at sea is well developed, including ICES guidelines and ICES codes of practice and the monitoring of the recovery rate of affected places.

5 Summary and conclusions

A great deal of relevant data on the marine environment are collected within monitoring and research programs, but in many cases they are not synthesised into forms which are readable to management. To date, very little data integration or processing into more applicable forms has been undertaken. Nevertheless, the process of integrating knowledge about the marine environment has already started in many countries and international commissions.

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

It is clear that indicators will be less informative than scientific papers or lengthy, up-to-date scientific assessments. Therefore, properly choosing indicators that are informative and representative is a very demanding task. The process will last for some years before the "toolbox" of indicators will be full and generally accepted. It is worth emphasising that even a very good "toolbox of indicators" will not reduce expert participation in the assessment process and should not reduce monitoring efforts. Indicators will help producing decision-maker-friendly assessments on environmental issues. They will also be useful to build better links to socio-economic driving forces and societal responses.

A step-by-step approach is proposed to achieve the full D-P-S-I-R framework of indicators. The first step is to develop P-S-R indicators. This should be done within an "environmental group" of experts, while driving force-Response (D-R) indicators should be dealt with in "socio-economic" group of experts. These two frameworks should be merged by a joint group of experts to elaborate the complete D-P-S-I-R framework of indicators.

By no means do the examples completely identify all of the related indicators. They do, however, illustrate an approach towards developing a complete, generally accepted set of indicators. This should help to understand and assess anthropogenic pressures on the ecosystem, and aid in preparing holistic and regional assessments. Consequently, they should assist in ecosystem-based management. There is also a need to develop indicators of physical disturbances in the marine environment caused by coastal construction projects, dredged spoils dumping, wind-mill parks, cables, pipelines and others. The development of indicators of sustainable development, biological diversity and coastal zone quality are challenging issues.

9 Recommended papers and reports

Anon. 1998. Workshop on the Ecosystem Approach to the Management and Protection of the North Sea. Oslo-Norway, 15–17 June ThemaNord 1998: 579, 100 pp.

EEA 1999a. EEA Technical Report, No. 17. Integration of information on Europe's marine environment, pp. 41.

EEA 1999b. Integration of information on Europe's marine environment. Ed. By T. Bokn and H.R. Skjoldal. Technical report, No 17.

ETC 1997. European Topic Centre on Marine and Coastal Environment. Indicators at the European Level for Coastal Zone Characterisation and Management (draft report).

EU COM 539. 2002. Towards a strategy to protect and conserve the marine environment. Communication from the Commission to the Council and the European Parliament. 65 pp.

McGlade, J.M. 2002. The North Sea Large Marine Ecosystem. *In* Large Marine Ecosystems of the North Atlantic. Changing States and Sustainability. Ed. By Kenneth Shermann and Hein Rune Skjoldal. Elsevier, 339–412.

Hammond, A.L. 1995. Environmental indicators. World Resource Institute, Washington D.C.

HELCOM. 1981. Assessments of the Effects of Pollution on the Natural Resources of the Baltic Sea, 1980 Baltic Sea Environment Proceedings No. 5B.

HELCOM. 1985. First Periodic Assessments of the State of the Marine Environment of the Baltic Sea, 1980–1985. Baltic Sea Environment Proceedings No 17 B.

HELCOM. 1993. Second Periodic Assessments of the State of the Marine Environment of the Baltic Sea, 1986–1988. Baltic Sea Environment Proceedings No. 35 B.

HELCOM .1996. Third Periodic Assessments of the State of the Marine Environment of the Baltic Sea, 1989–1993. Baltic Sea Environment Proceedings No. 64 B.

HELCOM. 2002. Environment of the Baltic Sea Area 1994-1998. Baltic Sea Environment Proceedings No 82 B.

ICES-ACMP. 1991. ICES Co-operative Research Report No. 177.

ICES-ACMP. 1992. ICES Co-operative Research Report No. 190.

Jansson, B.O. 1980. Natural Systems of the Baltic Sea. Vol. IX. No 3–4. 128–136.

OECD. 1993. OECD Core Set of Indicators for Environmental Performance Reviews Environmental Monographs No. 83. Synthesis Report OECD/GD (93)179.

Rio Convention 1992. Convention on Biological Diversity, 5 June 1992.

Skjoldal, H.R. 1998. Overview report on Ecological Quality (EcoQ) and Ecological Quality Objectives (EcoQOs). Institute of Marine Research, Bergen, Norway.

Sherman, K. 1994. Sustainability, biomass yields, and health of coastal ecosystems: an ecological perspective. Mar. Ecol. Prog. Ser. Vol., 112: 277–301.

Smeets, E., and Weterings, R. 1997. Environmental Indicators: Typology and Overview. TNO Center for Strategy, Technology and Policy. Apeldoorn, the Netherlands.

Wulff, F., and Niemi, A. 1992. Priorities for restoration of the Baltic Sea- a scientific perspective. AMBIO 2 (21), 193–195.

Annex 7 The HELCOM Waterbird Monitoring Plan

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The minimum requirements for a Baltic-wide monitoring programme for breeding waterbirds will include the following key habitats, which may be regarded as holding significant proportions of the European or Baltic populations:

- Lagoons and fjords in Germany and Denmark;
- Lagoons along eastern seaboard between Poland and Estonia;
- Archipelago areas of Estonia, Finland and Sweden;
- Seabird colonies of Gotland and Chr. Ö;
- Wetlands along the eastern Gulf of Finland.

The ongoing monitoring activities of the southern fjord and lagoon areas may be regarded as adequate in order to pick up large-scale trends of breeding waterbirds, although the current monitoring activities in the lagoons and fjords of Denmark, Poland, Lithuania and Latvia only allow for the calculation of trends of relatively few species. A minimum requirement for this habitat type would be to maintain the current levels provided that data from all regional and local sources are made available.

Monitoring of breeding waterbird populations in the archipelago areas is carried out in a few areas and regions, however several of the more important archipelago areas in the Stockholm and Åland Archipelagos are covered, and plans to expand these programmes exist. Accordingly, trends can be calculated for many of the more important species for the key areas. A minimum requirement for the monitoring of the archipelago areas would be to maintain the current levels if data from all regional and local sources are made available.

Seabird colonies of Gotland and Öland are monitored regularly and at a high intensity, which allows for the calculation of temporal trends. Thus, the current level of monitoring is regarded as the minimum requirement. The wetlands along the eastern part of the Gulf of Finland are not currently covered by breeding monitoring programmes. The minimum requirement for this habitat type would be to install monitoring of key species in the more important wetlands of Russia.

The minimum requirements for a Baltic-wide monitoring programme for wintering waterbirds would include the following key habitats, which may be regarded as holding significant proportions of the European wintering populations:

- Lagoons and fjords;
- Sandy and muddy coastal areas to a depth of 10 m;
- Archipelago areas of Estonia, Finland and Sweden;
- Sub-littoral soft and hard bottom areas between 10 m and 30 m;
- Offshore banks.

Due to the Wetlands International Midwinter Census the monitoring of waterbirds wintering in the littoral zone of the Baltic Sea is regarded as adequate to resolve time trends for most regions and countries for coastal habitats, including most ice-free lagoons, fjords and coastal areas.

As a contrast, the almost complete lack of monitoring of waterbirds in offshore areas currently makes it impossible to track changes in populations of wintering sea-ducks, divers and grebes, including the numerically and ecologically dominating sea-duck species like long-tailed duck *Clangula hyemalis*, velvet scoter *Melanitta fusca* and black scoter *Melanitta nigra*. The proportion of the Baltic wintering waterbird fauna, which is inadequately covered by monitoring activities in offshore waters, amounts to approximately 80%. While many of the species wintering predominantly in coastal areas have been recorded in increasing numbers over the last decade, species with a primarily offshore distribution seem to be in decline due to increases in offshore oil pollution, incidental bycatches in fishing nets and other factors. A minimum requirement in order to document whether the increasing utilisation and pollution of offshore Baltic waters affect the large numbers of wintering waterbirds would be to sample representative parts of the areas known to hold the largest concentrations, like North-western Kattegat, Pommeranian Bay, Hoburgs Bank and Gulf of Riga.

The current level of beached bird surveys is regarded as adequate for detection of trends in offshore oil pollution in the waters of the Kattegat, parts of the Straits, western Baltic and the Gulf of Riga. Additional coverage on Bornholm and Gotland is required to monitor trends along these sections of the main shipping routes passing close to major aggregations of waterbirds in the central part of the Baltic Sea.

Now that the pilot phase is finalized, HELCOM is investigating sources for support to carry out the planning phase of the waterbird monitoring programme. The planning phase is to be carried out through 2004 with possible implementation by member states in 2005. Following the decisions from earlier HELCOM HABITAT meetings the planning phase should include:

- Development of indicator species;
- Production of monitoring plan;
- Production of monitoring manual;
- Organization of monitoring workshop with waterbird experts from all Baltic states;
- Testing of monitoring plan.

Annex 8 Draft resolutions

A Study Group on Baltic Ecosystem Health Issues in support of the BSRP [SGEH] (Chair: E. Andrulewicz, Poland) will meet in Vilnius, Lithuania from 2–5 November, 2004 (date to be confirmed) to:

a) Continue to review of developments regarding ecosystem-based approaches to the monitoring, assessment and management of fisheries and the marine environment, with particular reference to progress in ICES, HELCOM, OSPAR and the North Sea Conference process, keeping in mind the aim of establishing and implementing the ecosystem approach in the Baltic Sea;

b) Further develop the Baltic ecosystem health concept in relation to the main ecological problem: eutrophication, hazardous substances, overfishing, invasive species, biodiversity and habitat destruction;

c) Initiate reference level/baseline work on a set of ecological quality (EcoQ) elements that reflect associated ecological quality objectives (EcoQOs);

d) Continue the development of ecological indicators and related reference points reflecting the objectives, constraints and state of key elements of the ecosystem in a coherent picture;

e) Inniciate conservation measures necessary to protect threatened or vulnerable species and habitats;

f) Discuss and propose a strategy for implementing the development of a habitat classification framework and habitat maps for the Baltic Sea (in collaboration with WGMHM) [HELCOM 2004];

g) Develop a Baltic MMED indicator system with the support of NOAA;

h) Review the COMBINE Programme, including methodology, especially coastal fish monitoring in co-operation with HELCOM MON-PRO including workshops already set by HELCOM MONAS 6/2003;

i) Evaluate the value of large projects being conducted in the Baltic Sea area, e.g., CHARM, BEEP, which deal with ecosystem health issues;

j) Prepare a workplan, including a schedule for deliverables and a description on how the Group will address the human dimension related to these issues, in cooperation with the other BSRP Groups and including considerations of potential contributions to 2006 Theme Session on Regional Integrated Assessments.

SGEH will report by 15 December 2003 for the attention of the Baltic Committee.

Supporting information

Priority	Ecosystem-based assessment and management in the Baltic Sea has been identified as an important issue by the Baltic Sea Regional Project (BSRP). In order to meet the requirements of the BSRP PIP (Project Implementation and Procurement Plan), an ecosystem health concept for the Baltic Sea must be developed and offered to managers in order to ensure sustainable management.
Scientific Justification:	Action Plan: 2.2 – a, b, c 2.2.1 – a, b, c 4.11 – a, b, c, d 4.11.3 – c, d 4.11.4 – c, d 5.6 – all When developing the concept of ecosystem health, the following issues should be included: • Identification of natural sub-systems in coastal areas • Monitoring the biological effects of eutrophication, contamination and fisheries • Ecological Quality Criteria (EcoQOs) for assessing ecosystem health • Environmental Reference Systems (including reference values, historical reference points and reference areas) • Classification lists of endangered species for different Baltic sub-regions • Update and continue developing existing biotope/habitat classification (in collaboration with WGMHM)

	• Biological diversity (including xenodiversity/invasive species) • Nature conservation areas [including management/protection plans] • Effects of pollution on the functioning and structure of the ecosystem • Multiple Marine Ecological Disturbances (MMED) The implementation of this concept will require decision-maker- friendly tools [practical approach] including decision-maker- friendly assessments; therefore it will be necessary to develop a scheme for providing timely and "user friendly" advice to management. This should be done through developments of DPSIR Indicators/Indices, Quality scoring/classification systems and Ecological Quality Objectives (EcoQOs). When developing EcoQOs following parameters should be considered: • Secchi depth or other proxy measure for light attenuation; • oxygen depletion in shallow waters; • phytobenthos (e.g., Bladder wrack - Fucus vesiculosus); • organic contaminant concentration (e.g., PCBs, DDts, TBT, dioxins, pesticides, algal toxins) in selected fish, shellfish and seabird eggs (bioaccumulation); • endocrine disruption (imposex, intersex, vitellogenin, embryo sex ratio, reproductive success, chromosomal aberrations in gonads); • biomarkers (AChE, MT, EROD, lysosomal stability, PAH metabolites, oxidative stress biomarkers); • changes in the size distribution of fish; • CPUE (catch-per-unit-effort) of non-assessed fish; • changes in fish community structure; • changes in abundance, biomass and distribution of species; • physical disturbance of the shoreline and coastal water zone (e.g., habitat destruction, nesting sites disturbed or disappearing, obstruction of migratory corridors, habitat fragmentation, shoreline disturbance, stagnation, turbidity). The ecosystem-based approach concept [ecosystem health concept] as well as appropriate management tools should be developed and offered to Baltic Sea management.
Resource Requirements:	
Participants:	Participants should be scientists primarily but not exclusively from the Baltic area, with experience in monitoring and assessments. Scientists with a broad knowledge of ecology systems, scientists with a strong interest in socio-economics and its applications. All Baltic countries specifically should provide relevant experts, and also participants from outside of the Baltic region. Members of WGPE who overview similar issues in a more global framework should be involved where appropriate.
Secretariat Facilities:	
Financial:	BSRP covers costs of two members/eastern Baltic country
Linkages to Advisory Committees:	ACE, ACMP. In the consideration of indicator issues, the group will closely follow the guidelines prepared by ACE.
Linkages to other Committees or Groups:	MHC, WGECO, WGMHM, WGEXT, MCWG, WGITMO, SGBOSV
Linkages to other Organisations:	HELCOM, OSPAR, IBSFC, EEA, IMO, IUCN, Baltic 21, BMB
Cost share:	BSRP 100%