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REPORT OF THE STUDY GROUP ON BALTIC ECOSYSTEM HEALTH ISSUES IN SUPPORT OF BSRP (SGEH)

9-11 NOVEMBER 2005

KALININGRAD, RUSSIA

International Council for the Exploration of the Sea
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Executive Summary

The Study Group on Baltic Ecosystem Health Issues in Support of BSRP (SGEH), at its third meeting in Kaliningrad, Russia (9–11 November 2005), reviewed progress on ecosystem-based approach in ICES, HELCOM, EU and US EPA and finalized its own developments on ecosystem health indicators undertaken during the last two years. Ecosystem health indicators were developed in relation to the four main Baltic Sea ecological concerns: eutrophication, hazardous substances, and effects of overfishing and biodiversity loss (including habitat destruction).

During the ICES/BSRP SGEH meeting in Kaliningrad, evaluation of indicators was performed for these issues. The following (US EPA) assessment criteria were applied:

- Regional response;
- Unambiguous interpretation;
- Simple quantification;
- Stability over the sampling period;
- Low year-to-year variability;
- Environmental impact.

As a result, a number of indicators was reduced and prioritized. Indicators which received scores “very good” or “sufficient” can be regarded as operational indicators. They can be used in the ecosystem-based assessment and management. Four tables of indicators were prepared in relation to:

1) Effects of Eutrophication;
2) Effects of Hazardous Substances;
3) Effects of Fishing Activities;
4) Biodiversity loss and Habitat Destruction.

Regarding new developments:

- An attempt was made on further integration of indicators into indices. This trial was based on US EPA experience and methodology. As a starting point the Benthic Community Index (BCI) was selected. Elaboration of it will require continuation.
- An effort to identify existing developments on socio-economic driving forces of pollution of the Baltic Sea was made.
- A presentation on public health aspects in relation to the ecosystem health was delivered to the SGEH meeting. This is a promising new field of research for the Baltic Sea.

SGEH was not able to develop issues related to reference levels in a satisfactory way. This task exceeded the realistic possibility of one meeting. However, there are some proposals of reference levels for biological effects of contaminants. Real developments will require access to national and international data.

1 Opening and welcome

The Study Group on Baltic Ecosystem Health Issues in Support of BSRP (SGEH) held its third meeting at the Atlantic Research Institute of Fisheries and Oceanography (AtlantNIRO) in Kaliningrad, Russia, in accordance with the Terms of Reference given by the ICES Baltic Committee. The SGEH Chair, Eugeniusz Andrulewicz, opened the meeting at 10.00 a.m. on Wednesday, 9 November 2005. The Scientific Director of AtlantNIRO, Dr Viatcheslav Sushin, welcomed the participants on behalf of AtlantNIRO and delivered the following message:

Ladies and Gentlemen,

Allow me on behalf of AtlantNIRO administration and scientists to greet you – the participants of the third meeting of the Study Group on the Baltic Ecosystem Health. The Study Group which is highly important to implementation of the objectives of the Baltic Sea Regional Project.

We are especially pleased with the fact that the Study Group meeting is held in our Institute. Firstly, because the issues relevant to the Baltic Sea ecosystem status, the concern over the high anthropogenic pressure and impact of the negative processes on the fishery and biological resources are similar and understandable to us. We have been treating them in our researches for a long time. I hope that the joint efforts of the scientists involved in the Baltic Sea Regional Project will succeed in development of practically important recommendations to improve the situation.

AtlantNIRO has gained the abundant experience in ecosystem researches and in application of the results in the fish stock management. As early as in 1950s AtlantNIRO had prepared the recommendation to change the existing system of fishery management in the Curonian Lagoon on the basis of the study of fish trophic interactions and forage resources. This has been successfully implemented resulting in the sharp increase of the Lagoon fish production owing to increase and stabilization of such important fish stock as pike-perch and bream.

We are pleased to meet you here in Kaliningrad also because AtlantNIRO was one of the first institutes where more than 10 years ago we discussed with Dr Dybern the general idea of the Baltic regional project development and implementation, especially of its scientific part. We are glad that this idea has been realized through the efforts of Dr Thulin and other enthusiastic scientists. We appreciate that our Institute is the Leading Laboratory of the Project on ichthyology and parasithology and that our scientist – Galina Rodyuk has been trusted to lead this event.

Besides, we are very glad to see among the participants our colleagues from Lithuania, Latvia and Poland with whom we are connected by a long-term cooperation. And this cooperation is still continued.

We wish successful and fruitful work to all participants of the meeting and to its chairman – Dr Andrulewicz. We shall try to do our best to provide your being in AtlantNIRO and Kaliningrad not only successful and useful from the professional point of view, but also warm and pleasant in the general sense.

The BSRP AC 1, Prof. Andris Andrushaitis, thanked the director of AtlantNIRO for his warm welcome on behalf of the coordination team of BSRP Component I. He underlined the importance to hold the ICES/BSRP Study Group meeting in Russia, one of the first ICES environmental meetings in Kaliningrad Region. He also informed the meeting about ongoing and recent initiatives related to the ecosystem-based management activities for the Baltic Sea, about Baltic Sea Regional Project (BSRP) progress, about the ICES initiative to re-arrange the data collection and management structure, about the EU Marine Strategy and about EU

BONUS initiative for scientific research in the Baltic Sea Region. A. Andrushaitis noted that the meeting was attended by nearly all Lead Laboratory representatives and Coordination Centres. He suggested holding an informal meeting of this group on Thursday, 10 November, to discuss Phase II of the BSRP project.

Dr Galina Rodjuk, the host of the meeting and the local organiser also welcomed SGEH participants and provided practical information about the local arrangements and facilities.

After welcoming addresses a round table introduction of the participants, including a group of PhD students from AtlantNIRO and Shirshov Institute of Oceanography in Kaliningrad was completed. The list of participants of the meeting is included as Annex 1 to the report.

2 Matters related to working procedures

2.1 Terms of Reference

A Study Group on Baltic Ecosystem Health Issues in support of the BSRP [SGEH] (Chair: E. Andrulewicz, Poland) will meet, jointly or back-to-back with SGPROD, in Kaliningrad, Russia, from 9–11 November 2005 to:

a) report on new developments regarding ecosystem-based approaches to management of the marine environment, with particular reference to progress in ICES, HELCOM, EU and US EPA;

b) further develop the Baltic ecosystem health concept in relation to the main ecological problems: eutrophication, hazardous substances, overfishing and biodiversity (including xenodiversity and habitat destruction);

c) develop reference levels for selected EcoQ elements;

d) continue discussion and propose, in cooperation with HELCOM MONAS (MON-PRO), reference levels for a set of ecological quality elements (EcoQ elements) that reflect associated ecological quality objectives (EcoQOs) for eutrophication, hazardous substances, impacts of fishing and loss of biodiversity (including xenodiversity and habitat destruction);

e) update and finalize deliverables from SGEH Study Group developments undertaken during the last three years;

f) identify potential contributions to 2006 ASC Theme Session on Integrated Assessments in support of regional seas ecosystem advice – beyond quality status reporting;

g) identify existing developments on socio-economic driving forces for pollution in the Baltic Sea. On the basis of this identification recommend strategies for further development;

h) evaluate and comment on the external review on the 2005 SGEH report.

SGEH will report by 13 January for the attention of the Baltic Committee and ACE.

2.2 Adoption of Agenda

The Chair presented the Terms of Reference for the SGEH meeting (Item 2.1) and the Final Agenda (Annex 2). There was discussion concerning ToR c) – "develop reference levels for selected EcoQO elements", as E. Łysiak-Pastuszak raised the problem that no general reference levels for the whole Baltic Sea can be developed for eutrophication indicators. Moreover she was of the opinion that the reference conditions should be developed by national experts not by SGEH meeting. E. Andrulewicz and A. Andrushaitis agreed to this and expressed the view that maybe the Baltic Committee expected too much of the Study Group. However, the meeting can provide some illustrative examples of reference levels for selected eutrophication indicators based on experiences gained in HELCOM EUTRO project.

K. Summers underlined the importance of verifying the list of indicators from a huge number of possible matrices to an operational system of a few most important indicators. He stressed the fact that reference conditions are the critical moment in the roadmap for a coherent system of management because an indicator can not be included for the assessment if reference conditions can not be determined.

With the above remarks, the meeting adopted the Agenda (Annex 2). It was expressed that the meeting should be pragmatic and flexible about the time schedule.

2.3 Election of Rapporteur(s)

The SGEH Chair proposed two Rapporteurs for the meeting: Dr Gedas Vaitkus from Lithuania (to take notes during the meeting) and Dr Elżbieta Łysiak–Pastuszak from Poland (to cooperate with the Chair – during preparation of the Draft Report). The meeting unanimously adopted both candidates.

2.4 Establishing Sub-groups and working procedures for Sub-groups

For the sake of efficiency of discussions, the meeting decided to establish four sub-groups covering the most important issues related to the ecosystem health of the Baltic Sea and appointed Chairs for these sub-groups:

Sub-group 1: Effects of Eutrophication

Co-Chairs: Elżbieta Łysiak-Pastuszak and Bärbel Müller-Karulis

Sub-group 2: Effects of Hazardous Substances

Co-Chairs: Kari Lehtonen and Thomas Lang

Sub-group 3: Effects of Fishing Activities

Co-Chairs: Maris Pliksh and Henn Ojaveer (by correspondence)

Sub-group 4: Habitat Destruction and Loss of Biodiversity

Co-Chairs: Sergey Olenin and Kevin Summers

Sub-group working procedure

The main task of the sub-groups was to operationalize indicator lists agreed upon during the ICES/BSRP/HELCOM/UNEP (Sopot) Workshop in March 2005. The following working procedure was suggested for the sub-groups:

- As a starting point use the ICES/BSRP/HELCOM /UNEP Sopot Workshop Report and the HELCOM EcoQO indicator outline (computer files and/or hard copies with these documents were available for each subgroup).
- Select/prioritize the list of indicators to absolute minimum for each topic. Include only those parameters for which you think that present data and scientific consensus is strong enough to create reference values/target levels (omit variables which are good but not yet ripe for implementation and try to raise above your own professional specialty and select only the best indicators for each general topic (Quality element etc.) even if you have personal interest in something else).
- If time allows, consider socio-economic (D- Driver type indicators) relevant to your subgroup and give illustrative examples of D-type indicators.
- Write a subgroup report consisting of selected indicator descriptions and the topics covered as headers for the indicators.

- Description (general description of the indicator and why this is good) (copy/paste relevant parts from HELCOM document)
- Measurement units (to make it clear)
- Data availability (indicate if you have some knowledge of existing data sources, particularly if they are not commonly known)
- Suggest reference levels (indicate the prospects for deciding on target levels).

Extra tasks were given to the Fishery Sub-group, which was asked to consider WG ECO recommendations, and to the Biodiversity Sub-group, which was asked to continue developments on benthic index.

3 Overview of developments of ecosystem-based approaches (ToR a,b,c)

3.1 Update on the developments of BSRP (Andris Andrushaitis)

Andris Andrushaitis, after a short presentation of BSRP working structure, described the events till the end of Phase II of the project and described major accomplishments:

Phase I of the project ends on 31 May 2006. Final reports of all units must be ready by the end of May 2006. There is a series of events to be scheduled until the end of BSRP Phase I:

IOC/IOD Ocean Data training in Vilnius and Fish Frame/DATRAS Fisheries data management training in Gdynia have just been completed with confirmed success. BSRP training workshops scheduled until the end of BSRP Phase I are: environmental genotoxicity (Gdynia/Vilnius), zooplankton indicators (Gdynia), fish pathology (Germany), fish aging (Germany), coastal fish monitoring (Helsinki), alien species (Helsinki), acoustic data processing (Kaliningrad), echo-sound analysis (Kaliningrad), zooplankton (Germany) and sampling gear inter-calibration (Helsinki). Plans to establish units for MMED and ICZM were postponed until the start of the second phase of the project.

BSRP technical capacity building efforts so far include purchase of sampling equipment for 763 thousand USD (Package 1). The major SGEH-related achievements include joint fisheries/productivity cruises, elaboration of indicator set to assess ecosystem status, enhancement of data management and analysis of tools, as well as integrated assessment efforts.

Now it is necessary to finalize and revise the working programs and to draft plans for the BSRP Phase 2. Amendments of work plans and work packages for Phase II have to be delivered by 1 December 2005. For Phase 2, it will be necessary to extend the circle of participating institutions, particularly from the Kaliningrad Region.

3.2 Plans for the ICES/BSRP/HELCOM Workshop on Developing Framework for Integrated Assessment for the Baltic (WKIAB) (Bärbel Müller-Karulis)

In continuation of A. Andrushaitis' presentation, B. Müller-Karulis informed the meeting of a new initiative within BSRP Component 1 to organize a mutual ICES/BSRP/HELCOM workshop on Integrated Assessment (WKIAB). The aim of the workshop would be to run a pilot IA for the Baltic Sea, i.e. combine the mainly eutrophication-oriented HELCOM assessment with fishery-oriented ICES assessment and biological effects. The workshop will be held in Tvärminne (Finland) from 1–4 March 2006.

Currently HELCOM assessments mainly deal with eutrophication, while ICES mainly concentrates on scientific evaluation of fish stocks and fisheries. BSRP took the initiative of providing links between those two activities by introduction of a concept based on assessment of productivity, which stimulates the development of fish stocks and triggers the effects of eutrophication. There is also strong socio-economic, conservation, and biodiversity implications, which all feed into the concept of Integrated Assessment. Review of the existing integrated assessment methodologies for the Baltic Sea has been carried out, pointing out the existing gaps and proposing additional activities towards improvement of the integrated assessment scheme for the Baltic Sea.

Discussion. In the discussion that followed, it was apparent that there was a great interest and support for the idea of such a workshop. T. Lang drew the attention to another ICES initiative in this respect, the newly formed Working Group on North Sea Ecosystem Assessment (REGNS). SGEH or the Baltic IA Workshop can utilize the experience and expertise from the North Sea Group. M. Balode expressed her view that too little attention is paid to ecosystem health problems and pollution as such. She suggested organizing a workshop deliberately devoted to ecotoxicological effects. K. Lehtonen and J. Baršienė were of the opinion that such a workshop on IA would be very valuable and it could include a thematic session on biological effects, including ecotoxicology. E. Łysiak-Pastuszak pointed out that information about the planned workshop should be passed to HELCOM MONAS to enable its distribution to Contracting Parties and interested institutions via HELCOM channels and to secure national funds for the participants. E. Boikova expressed some doubts as to whether the present data from HELCOM monitoring programme would be sufficient to carry out such an extensive IA. B. Müller-Karulis explained that HELCOM Monitoring programme is quite comprehensive and a pilot IA will be aimed to identify the gaps in the programme, to harmonise the HELCOM and ICES assessment schemes as well as to structure them. H. Bäcker explained that he missed in BSRP the notion of unification of the programmes, formats, etc., of various project branches/fields of interest. Such a pilot IA can be the platform to do it. B. Müller-Karulis added that data for this pilot IA should cover a really long-time data series to give the participants possibility to put very old data into digitalized form. S. Olenin inquired if the HELCOM biological data from the ICES database is planned to be used, because he was doubtful if any data can be supplied by ICES. G. Vaitkus explained that to carry out such an IA it is necessary to base statistical data processing on databases. The data should first be collected in respective databases for the whole project.

Doubt was expressed as to whether whether countries would accept that kind of change into their established monitoring schemes. On the other hand, finding possible solutions on how to integrate the ongoing monitoring activities into an integrated complex scheme is in fact the major priority of the BSRP, therefore certain solutions towards this direction will be found.

3.3 HELCOM activities including Baltic Sea Action Plan (Hermanni Bäcker)

H. Bäcker gave a short presentation of the Baltic Sea Action Plan, the new political initiative aimed at the protection of the Baltic Sea. He stated that the decisions concerning management measures should aim to attain good ecological status of the marine environment. In practice this means that we must reach a scientific consensus on a) what is the pristine, or background state, and b) what is the acceptable deviation from this state. The main fields of concern in the Baltic Sea Action Plan have been formulated as: eutrophication, contamination by hazardous substances, marine traffic and biodiversity and nature conservation, i.e. very similar to BSRP SGEH interests. Seta of indicators equipped with background levels as well as acceptable deviations should be developed for each of these concerns should be agreed upon.

H. Bäcker pointed out that ICES is a scientific organization, while HELCOM is mainly a political decision-making body, which mainly concentrates on practicalities. Therefore any scientific advise which HELCOM is looking for must be very practical, effective and relatively simple to implement. Draft HELCOM Baltic Sea Action Plan 2005 already includes preliminary threshold levels and reference values for the selected set of environmental indicators. During the current workshop we should concentrate efforts on finalizing discussion on the suggested indicators and begin considering threshold values and target quality levels. Ecosystem health, even though being a very complex issue, can be roughly covered with a relatively small set of environmental indicators for pragmatic assessment purposes.

Discussion. In the general discussion the procedures for subgroup work were elaborated. A. Andrushaitis stated that eutrophication indicators and eutrophication related issues have been already quite well elaborated by HELCOM EUTRO project and enquired what can be added by the SGEH meeting. E. Łysiak-Pastuszak explained that the indicators used in HELCOM EUTRO have not been prioritized. B. Müller-Karulis added that a summary of HELCOM EUTRO should be included in the SGEH-3 report. A. Andrushaitis raised also the problem of regional division of the Baltic Sea related to typology and the planned IA. K. Summers pointed out that the degree of disagregation should be dealt with from a practical point of view. M. Pliksh commented on the proposed division of the Baltic explaining that ICES fishery assessments are using very different division system – there are mainly two areas: the Western Baltic - up to Bornholm, while the Baltic Proper and the eastern and northern Baltic are considered together. V. Feldman pointed out that coastal lagoons are not included in BSRP activities. B. Müller-Karulis stated that the HELCOM Action Plan has to be checked against the EU Marine Strategy, so that there are no contradictions and the sets of indicators are well harmonized.

3.4 Indicator Selection and Development of Marine Environmental Quality Indices (Kevin Summers)

Indicator Selection

The National Coastal Assessment by the US EPA applies a set of indicator selection criteria that has been used to reduce the set of potential scientific environmental/ecological indicators to a limited set of operational indicators that are applied by all members participating in the surveys. These criteria imply that all operational indicators should be:

1) Regionally Responsive – The indicator must reflect changes in ecosystem conditions and respond to stressors (pressures) of concern across most resource classes and habitats within the monitored region.

2) Unambiguously Interpretable – Indicator must be related unambiguously to an assessment endpoint (relevant exposure/stressor/habitat variable) that forms part of the ecosystem's overall conceptual model of ecological structure and function.

3) Simply Quantifiable – Indicator can be quantified by synoptic monitoring or by cost-effective automated monitoring that can be adopted by all participants in the monitoring survey.

4) Stable over the Sampling Period – Indicator exhibits low measurement error and stability of regional cumulative frequency distribution during the sampling period (low temporal variation during the sampling period in regional statistics).

5) Low Year-to-Year Variability – Indicator must have sufficiently low natural year-to-year variation to detect ecologically significant changes within a reasonable time frame.

6) Environmental Impact – Sampling for the indicator should have minimal environmental impact.

Using these criteria, the National Coastal Assessment (US EPA) selected the following indicators to be used operationally in the monitoring surveys:

1) Exposure (Stressor) Indicators: nutrients (DIN, DIP), sediment contaminants, sediment toxicity, dissolved oxygen, and contaminants in fish and shellfish

2) Response Indicators: benthic community structure (species and abundance), fish community structure (species and abundance), and fish pathology (diseases and injury)

3) Habitat Indicators: percent light transmittance (water clarity), salinity, temperature, pH and substrate type (percent silt-clay).

Development of Marine Environmental Quality Indices

For the decision-making, even the simplest ranking (like “good”, “fair” and “poor”) is often sufficient as background information. Regional distribution of those values can serve as implication for the general level of management efforts: large area in poor quality would require massive international intervention, while local concentrations of bad quality sites may require national- or even municipal-level management activities. The five major marine environment quality indicators:

- Water Quality Index;
- Sediment Quality Index;
- Coastal Habitat Index;
- Benthic Community Index;
- Fish Tissue Contaminants Index,

were used to produce a set of the Overall Poor Condition Estimate values, which were also mapped for more clear perception by the general public.

Information about development of Benthic Community Index is given in Annex 3.

Discussion. During discussion A. Andrushaitis inquired about the pilot study in the application of benthic index if the assessment comprised 422 sites. K. Summers explained that the pilot study was conducted at 25 sites and the final project included all metrics applied in the pilot study. T. Lang was interested in the possibility to determine the causes of degradation using benthic index. K. Summers replied that information concerning non-biological parameters and their relation to environmental stressors, like hypoxia, contaminants, etc., was examined additionally in the project. T. Lang further inquired about the possibility to detect changes related to harmful algal blooms using benthic index. The reply was negative and M. Balode additionally explained that benthic organisms can accumulate algal toxins without showing harmful effects. N. Aladin raised the problem of communities’ succession and inquired whether benthic index made it possible to distinguish between young, mature or declining stage of community development. K. Summers replied that this index did not give such possibility. M. Balode asked a question about toxicity tests – if toxicity of sediment was detected by bioassay technique could this be correlated with the specific contaminant? And what particular substances were measured in the project? K. Summers answered that contaminant measurements included 170 specific compounds but in most cases correlation was established for the classes of substances not for specific compounds. E. Boikova inquired about the possibility to detect/check a false alarm signal. K. Summers explained that in cases a site was always “negative” and showed suddenly “positive” assessment result, the procedure required sampling for the second time within a short period.

3.5 Towards a zoobenthic index - availability of benthic and environmental Stressor data for development of Baltic Sea Benthic Index (Hermanni Bäcker)

H. Bäcker shortly described the availability of HELCOM data on macrozoobenthos, which can be used for the development of Baltic Sea benthic index. HELCOM collection of historical data on zoobenthos contains more than 1200 stations sampled during 1979–2003. Data on abundance and biomass of species are available.

Discussion. A. Andrusaitis: A series of historical data sets on benthos in the form of maps, etc. exists and might be considered, but how should we treat those in the light of “good”–“bad” range of environmental conditions? S. Olenin: Baltic Sea studies have produced extensive data sets, and it should be collected into one central location and analyzed in order to assess historical conditions of the physical environment, as well as condition of benthic communities.

3.6 Reference conditions, background values and target levels for eutrophication (Elżbieta Lysiak-Pastuszak)

E. Łysiak-Pastuszak shortly presented the aims, timetable and results of the HELCOM EUTRO project carried out in 2005 by all HELCOM countries (except Russia) for the development and testing of tools for thematic assessment of eutrophication in the Baltic Sea. Basing on experiences gained during HELCOM EUTRO project and definitions contained in WFD, some ideas were presented regarding reference conditions, methods of reference conditions development, background values equal to historical data and target levels for eutrophication taking into account reference conditions and acceptable deviation.

Reference conditions

According to the Water Framework Directive guidance documents, reference conditions should describe environmental status of NO or only MINOR disturbance from human activities, being synonymous to high ecological status. Hence, they may be either spatially based i.e. determined at reference sites or based on historical data and modelling or may be derived by a combination of these methods. Where it is not possible to use these methods, expert judgement may be used to establish such conditions.

The results of HELCOM EUTRO Project showed that reference sites are not found in the Baltic Sea area; hence the reference conditions were determined basing on historical data, modelling and expert judgement. Historical data were used mainly for winter DIP, DIN and Secchi depth as well as for depth range of macrophytes.

Background values

Historical data used in HELCOM EUTRO came from different time periods, e.g. submerged vegetation depth distribution data from Denmark, Estonia and Finland come even from 1880s, as do the Secchi depth data in Finland. Winter DIP data in Latvia and Poland come from the period after the World War II and early 1950, like the data on winter DIN and DIP in Germany. Different uncertainty is associated with these data than with the data from biogeochemical or ecological models. It is quite frequent that experts use the term background values in relation to historical values considering reference values as a different entity.

Target values

Ecological objective set by WFD is the good ecological status defined as slight change in ecological quality elements in comparison to high status. This can be regarded also as the target regarding combating eutrophication effects:

ecological objective = good ecological status = target.

Within HELCOM EUTRO the quality objective was set as the level of reference conditions increased by acceptable deviation:

eutrophication quality objective = REFCOND ± acceptable deviation.

("+" applied in the case of indicators having positive response to nutrient enrichment, e.g. chlorophyll-*a*, winter nutrient concentrations; "–" – for indicators having negative response to nutrient enrichment, e.g. Secchi depth, oxygen concentrations).

3.7 Progress in biological effects monitoring (Kari Lehtonen)

K. Lehtonen informed the meeting about the results of a demonstration project BIODEMO carried out in 2005 by two laboratories involved in biological effects studies. The project included sampling in a polluted and relatively unpolluted areas by institutes, analysis and comparison of results. No new methods were tested. The results of the project were very promising taking into account that the revision of HELCOM monitoring programme is aiming at inclusion of biological effects monitoring on a voluntary basis.

K. Lehtonen informed also about the new initiative within the Baltic Sea area – BONUS-169 project in which a work-package devoted to collaborative effort on biological effects of pollution is proposed.

BIODEMO

The plan of the BSRP Demonstration project BIODEMO, a small-scale pilot study on developing the application of biomarkers in the monitoring and assessment of the Baltic Sea was presented in the ICES Working Group for Biological Effects of Contaminants (WGBEC) in Reykjavik (3/2005). The expert group expressed its full support and gave some practical advice for the execution of the project. Two persons from the BSRP recipient countries also participated in the WGBEC meeting.

Due to practical reasons some modifications were made in the BIODEMO project:

- only laboratories from Poland (Sea Fisheries Institute, Gdynia) and Lithuania (Institute of Ecology, Vilnius) were involved;
- the use of lysosomal stability test (Neutral Red) was not considered possible at this stage.

Two Technical Assistants (TA), Janina Baršienė (IE/VU, Vilnius) and Dorota Napierska (SFI, Poland) were responsible for carrying out the BIODEMO studies in their respective laboratories. The report will contain the biomarker data collected by 1 December 2005 and a comprehensive report on the biological effects of environmental contamination in selected sites. The report will also include recommendations for future application of the biomarker approach in assessment of ecosystem health status and will be ready by the end of the BSRP Phase I (by 1 May 2006). Ad hoc reporting on specific aspects of the project may also be prepared by the TAs on request.

In September–October 2005 samples were collected in selected areas (polluted and reference) of Lithuanian and Polish coastal zones for a set of biomarkers determination [acetylcholinesterase activity (neurotoxicity), glutathione-S-transferase activity (biotransformation: conjugation) and catalase activity (oxidative stress) and micronuclei frequency (genotoxicity)]. The bioindicator species collected were: flounder (*Platichthys flesus*), turbot (*Scophthalmus maximus*) and blue mussel (*Mytilus* sp.). Method exchange and intercalibration (enzyme analysis and genotoxicity) will be carried out in late November 2005. Technical capacity building to the laboratories participating the BIODEMO amounting to 30 000 € had been granted by the BSRP.

Regarding other relevant activities, the revision of the HELCOM monitoring programme (MON-PRO project) with the inclusion of more biological effects methods into monitoring and assessment scheme (voluntary basis) was mentioned. In addition, cooperative actions in the planning of biological effects component for the forthcoming BONUS-169 programme for the Baltic Sea were stressed.

3.8 Programme of the ICES/BSRP Sea-going Workshop on Fish Diseases Monitoring in the Baltic Sea (WKFDM) (Thomas Lang)

T. Lang presented the programme and timetable of the workshop devoted to fish disease studies. The workshop is going to take place onboard RV "Walter Herwig III" from the 5–12 December 2005. The programme includes training and intercalibration of methods for disease diagnosing, development of fish health indicators and establishment of closer cooperation between the involved institutes. The training course will include sampling, diagnosis of diseases and visual lesions and age determination exercise in flounder, herring and cod.

Background

Based on long-term experience there is no doubt that fish diseases are an appropriate indicator of ecosystem health and that the prevalence's of diseases respond to environmental change, including contaminant effects. Furthermore, many fish diseases are of ecological and economical relevance since they may affect growth, reproduction and survival in affected fish populations. Therefore, many ICES member countries monitor fish diseases as part of their national marine monitoring programmes.

In the Baltic Sea, only Poland, Germany and partly Russia are presently conducting regular fish disease monitoring programmes. However, from data assessments carried out by the ICES Working Group on Pathology and Diseases (WGPDMO) there is an indication of methodological problems, particularly regarding the comparability of disease prevalence data, and a clear need for more intercalibration has, thus, repeatedly been emphasised.

Besides these countries, there is also interest in other Baltic Sea countries to implement fish disease monitoring as part of the coastal or offshore monitoring, but there has been an apparent lack of either capacity or experience. Within the BSRP, this has been realised and funding was provided for capacity building related to fish disease monitoring in the BSRP beneficiary countries. The AtlantNIRO was appointed as BSRP Lead Laboratory for Fish Diseases, Parasites and Histopathology in order to coordinate activities.

Since ICES has a long experience in developing and intercalibrating methodologies for fish disease surveys and has organised methodological workshops before (e.g. 1994 in the Baltic Sea, co-sponsored by the Baltic Marine Biologists, BMB), it was decided to organise an ICES/BSRP sea-going training workshop, aiming at standardisation and intercalibration of methodologies, addressing aspects from fish sampling, disease diagnosis to statistical data assessment. It is hoped that the workshop and related activities will build the basis for the incorporation of fish disease studies into national marine monitoring and assessment programmes of the Baltic countries and eventually into the HELCOM monitoring programme.

Workshop Programme

According to ICES Council Resolution 2005/2/BBCC02, the workshop objectives are:

- to provide training and intercalibration related to methodologies applied in fish disease monitoring in the Baltic Sea;
- to further develop and assess health indicators and indices appropriate for monitoring and assessment purposes;
- to establish a closer collaboration between institutes involved in fish disease monitoring in the Baltic Sea; and
- to build the basis for incorporation of fish disease surveys into the revised HELCOM monitoring programme.

The workshop will be organised according to the following timetable:

4 December	RV “Walter Herwig III” arrives in port of Gdynia
5 December	Participants arrive in Gdynia, start of workshop on board RV “Walter Herwig III”
6–11 December	Field work and training at selected sampling sites (see Figure 1)
11 December	RV “Walter Herwig III” returns to Gdynia, reception on board with participants and invited guests
12 December	End of workshop, RV “Walter Herwig III” leaves Gdynia

The workshop programme will consist of practical work and training with flounder (*Platichthys flesus*), cod (*Gadus morhua*) and herring (*Clupea harengus*) as target fish species as well as of theoretical work addressing aspects such as:

Practical work: methods of fish sampling, disease diagnosis (externally visible diseases/parasites and liver histopathology), intercalibration exercises, sampling for histopathology and biomarkers, fixation and preservation techniques, age determination, data entry software, hydrographic measurements, etc.

Theory: overview of national and international programmes and databases (e.g. ICES Data Centre), sampling design, data recording, analysis and assessment, development of health indicators, confounding factors with impact on diseases (host-specific, site-specific), quality assurance (e.g. BEQUALM), etc.

The Workshop results will be published as ICES/BSRP Report and will be presented to the ICES SGEH, the ICES Working Group on Pathology and Diseases (WGPDMO) and the ICES Baltic Committee (BCC).

Workshop Participants

The workshop will be attended by 14 participants, consisting of trainers (Germany, Finland, Sweden, and the UK) and trainees representing eight of the nine Baltic Sea countries.

The workshop will take place on board a German research vessel from 5–12 December 2005. Background was laid by the ICES Council Resolution 2005/2/BCC02. The aims of the training are mainly inter-calibration of research teams and exchange of experience. 14 participants are invited to join the cruise, including 4 official trainers (UK, Germany, Finland). Most of the sampling sites are located in southern part of the Baltic Sea (and a couple of sites in Swedish waters). Training will focus on identification of external/intestinal fish parasites, but also sampling, fixation techniques, data management, analysis, quality assurance, etc. The training workshop will result in an ICES/BSRP report.

The Chair and BSRP AC1 thanked T. Lang for his personal commitment to organise the workshop and the Germany for substantial financial support.

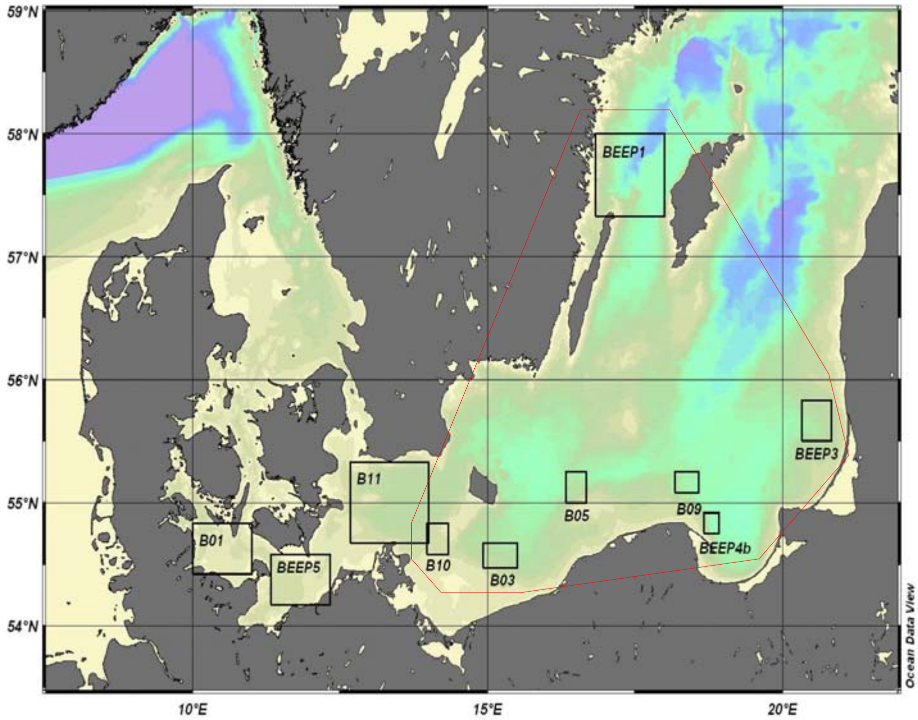

Figure 3.8.1: Location of sampling sites for the ICES/BSRP Sea-going Workshop on Fish Disease Monitoring in the Baltic Sea (WKFDM) (sampling area marked in red).

3.9 Public health aspects of pollution and eutrophication of the sea (Astrid Saava)

A. Saava gave a descriptive presentation of possible public health effects caused by eutrophication or pollution of the marine environment. She dwelled on the similarities between the human health – the state of complete physical, social and mental well being – not merely the absence of disease or infirmity – and the good ecological status of marine environment. Marine environment is valuable to humans in various aspects: for recreation, it supplies food and nutrition and enhances the quality of human life in terms of aesthetic enjoyment. Simultaneously, adverse public health effects can be direct – due to ingestion of polluted water, by skin contact with water or inhalation of polluted aerosols; or indirect – due to fish consuming, consumption of toxic seafood after toxic algal blooms. Among indirect effects the loss of recreational value due to massive growth of algal mats or toxic algal blooms were mentioned

The interactions between humans and the sea are significant and necessitate more comprehensive study and assessment. The seas provide great health benefits to humans, ranging from food and nutritional resources to recreational opportunities, and a novel resource for new bioactive compounds and food additives. Marine plants, animals and microbes have served as a source for pharmaceuticals to treat diseases.

The marine ecosystem acts as a conduit for many human diseases. The distribution of viral, bacterial, and protozoal agents and chemical contaminants in marine habitats depends on the interplay of currents, tides, and human activities. The presence of algal toxins in marine environment is receiving increasing attention around the world as a public health concern. The basic route of human exposure to hazardous agents is through ingestion of contaminated seafood, but illness can also result from direct contact with seawater during recreational or occupational activities and from contact through aerosols (sea spray) containing toxins.

Pathogens from human or animal waste and different chemical compounds contaminate coastal and estuarine areas through freshwater runoff from sewers, rivers and streams. Marine pathogen bacteria and harmful algal species can invade new areas through the transport of organisms in the ballast water of ships. Viruses and bacteria of faecal origin become concentrated in filter-feeding shellfish such as oysters and clams. No specific test exists for detecting contaminated fish. At the same time fisheries products are transported and sold worldwide.

Many types of chemical contaminants threaten the marine ecosystem as well as human health. Substances of particular concern are synthetic organic chemicals, specific heavy metals, marine (algal) toxins, and possibly genetically modified organisms. A major concern for public health is the ingestion of contaminated seafood, putting those humans who eat contaminated seafood over time at the greatest risk. The long-term exposure has a variety of effects on human reproduction, neurobehavioral development, liver and kidney function, immune response, and tumorigenesis. More recently, these compounds have been found to possess endocrine properties and have been associated in animals and humans with male fertility problems.

Algal toxins are produced by marine organisms on a scale large enough to induce adverse effects on communities of higher organisms. Humans may be exposed through the consumption of seafood or through dermal contact from occupational or recreational exposure to a toxin. Different toxins have different effects. Symptoms include nausea or respiratory problems up to severe memory loss, with fatality rates exceeding 10 % in some cases.

Linking the health of the marine ecosystem with that of human population is a long-term endeavour that will require considerable efforts and resources. Reduction and prevention of human health threats caused by marine ecosystem changes requires determination of cause-effect relationship. It is possible only by correlating data on ecosystem health changes with reliable reports from the public health sector.

Discussion. T. Lang congratulated the speaker on a thorough presentation of the subject. He informed the meeting that during the ICES Annual Science Conference in 2006 a Theme Session is planned regarding “Human health risk and marine environment”. The Chair asked A. Saava to submit the presentation for publication, to make it available for a wider public.

Note: Full text of the presentation is included to this Report as Annex 4.

4 Results of work in Sub-groups – categorization of indicators (ToR c,d,e)

A recommended working procedure for sub-group work was agreed upon under items 2.4 and 3.4. This work procedure consequently was followed by sub-groups.

4.1 Subgroup on Effects of Eutrophication

Elżbieta Łysiak-Pastuszak (Co-Chair), Bärbel Müller-Karulis(Co-Chair) Sergey Aleksandrov, Olga Dimitrieva, Georg Martin (by correspondence), Henn Ojaveer (by correspondence), Juris Aigars (by correspondence).

Indicators of eutrophication

The sub-group considered the following lists of eutrophication indicators:

- indicator list developed at the ICES/BSRP/HELCOM/UNEP Regional Sea Workshop on Baltic Sea Ecosystem Health Indicators, 30 March–1 April 2005, Sopot, Poland;
- indicator list compiled by the HELCOM EcoQO Project;
- indicator list suggested by ICES WG ECO;
- indicators applied in HELCOM EUTRO.

HELCOM EUTRO project was established to develop assessment tools for a Baltic-wide harmonization of eutrophication assessment criteria and procedures including determination of reference conditions for different parts of the Baltic Sea. Another aim of the Project was to test preliminary Pan-European guidance on assessment of eutrophication in European coastal waters but adapted to Baltic specific features. Altogether 13 open sea basins and 29 coastal or transitional water bodies were examined ranging from almost pristine areas in the open parts of the Bothnian Bay to areas in the central, eastern, southern and western Baltic which are generally regarded as eutrophication problem areas (HELCOM, 2002). The indicators used in HELCOM EUTRO were grouped in three categories:

- Category I: causative factors, e.g. N-riverine inputs, P-riverine inputs, atmospheric deposition of nitrogen, winter DIN and DIP concentrations;
- Category II: direct effects, e.g. primary production, chlorophyll-*a* concentrations, Secchi depth;
- Category III: indirect effects, e.g. zooplankton biomass, number of benthic species, zoobenthos biomass, number of species of phytobenthos, depth range of submerged vegetation, oxygen concentrations near bottom.

This categorization differed from the quality elements – phytoplankton, macroalgae and angiosperms, benthic invertebrates and general conditions – used in Water Framework Directive normative definitions. Various metrics were tested for individual indicators, e.g. for chlorophyll-*a*: summer (June to September) mean concentration, annual mean, summer (August) mean concentration or summer (August) maximum concentration were used; for phytoplankton: phytoplankton biovolume, species structure, abundance and biomass; for zoobenthos - BQI (<20 m), species richness, biomass and abundance. Reference conditions were established for various indicators using mainly expert judgement method, though historical data and modelling (Nielsen *et al*., 2003; Schernewski and Neumann, 2005) were also applied. It was concluded that reference sites were not found in the Baltic Sea area, i.e. there is no sites with high ecological status. It was concluded that the information on reference conditions is both an anchor and a bottleneck in the process of eutrophication assessment; the tested procedure does not work without information on reference conditions. At the first approach 50 % deviation from reference conditions (applied arbitrarily to all indicators) was used to determine the border between the good and moderate ecological conditions and the eutrophication objective of EUTRO. Though through the experience gained in the project it was concluded that the acceptable deviation for Secchi depth and depth range of submerged vegetation should not exceed 25 %. The data used for the assessment were taken from the present HELCOM COMBINE monitoring programme for the period 1999–2004 with the resulting conclusion that synoptic data (meaning both data on reference conditions and a monitoring system securing regular measurements) is a prerequisite for classification and assessment of eutrophication status in the Baltic Sea. The assessment principle applied in the Project was based on one-out-all-out rule though applied in a very constraint way – to individual indicators. Regarding pressure information considered in the Project, it was concluded that this information is relevant when it comes to understanding why an area is an "eutrophication problem area" and for the setting up the programme of measures, however pressure information should not be included in the classification of eutrophication status.

The preliminary assessment of eutrophication status in 42 areas carried out within the EUTRO Project resulted in the classification of all 29 coastal sites as "eutrophication problem areas" and also 13 open sea basins have been classified as "eutrophication areas", though two of the open sea basins (Bothnian Sea and Bothnian Bay) are considered as "false positive" results due to constraints in the principles used by HELCOM EUTRO.

Suitability of proposed indicators

Only indicators describing macrophytobenthos, macrozoobenthos, and Secchi disk depth fulfilled the criterion of low year-to-year variation (see table below). For Secchi depth, the low interannual variability is most likely due to the high background signal from water components other than phytoplankton, which make the method robust, whereas benthic fauna and flora contain long-living species that "integrate" the eutrophication signal over a time-period of several years. Turnover times in the pelagic system, on the other hand, span from several days (phytoplankton) to several weeks (zooplankton). These components therefore respond fast to changes in the nutrient supply. However, high interannual variation in nutrient supply is an inherent characteristic of the Baltic Sea, especially in coastal areas and semi-enclosed sub-basins, because of the high contribution of freshwater to the water budget.

An indicator system restricted to the interannually stable elements of the Baltic Sea ecosystem was not felt useful for eutrophication assessment, as it omits important causative factors (e.g. nutrient loads, winter nutrient concentrations), direct effects (e.g. changes in phytoplankton) and indirect effects of eutrophication (e.g. frequency of harmful algal blooms). Inclusion of the relatively variable pelagic indicators into the indicator framework is also necessary to fulfil the legal requirements to monitoring and assessment in the Baltic provided by the EU Water Framework Directive and the draft EU Marine Strategy. Both require a broad ecosystem status assessment, including also hydrographic variables, a description of the nutrient status, as well as phytoplankton and zooplankton (only Marine Strategy). To mitigate the effects of interannual variability we recommend that assessments should be based on averaging periods of several years.

Reference conditions

Reference conditions for indicators characterizing quality elements in the Baltic Sea were taken either to represent the situation in the early 1900s, the situation right after World War II, or the lowest percentiles of data from the 1970s and 1980s. Within the HELCOM EUTRO project an acceptable deviation from the reference conditions (50 % or less) was used to define good ecological status. The EU Marine Strategy suggests conducting initial assessments and defining good environmental status as a target for management. The developments coming out from the work of the Baltic GIG (Baltic GIG, 2005) recommend to focus on response curves which quantify relations between pressures and ecological indicators and are needed for several reasons: 1) they are easily understood, 2) they illustrate the range in pressures and environmental responses, 3) they are useful in justifying and explaining what an acceptable deviation between good and moderate ecological status is, 4) they should be the basis for setting up the measures.

Socio-economic aspects

Socio-economic indicators are useful to describe the driving forces leading to nutrient enrichment, especially indicators that describe the intensity of agriculture (e.g. fertilizer use, livestock density, farm size, number of manure tanks per specific number of farms), forestry, traffic emissions (e.g. number of cars) or industry (point source loads).

The costs of nutrient load reductions (direct costs of new constructions of e.g. sewage treatment plants, manure storage tanks and indirect costs of e.g. reduced harvest, set-aside land) can be regarded as socio-economic indicators or as requisite information to rank management options. Also the impact of nutrient load reduction, leading to decreased marine productivity and fish stocks has to be addressed to for ecosystem management of the Baltic.

Evaluation of individual indicators

The list of indicators evaluated by the sub-group is included in Table 4.1.1.

Indicators were evaluated with respect to the following criteria:

- Data availability;
- Regional responsiveness;
- Unambiguous interpretation of indicators;
- Index period stability;
- Year-to-year variation;
- Environmental impact.

The ranking was done according to the scale: 1 – very important and should be included in the list of operational indicators, 2 – moderately important, 3 – not important or data collection (measurement) rises significant problems.

Land-based nutrient inputs

Land-based nutrient inputs (N, P) provide information on the driving forces of marine eutrophication. Concentrations in the freshwater (N-tot, P-tot, DIN, DIP) describe changes in nutrient loss from land, whereas marine eutrophication is driven by the combined effect of riverine nutrient concentration and the freshwater runoff. Riverine nutrient loads are sensitive to the measurement frequency of riverine nutrient concentrations.

Atmospheric nutrient inputs

Atmospheric nutrient inputs are most important for the open areas of the Baltic Sea. Atmospheric N deposition in off-shore regions is determined by model calculations.

Nutrient concentrations

Winter nutrient concentrations provide a suitable eutrophication indicator. However, the use of winter nutrient concentrations can be hampered by ice conditions, especially in coastal areas. Also, some shallow coastal systems might not have a winter nutrient maximum because of high nutrient take-up by filamentous algae (HELCOM, 2002).

The draft of the EU Marine Strategy also demands information on nutrient cycling, specifically on currents and sediment-water exchange. With respect to the Baltic Sea, water/nutrient exchange between sub-basins and the exchange with the North Sea is important for several sub-regions/sub-basins (Stigebrandt and Wulff, 1987). The water and nutrient exchange is not an eutrophication indicator per se, but acts as a driver and is therefore important in assessing eutrophication. However, nutrient and water exchange between Baltic Sea sub-basins and Baltic Sea/North Sea is difficult to estimate.

Sediment-water exchange of nutrients, as suggested in the EU Marine Strategy, is mainly assessed through proxy data, e.g. near bottom nutrient concentrations, which in turn are affected by hydrological conditions. Direct measurements are restricted to research projects and have high spatial and temporal limitations. Therefore no indicators describing the sediment-water exchange of nutrients have been included in the current indicator system.

Phytoplankton

Chlorophyll-*a* is the most practical indicator to describe eutrophication effects of the Baltic Sea phytoplankton (Wasmund *et al*., 2000; Schrimpf *et al.,* 2002; 2003; 2004; 2005).

Chlorophyll-*a* is used most frequently as a proxy for phytoplankton biomass, because it is easy to measure, and has long time series of comparable data in the Baltic Sea.

Both with respect to chlorophyll-*a* as well as with respect to phytoplankton indicators, different seasons provide useful indicators. However, care has to be taken, that each season is covered by various monitoring surveys to provide stable indicators.

Chlorophyll *a*

Summer chlorophyll *a*. The summer period should include the time after the spring bloom subsided up to the beginning of autumn mixing. Measurements should cover a time period of several months, e.g. June to September as proposed in HELCOM EUTRO or May to September as proposed by the Baltic GIG.

Annual average chlorophyll *a*. Annual average of chlorophyll *a* should be determined for the period of ice-free water. Annual average stabilizes the variability of the chlorophyll indicator; however, calculation of annual averages is only feasible if the temporal sampling frequency is high.

Spring chlorophyll *a*. In many areas of the Baltic Sea the spring bloom is more pronounced than the summer bloom. The intensity of the spring bloom also determines the input of organic matter to the bottom sediments and therefore is important with respect to ecosystem functioning. Determination of a spring chlorophyll average requires high temporal sampling frequency for the spring months and is not feasible in many monitoring programmes.

Phytoplankton species composition provides important information on foodweb functioning and biogeochemical processes, but analysis is time consuming and reference conditions for phytoplankton species composition are difficult to establish. In addition, phytoplankton species composition is sensitive to changes in salinity and therefore reflects also changes in hydrological conditions. Phytoplankton species composition, especially the proportion of functional groups, is considered sensitive to eutrophication in several seasons. The proportion of functional groups also provides important information on organic matter fluxes in the marine ecosystem.

Several HAB indicators have been included in the indicator system. Assessment of the frequency and duration of HAB blooms relies on measurements with high temporal coverage, e.g. SOOP data. It also has to be taken into account that the occurrence of HAB species is region specific, as for example cyanobacteria blooms are restricted to salinities below 11 PSU (Wasmund, 1997).

Primary production, though providing important information on the organic carbon available to the ecosystem, is currently measured only in some subareas of the Baltic Sea. The amount of data is insufficient to use primary production as eutrophication indicator for the entire Baltic Sea area.

Macrophytes

In areas with substrate suitable for macrophyte growth, the depth ranges of several species provide suitable eutrophication indicators. In some cases, historical data exists that allow establishing well-defined reference conditions. However, eelgrass (*Zostera marina*) distribution has also been affected by diseases not only by eutrophication (Frederiksen *et al.*, 2004).

In order to select potential ecosystem health indicator the following criteria were used in the case of macrophytes.

A good indicator should:

1) respond predictably to changes in trophic levels;
2) have well-defined reference conditions;
3) have a wide potential distribution range;

and should preferably:

1) be relevant for the ecosystem;
2) be simple to measure.

Based on these criteria and existing knowledge on marine vegetation, 9 potential indicators were selected and tested in different activities (CHARM deliverable 15, BSRP LL PB monitoring, BSRP EUTRO test study on GoR).

Four of the indicators concern the depth distribution of the vegetation and include various parameters describing depth distribution (see Figure 4.1.1):

1) The depth limit of eelgrass shoots/algal individuals;
2) The depth limit of eelgrass meadows/algal belts;
3) The depth of maximum abundance of eelgrass/macroalgae;
4) The downward slope of eelgrass/macroalgal abundance.

Table 4.1.1. Selected indicators/metrics.

INDICATOR	HABITATS
Depth distribution of *Zostera marina*	Soft/sandy substrates
Depth distribution of *Fucus vesiculosus*	Hard substrates
Depth distribution of *Furcellaria lumbricalis*	Hard substrates
Depth distribution of total algal community	Hard substrates
Ratio annual/perennial macroalgae	Hard/soft substrates
(Ratio filamentous algae/*Zostera marina*)*	Soft/sandy substrates
Sensitive species e.g. Charophytes	Soft/sandy substrates
(Area covered and bed structure of *Zostera marina*)	Soft/sandy substrates
(Eelgrass-associated fauna)	Soft/sandy substrates

The term “depth distribution” includes: “the depth limit of the deepest found individuals”, “the depth of maximum abundance”; in addition for *Fucus vesiculosus* “the depth limit of the continuous Fucus belt” and for eelgrass “the depth limit of meadows”. The indicators in parenthesis are of secondary priority and *indicates that no work is done so far.

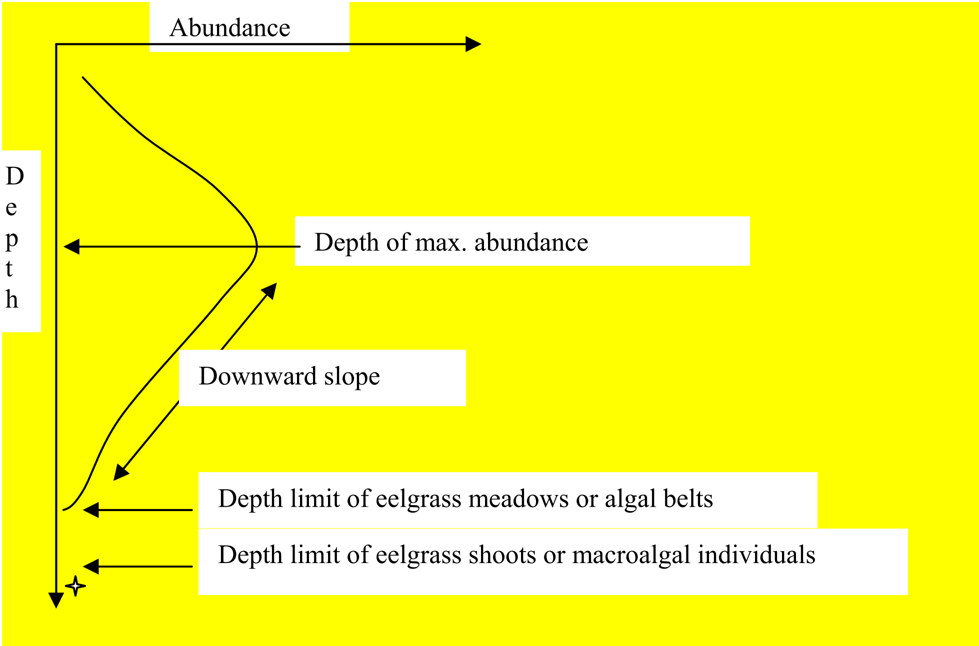

Figure 4.1.1: Schematic presentation of parameters describing the depth distribution of macropyhyes.

Depth distribution of macrophytes is largely determined by light (e.g. Duarte 1991, Nielsen *et al.,* 2002) and therefore also by parameters affecting the light climate. Increased nutrient concentrations stimulate the production of phytoplankton and epiphytes, which reduce water clarity and thereby reduce the depth penetration of macrophytes (Nielsen *et al.,* 2002). Depth distribution of macrophytes should therefore respond predictably to eutrophication.

The ratio of annual to perennial macroalgae and of filamentous algae to Zostera marina form potentially sensitive indicators because high nutrient concentrations generally favour the growth of ephemeral flora (Sand-Jensen and Borum, 1991; Duarte, 1995; Pedersen, 1995).

The presence and abundance of sensitive species such as Charophytes is suggested a potential indicator because Charophytes are believed to be very sensitive to eutrophication, especially to increased turbidity. The presence of at least some Charophyte-species therefore seems to be a reliable quality indicator in limnetic ecosystems (e.g. Melzer, 1981; Berg, 1999; Scheffer, 1998).

The area covered and the bed structure of eelgrass is suggested as potential macrophyte indicator because a reduction in depth limit due to low water quality should also reduce the potential area covered by this species and possibly also change the bed structure towards more sparse and scattered patches.

Eventually, the eelgrass-associated fauna is suggested a potential indicator because recent studies have shown that the fauna composition responds to changes in water quality (Boström *et al.,* 2002).

Water clarity

Secchi depth is the most simple and robust indicator of water clarity. Similarly to chlorophyll-*a*, several metrics can be used to define water clarity indicators, e.g. summer average, annual average or spring average. Most historical data are available for the summer season.

Oxygen conditions

Oxygen conditions provide a suitable indicator in some areas of the Baltic Sea, but cannot be used as an eutrophication indicator in the deep Baltic basins, because the hydrological regime controls the extent of anoxia there. Depending on the shape of the coastline, oxygen conditions in coastal areas can also be affected by upwelling.

Zooplankton

Zooplankton is an important link between primary producers and secondary consumers (planktivorous, young and larval fish) in the Baltic foodwebs. Zooplankton abundance and biomass dynamics is affected by changes in productivity, but reacts also to forcing from its predators. In addition, some zooplankton species are sensitive to changes in temperature, salinity and eutrophication/pollution. Design of zooplankton indicators for the Baltic is currently under development within the BSRP project and the HELCOM Zooplankton expert network.

Macrozoobenthos

Macrozoobenthos should be used as eutrophication indicator only in shallow areas of the Baltic. In deep areas, hydrological conditions regulate oxygen regime and thus macrozoobenthos occurrence. Several indicators have been proposed during last years to be used to assess eutrophication but for most of them defining good reference conditions were proven to be a difficult task. The use of different indices characterizing the community structure, species richness, and functionality have been tested in several recent investigations and the results show some promising conclusions in certain areas and complete failure in others. More investigations should be concentrated on this topic in nearest future.

Fish

Baltic fish catches increased considerably during the 20th century (ca. 10-fold since the 1930s–1940s); amongst other factors, this increase has been attributed to increased fish production, resulting from eutrophication, but also to increased fishing effort and developments in fishing techniques.

It is generally accepted that some fish species withstand eutrophication better while other do not. It has been shown that species like bream *Abramis brama*, ruffe *Gymnocephalus cernuus*, pikeperch *Stizostedion lucioperca*, perch *Perca fluviatilis* are more abundant in eutrophic conditions by gaining profit from eutrophication (partly through increased food supply). However, excessive eutrophication is detrimental also for them. At the same time, several marine and migratory species (like flounder *Platichthys flesus*, fourhorned sculpin *Triglopis quadricornis*, herring *Clupea harengus membras*, whitefish *Coregonus lavaretus*) but also freshwater species (e.g., pike *Esox lucius*) tend to avoid the most eutrophied areas (Anttila, 1973; Lehtonen and Hilden, 1980; Lappalainen and Pesonen, 2000).

There is some evidence, based on the long-term catch dynamics of pikeperch in the southern Baltic Sea, that eutrophication has already had an effect on fish since the end of the 1930s (Winkler, 1991). Winkler (1991) suggests that this species gains in recruitment because of eutrophication as eutrophication provides better conditions for hunting. The negative impact of eutrophication is seen on pike through the destruction of spawning and nursery grounds (lack of shelter) as a consequence of the decline of macrophyte covered areas (Winkler, 1996).

For the most abundant marine fish – herring - the effect of eutrophication can be variable: increased densities of filamentous brown algae may have negative effect on reproduction success while increased zooplankton production could increase growth and survival of larvae and young fish. It has been demonstrated that continuous deterioration of environmental conditions can increase egg mortality due to disappearance of natural spawning substrates (Raid, 1991).

Therefore, selected fish species or their various life stages (adults, juveniles, larvae or eggs) can be good indicators for eutrophication. Based on the available research results it may be concluded that percids and cyprinids are good indicators of eutrophication. However, it must be stressed that there can be other processes in parallel at work which may impact fish species dynamics in a similar direction. For instance, warm summers facilitate an increase in the abundance of cyprinids and percids and very often, separation of these effects from eutrophication is very difficult. In a similar manner, a decrease of abundance of several marine commercial species might mainly be due to fishery, not just because of decreased eutrophication.

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Table 4.1.2: Evaluation of indicators of eurtophication (Ranking criteria: 1- very important; 2 – moderately important; 3 – not important or showing significant problems with data collection)

INDICATOR	Indicator type	Indicator diagnosis	Data availability/source	Indicator Assessment Criteria						REMARKS
				Regionally responsive	Unambiguously interpretable	Simple quantification	Index period stability	Low year-to-year variation	Environmental impact	
EUTROPHICATION										
Land based nutrient inputs										
Concentrations of N-tot, P-tot, DIN and DIP in freshwater input	P	1	HELCOM PLC	Y	Y	Y	Y (?)	N	Y	Temporal coverage problematic, ref cond mainly by modelling
Riverine discharge	P	1	HELCOM PLC	Y	Y	Y	Y	N	Y	Ref cond mainly by modelling
Atmospheric nutrient inputs										
Atmospheric deposition of nitrogen	P	1	EMEP	Y	?	Y	Y	N	Y	Quantification by model output, ref cond unclear
Nutrient concentrations										
Winter DIN	S	1	HELCOM COMBINE	Y	Y	Y	Y	N	Y	Historical data and modelling
Winter DIP	S	1	HELCOM COMBINE	Y	Y	Y	Y	N	Y	Historical data

INDICATOR	Indicator type	Indicator diagnosis	Data availability/source	Indicator Assessment Criteria: Regionally responsive	Unambiguously interpretable	Simple quantification	Index period stability	Low year-to-year variation	Environmental impact	REMARKS
Summer N-tot	S	2–3	HELCOM COMBINE	N	Y	Y	Y	N	Y	Provides a useful indicator in specific areas
Summer P-tot	S	2–3	HELCOM COMBINE	Y	Y	Y	Y	N	Y	Provides a useful indicator in specific areas
Phytoplankton										
Summer chlorophyll *a*	S	1	HELCOM COMBINE	Y	Y	Y	Y	N	Y	Ref cond mainly modelling
Spring chlorophyll *a*	S	2	HELCOM COMBINE	Y	Y	Y	N	N	Y	Requires high temporal sampling frequency , ref cond can be derived by modelling
Annual average chlorophyll *a*	S	1	HELCOM COMBINE	Y	Y	Y	Y	N	Y	Ref cond can be derived by modelling
Phytoplankton species composition/proportion of species groups	S	1	HELCOM COMBINE	Y	Y	N	N	N	Y	Seasonally stable, but fast changes in spring, ref cond difficult to set, expert judgment
Abundance of HAB species	S	2	HELCOM COMBINE	N	Y	?	N	N	Y	Regional differences present, ref cond difficult to set, expert judgment
Frequency and duration of HAB blooms	S	2	Alg@line, remote sensing	N	Y	N	N	N	Y	Relies on high frequent measurements, e.g. SOOP and satellite, regional differences ?, ref cond difficult to set, expert judgment
Frequency of closed beaches due to occurrence of HAB	S	2	National/ municipal sanitary administrations	Y	Y	Y	Y		Y	If taken as indicator, data collection procedure should be established (EU Blue flags?). ref cond 0

INDICATOR	Indicator type	Indicator diagnosis	Data availability/source	Indicator Assessment Criteria						REMARKS
				Regionally responsive	Unambiguously interpretable	Simple quantification	Index period stability	Low year-to-year variation	Environmental impact	
Primary production										
Under construction	S	2	Research programmes	Y	?	N	N	N	Y	Relies on high frequent measurements, e.g. SOOP and satellite, ref cond can be derived from modelling
Macrophytes										
Depth range of submerged vascular plants/macroalgae	S	1	HELCOM COMBINE, EU WFD monitoring	Y	Y	N	yes	yes	ye s	Impact of diseases has to be excluded, ref cond on historical data in some areas, can also be derived from modelling
Proportion/biomass/coverage of opportunistic species	S	2	HELCOM COMBINE, EU WFD monitoring	Y	Y	N	Y	Y	Y	Ref cond partially historical data, partially expert judgment
Water clarity										
Summer Secchi depth	S	1	HELCOM COMBINE	Y	Y	Y	Y	Y	Y	
Spring Secchi depth	S	2–3	HELCOM COMBINE	Y	?	Y	?	N	Y	Depends on sampling temporal frequency?
Annual average Secchi depth	S	2	HELCOM COMBINE	Y	Y	Y	Y	Y	Y	

INDICATOR	Indicator type	Indicator diagnosis	Data availability/source	Indicator Assessment Criteria: Regionally responsive	Unambiguously interpretable	Simple quantification	Index period stability	Low year-to-year variation	Environmental impact	REMARKS
Oxygen conditions										
Summer/autumn minimum oxygen concentrations	S	1	HELCOM COMBINE	Y	Y	Y	N	N	Y	Sensitive to measurement frequency, upwelling, hydrology
Kills of invertebrates	S	1	project based, national data collection	Y	Y	Y	N	N	Y	
Zooplankton										
Under construction	S	2	HELCOM COMBINE, national institutes involved in fish monitoring	?	?	?	?	?	?	Zooplankton is an important productivity indicator, but not a straightforward eutrophication indicator
Macrozoobenthos										
Biomass/abundance of functional groups	S	2	HELCOM COMBINE	Y	Y	N	Y	Y	Y	
Abundance of species sensitive to TC	S	3	HELCOM COMBINE	Y	Y	N	Y	Y	yes	
Other indicators (e.g. BQI) under construction	S	2		?	?	?	?	?	?	

INDICATOR	Indicator type	Indicator diagnosis	Data availability/source	Indicator Assessment Criteria						REMARKS
				Regionally responsive	Unambiguously interpretable	Simple quantification	Index period stability	Low year-to-year variation	Environmental impact	
Sedimentation of particulate organic matter		3	project based, few stations	?	yes	N	N	N	N	

Action plan

The Sub-group on Effects of Eutrophication will continue developments of EcoQOs, Indicators and Reference Conditions related to eutrophication and biological effects of eutrophication. This development should be linked to SGPROD developments, particularly in the case of productivity indicators.

4.2 Subgroup on Hazardous Substances and Biological Effects (incl. disease and parasites)

Kari Lehtonen (Co-Chair), Thomas Lang (Co-Chair), Maija Balode, Janina Baršienė, Galina Rodjuk, Astrid Saava, Natalia Chukalova, Aleksander Eliseev and Olga Shukhgalter

Table 4.2.1: Evaluation of contamination indicators (Sub-group on Hazardous Substances and Biological Effects felt it better to apply 5-step evaluation scores: 1 – very good, 2- good, 3- sufficient, 4-poor, 5-bad).

INDICATOR	Indicator type	Indicator diagnosis	Data availability/source	Indicator Assessment Criteria						REMARKS
				Regionally responsive	Unambiguously interpretable	Simple quantification	Index period stability	Low year-to-year variation	Environmental impact	
Hazardous substances and biological effects										
Hazardous substances										
Cu, Cd, Pb, Zn in seawater (suspended matter, open sea)	S	**2	2 national, ICES, HELCOM	5	5	3	2	2	* 3	Why is Hg not included? *depends on concentration **the applicability of passive sampling techniques replacing measurements in seawater should be assessed
Hg, Cu, Cd, Pb, Zn, DDT and metabolites, CBs, HCB, a-HCH, g-HCH in seawater (dissolved phase)	S	**2	2 national, ICES, HELCOM	5	5	3	2	2	* 3	*depends on concentration **the applicability of passive sampling techniques replacing measurements in seawater should be assessed
Oil hydrocarbons in seawater	S	1	? national, HELCOM	5	5	5	4	4	* 4	*depends on concentration
Radionuclides in seawater	S	1	3 national, HELCOM	5	5	5	4	4	* 5	*depends on concentration

INDICATOR	Indicator type	Indicator diagnosis	Data availability/source	Indicator Assessment Criteria: Regionally responsive	Unambiguously interpretable	Simple quantification	Index period stability	Low year-to-year variation	Environmental impact	REMARKS
Hg, Cu, Cd, Pb, Zn, DDT and metabolites, CBs, HCB, a-HCH, g-HCH, organotin compounds, dioxins and furans, brominated flame retardants, toxaphene in biota	S	1	4 national, ICES, HELCOM	5	5	*3	5	5	** 4	*depends on substance **depends on substance and concentration (incl. human consumption)
Radioactive substances (γ-emitters K-40 and Cs-137; Sr-90, Tc-99, Pu-239/240, Am-241 natural radionuclides) in biota	S	1	3 national, HELCOM	5	5	4	5	5	* 5	*depends on concentration
Hazardous substances (continued)										
Hg, Cu, Cd, Pb, Zn, DDT and metabolites, PCBs (IUPAC), HCB, a-HCA, g-HCH in sediments	S	1	4 national, ICES, HELCOM	5	5	4	5	5	* 4	*depends on concentration
Radioactive substances (Sr-90, Pu-239/240, Am-241, natural radionuclides) in sediments	S	1	3 national, HELCOM	5	5	4	5	5	* 5	*depends on concentration
Early warning biomarkers										
Non-specific stress biomarkers: Lysosomal stability Macrophage activity Micronuclei frequency Catalase Glutathione reductase	S	 1 2 1 2 2	2 national	5	3	*4	*3	*3	* 3	*depends on parameter

INDICATOR	Indicator type	Indicator diagnosis	Data availability/source	Indicator Assessment Criteria: Regionally responsive	Unambiguously interpretable	Simple quantification	Index period stability	Low year-to-year variation	Environmental impact	REMARKS
"Contaminant-specific" biomarkers: EROD GST AChE PAH metabolites in bile DNA adducts MT ALA-D	S	 1 1 1 1 2 1 2	*3 national	5	4	*4	*3	*3	* 3	*depends on parameter
Individual and population level biological effects										
Health effect: Externally visible diseases/parasites in fish Histopathology (fish liver, seal intestinal tract, bivalve soft body)	S	 1 1 for fish/bivalves, 3 for seals	*4 national, ICES	*3	4	*3	5	4	4	*depends on parameter
Reproductive disorders: Imposex/intersex in gastropods Reproductive success in eelpout M74 syndrome in salmon Gonad histopathology (fish and shellfish) VTG Histopathology in seal reproductive organs Shell thickness of guillemot eggs Breeding success/brood size of white-tailed eagle	S	 1 1 3 1 1 3 1 1	*3 HELCOM (?)	*4	5	*3	5	4	5	*depends on parameter
Bioassays										

INDICATOR	Indicator type	Indicator diagnosis	Data availability/source	Indicator Assessment Criteria: Regionally responsive	Unambiguously interpretable	Simple quantification	Index period stability	Low year-to-year variation	Environmental impact	REMARKS
Sediment toxicity: Acute Corophium or Mysid toxicity test	S	2	2	5	5	4	5	5	5	Experimental studies

Biological Effects of Hazardous Substances

In this table, the "Parameters" (measurements) used have been categorized under three biological response levels (column "Effects Level") that have been further divided under five "Indicators". In the assessment, each indicator has to be represented by using at least one parameter (preferably more) from the respective indicator group.

Since all parameters in each indicator group have been selected to be good representatives of an effect observed at that level, the choice of the parameter is free. This facilitates the required inclusion of parameter(s) from each indicator group diminishing problems related to matters such as the lack of technical capacity and local species availability, as well as enables the possibility to focus on problems at regional level and the continuation of long-term data series if considered feasible.

For the large-scale assessment of the Baltic Sea, a synthetic index enabling comparisons between each indicator has to be developed if different parameters are used within each indicator.

Table 4.2.2: Evaluation of biomarkers. Scoring system for "parameter diagnosis": 1 -very good, 2 - sufficient, 3 - not recommended

Effects level	Indicator	Parameter	Parameter Diagnosis	Indicator Assessment Criteria							Remarks
				Data availability/ source	Regionally responsive	Unambiguously interpretable	Simple quantifycation	Index period stability	Low year-to-year variation	Environmental impact	
Molecular, biochemical, physiological level ("early-warning" biomarkers)	"General/non-specific stress" biomarkers Data source: national	Lysosomal stability Macrophage activity Micronuclei frequency Catalase Glutathione reductase	1 2 1 2 2	2	5	3	*4	*3	*3	*3	*Depends on parameter
	"Contaminant-specific" biomarkers Data source: national	EROD GST AChE PAH metabolites in bile DNA adducts MT ALA-D	1 1 1 1 2 1 2	*3	5	4	*4	*3	*3	*3	*Depends on parameter
Individual and population level	Health effect Data source: national, ICES	Externally visible diseases/parasites in fish Histopathology (fish liver, seal intestinal tract, bivalve soft body)	1 1 for fish/bivalves, 3 for seals	*4	*3	4	*3	5	4	4	*Depends on parameter
	Reproductive disorders Data source: national, HELCOM (?)	Imposex/intersex in gastropods Reproductive success in eelpout M74 syndrome in salmon Gonad histopathology (fish and shellfish) VTG Histopathology in seal reproductive organs Shell thickness of guillemot eggs Breeding success/brood size of white-tailed eagle	1 1 3 1 1 3 1 1	*3	*4	5	*3	5	4	5	*Depends on parameter

Effects level	Indicator	Parameter	Parameter Diagnosis	Indicator Assessment Criteria							Remarks
				Data availability/ source	Regionally responsive	Unambiguously interpretable	Simple quantifycation	Index period stability	Low year-to-year variation	Environmental impact	
Population and community level	Quantitative population/community change Data source: national, ICES, HELCOM (?)	Abundance and biomass Biodiversity indices (phyto- and zooplankton, benthos, fish, mammals and birds)	2	*4	*4	3	*3	*3	*3	*3	*Depends on parameter

Preliminary reference levels of selected biological effects basing on data from the EU BEEP project.

In order to develop the concept of detecting contamination-related effects, the approach of utilising “reference values” for biological effects was initiated by using data obtained during the EU Project BEEP. The data represented selected parameters measured for flounder and blue mussels from different study areas.

The lowest seasonal mean response levels recorded at each study area were rounded downwards by ca. 20 %. The recommended reference value was obtained by the approximate mean of values from all areas using expert judgement. Exceptions are indicated in footnotes.

As a working hypothesis, an elevation/decrease (depending on the effect) of two-fold represents an effect [signal] in most of the selected biomarkers. However, more reliable criteria have to be created.

It is emphasized that this is the first exercise to estimate the reference levels for a set of biomarkers in the Baltic Sea covering a larger geographical area. More relevant data, existing and new, are needed for more precise evaluation of reference levels. Furthermore, the use of other approaches, e.g. including “grey areas” of response levels or calculating the mean only for a fixed percentage of the most affected individuals (most sensitive part of the population) at ach site, have to be tested.

Table 4.2.3: Approximate reference levels of biological effects in flounder (*Platichtys flesus*).

	LITHUANIAN COAST		GULF OF GDANSK		OFFSHORE AREAS	RECOMMENDED REFERENCE VALUE
	Spring	Autumn	Spring	Autumn	December	
LMS	8	13	12	12	15	12
AChE	300[1]	250[1]	100[1]	200[1]	550	500
MN	0.15	0.15	0.40[2]	0.30[2]	0.10	0.15
MT	350	500	300	400	500	300/450[3]
FAC	4	3	2	5	2	3
Liver histopathology	2.0	1.0	1.0	0.0	0.0	1.0
Lymphocystis					10	10
Skin ulcer					0	0

1. Inadequate data.

2. High values likely associated with biological effects of contaminants.

3. Spring and autumn values separated because of seasonal variability.

Table 4.2.4: Approximate reference levels of biological effects in the blue mussel *Mytilus* sp.

	LITHUANIAN COAST		GULF OF GDANSK		WISMAR BAY		RECOMMENDED REFERENCE VALUE
	Spring	Autumn	Spring	Autumn	Spring	Autumn	
LMS	12	15	10	8	10	12	12
AChE	40	30	30	30	70	50	40[1]
MN	1.00	2.00	2.00	2.00	2.00	1.00	1.50
MT	250	200	150	200	120	200	150/200[2]

1. Levels possibly related to higher salinity.

2. Spring and autumn values separated because of seasonal variability.

Preliminary proposal for Socio–economical indicators regarding to harmful substances

- Loss in fisheries (change in fisheries value, reduction of commercial fish stocks, and species diversity);
- Lowered quality of fish and other marine organisms as food;
- Increased costs of fish surveillance in the case of toxin incidence [monitoring];
- Loss of marine organisms (micro-, macroalgae and others) used for producing food additives, cosmetics, fertilisers, pharmaceutics;
- Reduced options for aquaculture development;
- Increased risk to human health (infection diseases, poisonings, allergy, cancer, etc);
- Increased costs of human health protection and medical treatment;
- Loss of tourism, recreation and aesthetic values (closing of beaches, etc.);
- Costs of monitoring (monitoring of pollution, biota, human health);
- Costs for remediation of aquatic ecosystem (removal of polluted sediments, beach cleaning, etc);
- Costs of reduction and liquidation of pollution (liquidation of oil spots and cleaning, etc.).

Action plan

The Sub-group on Biological Effects of Harmful Substances will undertake the following actions:

- Establishment of a leading laboratory (LL) for Biological Effects Monitoring (hazardous substances are the only topic for which a LL has not been established).
- Demonstration Project: sampling and biomarker determination in chosen areas. Arranging exchange of scientists and inter-calibration of selected biomarker methods
- Participation of eastern Baltic Sea countries in ICES WGBEC meetings.

4.3 Sub-group on Effects of Fishing Activities

Maris Plikshs (Co-Chair), Valery Feldman (Co-Chair), Markus Vatemaa, and Henn Ojaveer (by correspondence)

Ecosystem indicators related to fishery and fishery impact on ecosystem so far have not been considered in HELCOM EcoQO project: the set of HELCOM Indicators for Ecosystem Assessment. The first list of indicators related to fishery issues for the Baltic Sea was developed during the meeting of SGEH in March 2005 in Sopot (ICES, 2005a). It was also considered by ICES Working Group on Ecosystem Effects of Fishing activities [WGECO] in April 2005 (ICES, 2005b).

WGECO has mainly developed indicators for the North Sea. Unfortunately, as the fisheries ecosystems of the 'true seas' (e.g. North Sea) are very different from the brackish young seas (the Baltic Sea), the indicators which have been developed and are working there cannot be directly applied in the conditions of the Baltic Sea. Even more, most of them were ranked as 'requires further evaluation' or even dropped out of the list. It should be mentioned here that both the scope and efforts of the fisheries science in the Baltic Sea region (i.e., by countries) differs from that in other major fisheries regions, which is partly due to substantial regional natural heterogeneity within the Baltic Sea. In addition, for instance, our knowledge on population characteristics is very limited for most of the non-commercial fish.

The SGEH sub-group has reviewed the list of indicators for sustainable fishery and fisheries impact on ecosystem and set preferences based on the above mentioned criteria. Additionally the sub-group has considered two types of indicators, namely S - state indicators and P – pressure indicators that are important elements to evaluate fishery impact on ecosystem. The evaluation of indicators is shown in table 4.3.1 and can be summarized in the following:

1) Priority 1 (High priority, indicator must be kept) was set to indicators related to SSB, F for internationally and nationally assessed fish stocks, CPUE indices for not assessed fish stocks and wild smolt production by River. These indicators are already available from presently running monitoring or data collection programs. As it stands now, only single stock parameters of internationally assessed marine fish are of high priority and these numbers are convincingly indicative of the condition of a stock. But as the Baltic fish community consists of several other fish species, it is needed to put relatively higher attention to evaluate sustainable fisheries indicators for other species/fish communities to a point where these are agreed as priority #1 indicators and mirror the health of these fish communities. It is suggested to consider further development and testing of such indicators by the HELCOM/BSRP coastal fish specialist network.

2) Such important indicators of fishery impact on ecosystem (P – pressure type) as bycatch of marine mammals (1), bycatch of sea birds (2), total amount of discards (3), amount of discards of high-risk species (or species groups) (4), size spectrum of fish community (open sea) (5),

3) size spectrum of fish community (coastal areas) (6) on which there are available data in some areas and which have regional importance were suggested as a biodiversity indices by WGECO. However it is still included in the fish and fishery indicator list because:

   a) bycatch of birds and mammals in some respect reflect removal of birds and mammals from the ecosystem and not directly represent the state of these stocks in the ecosystem. The information is compiled in some countries but does not cover the whole Baltic.

   b) discards – so far the data on discards are compiled for the Baltic cod, however based on EU National fishery data collection programme, the data are available for several other species and fisheries. Discards also mainly represent fishing activities rather than biodiversity issue because they are dependent on the used gears (fishery regulations) and recruitment abundance.

   c) Size spectrum of fish community. The Sub-group agreed with WGECO recommendation that for the open sea species it can be covered by SSB. The testing of the indicator of "Slope of the size spectra for coastal fish species/community" is planned during 2006.

4) Such indicators as fishing effort of different fleets (1), fleet capacity (2) and fish landings by major species by area (3) were considered as socio-economic indicators and are discussed in Section 6.2.

5) Area of the fishery impacted by gear (1), area of fish nursery habitat degraded (3) and number of deaths of vulnerable and/or protected species (3) were found presently very difficult to evaluate and quantify. Following WGECO recommendation these indicators are relevant to management.

6) Mean trophic level of catch (open sea) (1) and mean trophic level of catch (coastal areas, e.g. Cyprinide/Percide fish ratio) (2) are very useful indicators in principal. However, it can be covered by SSB (open sea internationally assessed fish species) and CPUE (for coastal fish species). These indicators, especially in the case of coastal species, need to be tested because changes in trophic level could be dependent on natural (recruitment) and human impact (fishery) as well.

References

ICES. 2005a. Report of the ICES/BSRP/HELCOM/UNEP Regional Seas Workshop on Baltic Sea Ecosystem Health Indicators, 30 March–1 April 2005, Sopot, Poland. ICES CM 2005/H:01 Addendum. 68 pp.

ICES. 2005b. Report of the Working Group on Ecosystem Effects of Fishing Activities (WGECO), 12-19 April 2005, ICES Headquarters, Copenhagen. ACE:04. 146 pp.

Table 4.3.1: Evaluation of fishery indicators (Diagnosis: 1-very important; 2 – moderately important; 3 – not important or showing significant problems with data collection).

INDICATOR	INDICATOR TYPE	INDICATOR DIAGNOSIS	DATA AVAILABILITY/SOURCE	INDICATOR ASSESSMENT CRITERIA						REMARKS
				Regionally responsive	Unambiguously nterpretable	Simple quantification	Index period stability	Low year-to-year variation	Environmental impact	
SUSTAINABLE FISHERY AND FISHERIES IMPACT ON ECOSYSTEM										
Spawning stock biomass (SSB) of internationally assessed marine fish species (herring, cod, sprat)	S	1	Yes/ICES	Y	Y	Y	Y	Y	Y	Assessments are based on stock units, /VPA type model
Spawning stock biomass (SSB) of nationally assessed marine and coastal fish species	S	1	Yes/ National laboratories	Y	Y	Y	Y	Y	Y	/VPA type model
Fishing mortality (F) of internationally assessed marine fish species (herring, cod, sprat)	S, P	1	Yes/ICES	N ?	Y	Y	Y	?	?	Not always regionally responsive: Assessments based on stock units, /VPA type model
Fishing mortality (F) of nationally assessed marine and coastal fish species	S, P	1	Yes/ national laboratories	Y	Y	Y es	Y es	?	?	/VPA type mode
Catch per unit of effort (CPUE) for non assessed fish species/stocks	P	1	National laboratories/ Commercial fisheries and research survey data; EU data collection program	Y	Y	Y	Y	?	?	
Anadromous fish (salmon, sea trout) wild smolt production by River	S	1	YES/ICES	Y	Y	Y	Y	?	Y	In accordance with IBSFC Salmon action plan: The production of wild Salmon should gradually increase to attain by 2010 for each Salmon river a natural

INDICATOR	INDICATOR TYPE	INDICATOR DIAGNOSIS	DATA AVAILABILITY/SOURCE	INDICATOR ASSESSMENT CRITERIA						REMARKS
				Regionally responsive	Unambiguously nterpretable	Simple quantification	Index period stability	Low year-to-year variation	Environmental impact	
										production of wild Baltic Salmon of at least 50 % of the best estimate potential and within safe genetic limits, in order to achieve a better balance between wild and reared Salmon
Bycatch of marine mammals	P	2	Several national laboratories	Y	Y	?	?	?	?	Suggested as biodiversity indicator (WGECO)
Bycatch of sea birds	P	2	Several national laboratories	Y	Y	?	?	?	?	Suggested as biodiversity indicator (WGECO)
Fishing effort of different Fleets.	P	3								Not relevant/Socio-economic indicator
Fleet capacity	P	3								Not relevant/Socio-economic indicator
Fish landings by major species by area.	P	3								Not relevant/Socio-economic indicator
Total amount of discards.	P	2	Baltic cod only/Used in Baltic cod assessment	Y	Y	N	N	N	Y	Suggested as biodiversity indicator (WGECO), small number of strata sampled
Amount of discards of high-risk species (or species groups).	P	3	? /EU data collection program	?	?	?	?	?	?	Suggested as biodiversity indicator (WGECO) What is high risk species?
Number of deaths of vulnerable and/or protected species	P	3	?	?	?	?	?	?	?	Not understandable; how to quantify the death of fish species (fishery, natural). Is the list of valuable and protect fish species in Baltic?
Area of the fishery impacted by gear	P	3	?	?	?	?	?	?	?	Not relevant, more appropriate for management

INDICATOR	INDICATOR TYPE	INDICATOR DIAGNOSIS	DATA AVAILABILITY/SOURCE	INDICATOR ASSESSMENT CRITERIA						REMARKS
				Regionally responsive	Unambiguously nterpretable	Simple quantification	Index period stability	Low year-to-year variation	Environmental impact	
Amount of habitat protected by MPAs	P	3	?	?	?	?	?	?	?	Not relevant, more appropriate for management
Size spectrum of fish community (open sea)	P	3	Yes/ICES	?	?	?	?	?	?	Suggested as biodiversity indicator (WGECO); Covered by SSB for open sea species
Size spectrum of fish community (coastal areas)	P	2	Yes/ IC ES and national laboratories	?	?	?	?	?	?	Suggested as biodiversity indicator (WGECO); Can be covered by CPUE for coastal fish species
Area of fish nursery habitat degraded	P	3	?	?	?	?	?	?	?	Not relevant, difficult to quantify. Can be covered by biodiversity
Mean trophic level of catch (open sea)	S	3	Yes/ICES and national labs	?	Y	Y	?	?	?	Can be covered by SSB for open sea species
Mean trophic level of catch (coastal areas e.g. Cyprinide-Percide fish ratio)	S	2	Yes/ national labs	Y	Y	Y	?	?	?	Can be covered by CPUE for coastal fish species; need to be tested

Action plan

Sub-group on Effects of Fishing Activities recommends organising a workshop which should be held for 2–3 days [dates and venue to be determined] in 2005 to develop an EcoQO framework for the additional proposals provided above and the FAO list (see Table 4.3.1). Additionally, the workshop should review development of the two activities.

4.4 Sub-group on Habitat Destruction and Loss of Biodiversity

Kevin Summers (Co-Chair), Sergej Olenin (Co-Chair), Elmira Boikova, Elena Ezhova.

Selection criteria elaborated by the US EPA National Coastal Assessment (see item 3.4), were used for evaluation of biodiversity indicators (Table 4.4.1).

Table 4.4.1: Evaluation of biodiversity indicators (Diagnosis: 1- very good, 2-sufficient/acceptable, 3-not recommended)

INDICATOR	INDICATOR TYPE	INDICATOR DIAGNOSIS	DATA AVAILABILITY/SOURCE	INDICATOR ASSESSMENT CRITERIA						REMARKS
				REGIONALLY RESPONSIVE	UNAMBIGUOUSLY INTERPRETABLE	SIMPLE QUANTIFICATION	INDEX PERIOD STABILITY	LOW YEAR-TO-YEAR VARIATION	ENVIRONMENTAL IMPACT	
BIODIVERSITY										
Shoreline development	P	2	Not available from all countries	N	Y	Y	Y	Y	Y	
Commercial fishing pressure	P	3								Also relevant to fisheries
Status of Baltic Sea Protected Areas - Percentage of the MPA from total coastal zone and marine areas	D	1	Y	Y	Y	Y	Y	Y	Y	
Status of Baltic Sea Protected Areas - Proportion of different depth ranges under protection	D	1	Y	Y	Y	Y	Y	Y	Y	
Status of Baltic Sea Protected Areas - Proportion of biotope types protected	D	2	Not Available	Y	Y	Y	Y	Y	Y	
NATURA 2000 habitats (e.g. reefs, etc) the area of each habitat type (if possible assessed on the regular basis)	D	2	Available only from selected locations	Y	Y	Y	Y	Y	Y	

INDICATOR	INDICATOR TYPE	INDICATOR DIAGNOSIS	DATA AVAILABILITY/SOURCE	INDICATOR ASSESSMENT CRITERIA						REMARKS
				REGIONALLY RESPONSIVE	UNAMBIGUOUSLY INTERPRETABLE	SIMPLE QUANTIFICATION	INDEX PERIOD STABILITY	LOW YEAR-TO-YEAR VARIATION	ENVIRONMENTAL IMPACT	
Area and depth distribution of submerged vascular plant meadows	S	1	Available only from selected locations	N	N	N	N	N	N	Redundant
Area and depth distribution of perennial macroalgae beds	S	1	Available only from selected locations	N	N	N	N	N	N	Redundant
Area of coastal wetlands and associated reed and rush species NATURA 2000	S	2	Available only from selected locations	N	N	N	N	N	N	Redundant
Size distribution of Blue mussels	S	2	Available only from some countries	Y	Y	Y	Y	Y	Y	
Biomass of Blue mussels	S	2	Available only from some countries	Y	Y	Y	Y	Y	Y	
Area of Blue mussel beds	S	2	Available only from some countries	Y	Y	Y	Y	Y	Y	
Coastal fish community structure including specific information on species of interest e.g. perch,pike and herring	S	1	Yes	Y	Y	Y	?	Y	Y	
Offshore (Marine trophic index of commercial) fish species	S	1	Yes	Y	Y	Y	Y	Y	Y	
Zooplankton community	S	2	Yes	Y	Y	Y	N	N	?	

INDICATOR	INDICATOR TYPE	INDICATOR DIAGNOSIS	DATA AVAILABILITY/SOURCE	INDICATOR ASSESSMENT CRITERIA						REMARKS
				REGIONALLY RESPONSIVE	UNAMBIGUOUSLY INTERPRETABLE	SIMPLE QUANTIFICATION	INDEX PERIOD STABILITY	LOW YEAR-TO-YEAR VARIATION	ENVIRONMENTAL IMPACT	
Phytoplankton community	S	2	Y	Y	Y	Y	N	N	?	
Zoobenthos community structure [1] including Baltic Sea glacial relict species trends (crustaceans)	S	1	Y	Y	Y	Y	Y	Y	Y	
Number of (extinct), threatened (close to extinction, look for specific definition) and declining Baltic Sea species	S	1	Available only from some countries	Y	Y	?	Y	Y	Y	
Commercially fished species -Spawning Stock Biomass	S	3	Should be Moved to Fisheries							Should be Completed in Fisheries Module
Coastal fish species- Spawning Stock biomass	S	3	Should be Moved to Fisheries							Should be Completed in Fisheries Module
Seal species populations	S	1	Yes	Y	Y	Y	Y	Y	Y	
Porpoise (*Phocoena phocoena*) bycatch and population	S	2	Available only from a few countries	Y	Y	Y	Y	Y	Y	
Coastal bird species populations (key groups – sea ducks, divers, eiders, auks, cormorants)	S	1	Yes	Y	Y	Y	Y	Y	Y	
Offshore bird species populations (key groups – sea ducks, divers, eiders, auks)	S	2	Available only from some countries	Y	Y	Y	Y	Y	Y	
Baltic Sea glacial relict species trends (crustaceans)	S	3	Included in Benthic Community	N	N	?	N	N	?	Redundant

INDICATOR	INDICATOR TYPE	INDICATOR DIAGNOSIS	DATA AVAILABILITY/SOURCE	INDICATOR ASSESSMENT CRITERIA						REMARKS
				REGIONALLY RESPONSIVE	UNAMBIGUOUSLY INTERPRETABLE	SIMPLE QUANTIFICATION	INDEX PERIOD STABILITY	LOW YEAR-TO-YEAR VARIATION	ENVIRONMENTAL IMPACT	
			Information							
Non-indigenous species (proportion of NIS in existing communities)	S	2	Yes	Y	N	Y	Y	Y	Y	
Non-indigenous species (rate of new introductions)	S	1	Yes	Y	Y	Y	Y	Y	Y	

Action plan

It is planned that Sub-group on Habitat Destruction and Loss of Biodiversity will continue work intersessionally.

5 Identification of potential contributions to 2006 ASC Theme Session on Integrated Assessments (ToR f)

The SGEH meeting was of the opinion that potential contributions to 2006 ASC Theme Session on Integrated Assessments can be identified during the ICES/BSRP Workshop on Developing Framework for Integrated Assessment for the Baltic (WKIAB) in March 2006 in Tvärminne (Finland) where most of SGEH key experts will be present.

The meeting particularly encourages sub-group Chairs (Georg Martin, Elżbieta Łysiak-Pastuszak, Kari Lehtonen, Thomas Lang, Henn Ojaveer, Maris Pliksh, Kevin Summers and Jan Marcin Węsławski) to take an initiative and effort to present to ICES Theme Session an output of their sub-groups. Information on the 2006 ASC Theme Sessions is available on the ICES web page – www.ices.dk

6 Strategies for development of socio-economic issues (ToR g)

It was clear that there will be difficulties in fulfilling this ToR, because expert groups dealing with socio-economic issues in relation to marine environment practically do not exist in the Baltic Sea area. During the planning phase of the SGEH meeting in Kaliningrad, the SGEH Chair approached a number of experts recognized as those which were dealing with socio-economic issues. There was some positive response from experts who previously were involved in activities of GIWA and HELCOM PLC. BSRP financial support was arranged for them. Unfortunately, for various reasons the expected experts were not able to attend the meeting. There were several excuses expressed, such as visa problems, overlapping meetings, etc.

6.1 Strategy for developing socio-economic indicators (D-type indicators) for managing human impacts on the ecosystem of the Baltic Sea (Eugeniusz Andrulewicz)

A draft discussion/facilitation paper on strategy for developing socio-economic indicators (D-type indicators) was prepared by the SGEH Chair (Annex 5). In this paper, some existing developments regarding general geographical and socio-economic characteristics of the Baltic catchment area were identified. The following international organisations/activities were recognised: VASAB 2010, UNEP/GIWA, HELCOM PITF MLW, HELCOM PLCs, NGOs (Baltic 21 and WWF); scientific projects: MARE (Marine Research on Eutrophication – a Scientific Base for Cost-Effective Measures for the Baltic Sea, ELME (European Life Styles and the Marine Environment), and INDECO (Development of Indicators of Environmental Performance of the Common Fisheries Policy).

The author presented some illustrative examples of D-type (D-Driving forces) socio-economic indicators for the main Baltic environmental concerns: Eutrophication, contamination, overfishing and biodiversity. He proposed to adopt the so-called “casual-chain analysis” (described in GIWA methodology) in order to determine what are the social/political/legal/economic reasons for the existing environmental pressures.

Although most of the SGEH participants are not economists, each of the working groups was requested to pay specific attention to the socio-economic aspects of their relevant fields of activities.

During discussion A. Andrusaitis pointed out that SGEH should seriously consider the preparation of plans for the BSRP Phase 2. H. Bäcker commented that socio-economic approach assumes that environmental problems are addressed by the society. The major interests of the society are mainly related to sustainable use of resources, human health, nature conservation, etc. Quality objectives are in fact measured in monetary terms. K. Lehtonen: HELCOM pointed out that monitoring is implemented by countries and it is critically important to encourage countries to include socio-economic aspects into their monitoring programs.

6.2 Activities of BSRP on Socio-economy (Markus Vetemaa)

There is a large number of possible study areas on socio-economic issues related to marine environment (key words: integrated assessment, human forcing, sustainability, socioeconomic benefits). The positive side of that is that BSRP Project Implementation Plan leaves large degree of freedom in defining detailed topics. However, the negative is that nearly everybody expects this CC to work with different topics (i.e. in close cooperation with respective CC or LL).

The possible research tasks could be: socioeconomy of fish resource use; socioeconomic aspects of pollution; socioeconomic aspects of increasing/decreasing trophic status; valuation of environmental goods (incl. non-monetary); Integrated coastal zone management; etc.

The main problem of the CC SE is that goals and preconditions to fill them are not in good balance. The final goal is very ambitious, "Establish socioeconomic analysis as an integral component of Baltic Sea resource use and ecosystem protection in the HELCOM beneficiary countries". However, the preconditions are weak. Expert groups dealing with socio-economic issues are practically not existent in the Baltic Sea area (a big difference in comparison to most of other CCs and LLs). Secondly, the BSRP project grants only financial support for one person, the coordinator (ca 0.3 of permanent position), and no support for partner institutions up to day.

So, the only way to proceed is to set strong priorities and concentrate on them. The first step of BSRP Socio-economy CC (2004) was to map possible study areas through conflict research. After careful consideration, the following four topics were defined as the core program objectives of the CC SE during its two first working years: 1) Participation in the EU fisheries data collection program (subprogram: economic data), 2) Study on management options and resource partitioning between different segments of the Baltic Sea fisheries, 3) Resource partitioning: conflict between fisheries and nature protection interests (bycatch of seals and birds, competition for the resource), and 4) Mapping of fisheries development in the BSRP countries

Up to day, two papers analyzing resource use and management system have been prepared for publication, one was accepted and the other will be submitted soon:

1) Eero, M., Vetemaa, M., and Hannesson, R. 2005. The quota auctions in Estonia and their effect on the trawler fleet. Marine Resource Economics, 19: 99–110.
2) Vetemaa M., Eschbaum R., and Saat T. The transition from Soviet system to market economy as a cause of instability in the Estonian coastal fisheries sector. Marine Policy, in press (available online: www.sciencedirect.com)
3) Vetemaa, M., Eschbaum, R., Verliin, A. Albert, A., Eero, M., Lillemägi R., Pihlak, M., and Saat, T Annual and seasonal dynamics of fish in the brackish-water Matsalu Bay, Estonia. Ecology of Freshwater Fish, accepted.
4) Vetemaa, M., Eschbaum, R., Verliin, A. Albert, A., Kesler, M., and Saat, T. Do cormorants and fishermen compete for fish resources in the Väinameri (eastern Baltic) area?

Latest developments in the CC SE

1) Start of the procurement of equipment, technical specifications submitted, 8 November.

2) Agreement on joint work (meeting during the EAFE Symposium in Thessaloniki, April 2005); the most important next task of CC Socio-economy is to map the developments in the open-sea fisheries (Est, Lat, Lit, Pol) sector during the post-soviet period. Present stage: data collection phase.

3) BSRP CC Socio-economy and LL Coastal activities joint meeting in Panga (Saaremaa, Estonia, 24–27 October 2005): collection of data on performance of coastal fisheries in Estonia, Latvia, Lithuania, Russia. Present stage: data collection phase. Minutes of the meeting ready in 2 weeks.

Discussion

A. Andrushaitis inquired about the availability of the data collected within the EU system to outside scientific community. M. Vetemaa explained about the website created in the Netherlands where these data are available. He mentioned that the data collected at that website are not analyzed. A. Andrushaitis further inquired weather this system included information on coastal fish. M. Vetemaa explained that it is obligatory to include information on coastal fishery. He added information about an international workshop on socio-economic issues that is planned for spring 2006 and where the Baltic Sea was chosen as a case study area. V. Feldman inquired about the possible reference values for economic indicators and B. Müller-Karulis was interested particularly in indicators and reference values for sustainable fishery. M. Vetemaa replied that sustainability can be considered from different angles, e.g. human and biological, and rather complicated bio-economic models, like a Norwegian model for the Barents Sea, have been applied to determine reference conditions. H. Backer directed his question to economic evaluation of natural resources, e.g. when the eutrophication/pollution is abated what we gain back. M. Vetemaa answer was that the CC did not dwell on this topic.

B. Müller-Karulis added to the previous question that the matrix presented in the presentation is showing a status quo and the abatement of eutrophication would mean changes, probably decline, in primary production and this would inevitably affect fisheries. M. Pliksh also criticised the presented matrix stating that it shows the status quo of the Estonian fishery only. Fisheries in other countries can be differing from that and the matrix should be modified by addition of data from other Baltic countries by retrieving the data from EU data base. S. Olenin wanted to add additional cell to the matrix – a conflict between fishery and maritime transport including the potential threat of a major oil spill accident in the Baltic Sea. M. Vetemaa answered that both indicated issues are going to be considered as well as the influence of invasive species. E. Andrulewicz explained that the indicators presented by M. Vetemaa are suitable for the evaluation of goods and services of the ecosystem while the SGEH task is to develop indicators in relation to pollution effects; hence the question is whether the presented once should be rejected or just modified. J. Thulin intervened concluding that the group should adopt a step-wise process – start with fishery indicators and go to the more advanced socio-economic indicators of pollution effects gradually using also knowledge gathered within BONUS-169 where socio-economic module is also included.

N. Aladin expressed his gratitude to A. Saava and M. Vetemaa for splitting the barriers between the biological sciences and socio-economic issues. There is quite an intensive activity in this field around the world, e.g. similar matrixes were presented for the Caspian and Aral Seas.

7 Matters related to the external review of the 2005 SGEH Report (ToR h)

E. Andrulewicz presented an external review of 2005 SGEH Report. The reviewer was from outside the ICES scientific community and had some problems with identifying ICES acronyms. The review was in general positive and encouraging. The reviewer underlined valuable and worth noticing SGEH output on developments of pragmatic system of indicators for the quantification of the Baltic Sea environmental status.

Note: Full text of the review is available under Annex 6.

8 Any other business

8.1 Matters related to HELCOM MONAS

A. Andrusaitis agreed to present the results of the SGEH 3 meeting in Kaliningrad to HELCOM MONAS 8 (Riga, 21–25 November 2005). For the sake of preparation of this document, the sub-group Chairs were asked to revise and finalize sub-group reports within one week after the meeting. A. Andrushaitis agreed to compile and prepare a document/communication ("Evaluation of the Proposed Baltic Sea Large Marine Ecosystem Indicators") to be presented to HELCOM MONAS.

8.2 Matters related to BSRP Phase II

A. Andrushaitis informed that BSRP soon will be stepping into the Phase II; therefore there is a need to be very pragmatic about priorities of BSRP work. It will be useful to take into account practicalities of implementation of the future HELCOM monitoring programme. This programme will be based on the proposed set of indicators and a set of defined reference levels. It would also be useful to produce a special background document for the preparation of the monitoring program and action plan in future.

8.3 Matters related to socio-economy

The SGEH Chair expressed the view that it would be reasonable to establish a SGEH Sub-group on socio-economic issues. This might be an issue for consideration by the BSRP Phase II.

8.4 Matters related to public health in relation to ecosystem health

It was a general view of SGEH members that the presentation on public health aspects in relation to ecosystem health (by Astrid Saava), should appear as an Annex to SGEH Report. Several members of the meeting expressed the opinion that this paper should be better known to the ICES community (also outside the Baltic Sea).

9 Adoption of the report and recommendations

9.1 Adoption of report

During the meeting, SGEH Chair was able to collect notes taken by the Rapporteurs, summaries of participant's presentations and the Sub-group reports. On the basis of this material, SGEH Chair was tasked to prepare the first draft of the report and distribute it to SGEH members for critical review and adoption. After adoption, the final draft would be transferred to the ICES Secretariat for final editing.

9.2 Regarding the ToRs for next SGEH

The general opinion of the meeting about the 2005 Terms of Reference was positive. They were well designed and reflecting ICES Strategic Plan and BSRP objectives. The 2005 ToRs covered the main Baltic Sea environmental concerns as well as the need for the development of ecosystem-based management tools.

Discussion about ToRs for 2006 was in the shadow of an unclear future of this Study Group. The existence of the ICES/BSRP Study Groups is not certain due to completion of the three-year regular term for the ICES Study Groups. Besides that, the existence of the SGEH Study Group will depend on the BSRP financial support.

Assuming positive developments, the future ToRs for SGEH should be partly based on standing/regular SGEH activities, such as:

- report on new developments regarding ecosystem-based approaches to management of the marine environment, with particular reference to progress in ICES, HELCOM, EU and US EPA;
- further develop the Baltic ecosystem health concept in relation to the main ecological problems: eutrophication, hazardous substances, overfishing and biodiversity;
- develop monitoring scheme for biological effects of harmful substances.

Some new tasks clearly related to ecosystem health should be considered as well, e. g.:

- socio-economic driving forces for pollution of the Baltic Sea;
- ecosystem health aspects in relation to human health;
- marine habitat mapping and biotope classification;
- issues related to impact of marine transport on the marine ecosystem;
- issues related to the development of integrated assessments (e.g. developing environmental indices);
- Mutiple Marine Environmental Disturbances;
- management of BSPAs.
- impact of coastal activities on marine ecosystem.

10 Next SGEH meeting

The next SGEH meeting will depend on BSRP continuation, practically if the BSRP Phase II is adopted. In case of positive developments, it was proposed to hold the next SGEH meeting in Tallinn, Estonia. The BSRP C1 Coordinator agreed to take the necessary steps to identify the host institute for the meeting (this will probably be the Estonian Marine Institute). Preferable time for the Study Group meeting would be November 2006.

11 Closing of the meeting

The Chair thanked the management of AtlantNIRO for arranging perfect working conditions and very good meeting facilities. He personally thanked Konstantin Kukhorenko, AtlantNIRO Managing Director, Vladimir Sushin, AtlantNIRO Scientific Director, Galina Rodjuk and Valery Feldman, the hosts and the organisers of the meeting.

The Chair thanked the SGEH members and participants for their valuable contributions to SGEH developments. He particularly addressed experts from western countries, who attended this meeting on their own financial arrangements and sacrificed their own time. Namely he thanked: Kari Lehtonen (supporting SGEH developments of biological effects of contaminants and biomarker studies), Thomas Lang (supporting BSRP developments of studies on diseases of marine organisms), and Kevin Summers (offering US EPA experience to SGEH and supporting developments of integrated assessments and biodiversity assessments)

Finally, the Chair thanked all the Sub-group Chairs for their cooperation and effort to chair expert meetings. The meeting was closed at 1:00 p.m. on 11 November 2005.

Annex 1: List of participants

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Annex 2: ICES/BSRP SGEH agenda, 9–11 November 2005

1) Opening and welcome
2) Matters related to SGEH Working procedures
3) Presentations on developments of ecosystem-based approaches (ToR a,b)
4) Developments of socio-economic issues (ToR g)
5) Results of Work in sub-groups – developing of indicators (ToR c,d,e)
    a) Effects of Eutrophication
    b) Effects of Hazardous Substances
    c) Effects of Fishing Activities
    d) Habitat Destruction and Loss of Biodiversity
6) Strategies for further development of socio-economic issues (ToR e)
7) Public health aspects of pollution and eutrophication of Baltic Sea
8) Identification of potential contributions to 2006 ASC Theme Session on Integrated Assessments (ToR f)
9) Social and Economic Aspects of Pollution of the Baltic Sea (ToR g)
10) Matters related to the external review of the 2005 SGEH report (ToR h)
11) Adoption of the Report and Recommendations
12) Next SGEH meeting
13) Any other business
14) Closing of the meeting

Annex 3: Development of Benthic Index (Kevin Summers)

Benthic community structure was selected for the development of Benthic Index because benthos represents a major trophic link between plankton and demersal fish. Benthic filter feeders directly affect water quality and productivity. Benthos affects sediment depositional patterns through bioturbation and affects chemical transformations by sediment re-oxygenation.

US EPA started with a list of ~700 environmental indicators and ended up with some 12 complex indicators. One of those is Benthic Community Index (BCI), which clearly indicates a broad range of environmental changes. A set of criteria was used to evaluate the BCI-related indicators during the process of their selection. The selected variables are representative, stable in temporal scale, have low natural variability and are able to clearly indicate the environmental impacts. BCI is specifically representative as reflectance of trophic conditions, marine habitat quality and even human stressors (pollution, habitat destruction, etc.). BCI for the US is largely regionalized, because benthic communities are very diverse along the long coastline. Conceptual model of designation of BCI was rather complex, but there was a strong relationship between stressors and environmental response, which was integrated into the procedure. So it is necessary to have all the range of information for each of the regions of interest (e.g. for the Baltic Sea) in order to draw out the BCI. Mathematical relationship between communities and the environments of different level of destruction lay in the background of selection of reference and threshold values.

Working with the original data samples, it is necessary to remove variability related to natural (physical) conditions of the environment in order to find differences between degraded and pristine communities. Then it is step-wise and canonical discriminate analysis, which points out variables specifically related to the stressors. Proportion of expected diversity for instance is one of the most important components detected during this stage of analysis. Cumulative analysis of BCI values in different sampling sites allowed to separate between "good" and "bad" conditions, in this case BCI<3 was considered as "bad", while BCI>5 - "good". A series of additional measurements (like oxygen conditions, sediment contamination, etc.) was used to separate degraded sites from those in good condition. The level of year-to-year variation was specifically tested on revisiting during re-visits of stations and analysis of the existing data sets. Stability over the index period makes it possible to extend the sampling period without a threat to get biased by natural or seasonal variation of samples. Short-term stressors (e.g. seasonal hypoxia events), however, can impose certain reversals within the sample, but this is not a part of some long-term ecosystem trends, and recovery of the communities would usually follow within a relatively short period of time. In addition to the statistical analysis of sampled data, additional ranking of general environmental quality of known sites was carried out by scientists, and those assumptions were compared with the ranking resulting from the statistical analysis.

In order to construct the index, benthic community information (species identification, abundance, and sediment substrate) was taken from 422 randomly selected sites from 1991–1994. These data were divided into two subsets – describing degraded and reference sites. Degraded sites were characterised as having either low dissolved oxygen (< 2 mg/l), high concentrations of at least a single contaminant or moderate concentrations of at least 4 contaminants, or sediment bioassays showed mortality rates for amphipods of the order of > 20 %. Reference sites were characterized as having levels of dissolved oxygen > 3 mg/l, no contaminant concentrations that were high and no more than three contaminants with moderate concentrations, and bioassay survival rates for amphipods > 85 %.

The benthic index was determined by partitioning the benthic information into numerous measures: measures of species richness or diversity, measures of abundance, measures of taxonomic composition, and measures of trophic level composition. This partitioning resulted in approximately thirty variables for analysis. All variables were evaluated for significant correlations with natural habitat factors (e.g., salinity or silt-clay) and adjusted (normalized), if necessary. Then using a stepwise canonical discriminant analysis in an iterative process, the components of the index were determined that best discriminated between degraded and reference sites (components that best explained the residual variability). The NCA benthic index for the Gulf of Mexico included the proportion of expected diversity (species diversity normalized for salinity), tubificid abundance, and percent of amphipods (percent of total benthic abundance), percent of capitellids, and percent of bivalves. These components resulted in a squared canonical correlation of 0.7467 and F value of 23.58 ($p<0.0001$), and a correct classification rate between 90.9 % (degraded sites) and 95.8 % (reference sites). Examination of the analysis results indicated that an index score greater than 5.0 indicated a benthic community in good condition (>75 % of expected diversity, high abundances of pollution sensitive groups such as amphipods and bivalves and low abundances for pollution tolerant species such as tubificids and capitellids. Similarly, an index score less than 3.0 indicated a benthic community in poor condition (low expected diversity, high pollution tolerant species and low pollution sensitive species).

Examination of the index application over the period from 1991–1994 showed low year-to-year variability and re-sampling within the sampling period showed 97 % fidelity (same index category measured at each sampling site (measuring index is stable throughout the sampling period). Scores were than transformed into site criteria values: < 3 was considered to be of poor quality/condition, 3–5 as intermediate or fair condition and >5 as good condition. These measurements were then aggregated over regional areas (e.g. Gulf of Mexico) to determine the percentage of estuarine sediments in good, fair and poor condition. Finally, a set of decision-making value criteria were determined to assess overall regional condition (as opposed to site condition or the distribution of condition within a region). These criteria were to assess the overall condition as good if < 10 % of the region was in poor benthic condition and < 50 % of the region was in fair; overall condition as fair if between 10–20 % of coastal sediments are in poor condition or > 50 % are in fair condition, and in poor regional condition if > 20 % of sediments are in poor condition.

The evaluations based on benthic index represent one of the five indices used in the National Coastal Assessment (US EPA 2001, 2004). The percent area in poor benthic condition in each region of the US is determined and compared to the decision criteria and rated as good, fair or poor. The regional assessments are combined into a national assessment for each index (water quality, sediment quality, habitat quality, benthic quality, and fish tissue quality) and then combined into a single overall assessment of ecological quality.

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Annex 4: Public health aspects of pollution and eutrophication of the sea (Astrid Saava)

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There are basic similarities in the concept of ecosystem health and public (human) health. The term ecosystem can be defined as a system of dynamic interdependent relationships among living organisms and their physical environment. It is a bounded entity that has acquired self-stabilizing mechanisms and an internal balance that has been evolving over the course of centuries. Stable and balanced ecosystems will survive longest (Yassi *et al*., 2001).

Human health is defined as a state of complete physical, social and mental wellbeing, and not merely the absence of disease or infirmity (WHO, 1948). Health is a resource for everyday life, not the object of living.

Human health is a state where you are fit and well. Good health or normal functioning of the whole organism is possible in the definite desirable conditions. When these conditions deviate substantially from desirable level serious or irreversible adverse health effects will result. We should know these levels and, accordingly, take precautions to prevent transgressing these levels (something dangerous or unpleasant).

Usually it is considered that humans impact the sea and its ecosystem through their activities, but sea and its ecosystem impacts humans and their health as well. The impact on population health and quality of life depends on the type of interaction of humans and sea (Box 1).

Public health effects

Seas provide great health benefits to humans, ranging from recreational opportunities (bathing, boating, water-contact sports, and fishing) to food and nutritional resources, and to a novel resource for new bioactive compounds and food additives. Marine plants, animals and microbes have served as a source for more than half of pharmaceuticals to treat diseases. Therefore it is very important to safeguard the biodiversity of the ecosystem. Sea provides the aesthetic enjoyment also.

Box 1. Humans and marine environment

- Water recreation
    - Bathing, boating
    - Water-contact sports
    - Fishing
- Tourism
- Food and nutritional resources
- Quality of life
- Aesthetic enjoyment

Cited above impacts describe the positive or well effects of sea on human health and quality of life, but every medal has two sides. So has the sea. Nowadays we are interested, first of all, in ill or adverse effects. These effects can be direct and/or indirect in their character.

Direct health effects are directly connected with water (caused by water itself) and they develop after the exposure to water. The routes of exposure are:

- ingestion (swallowing) of water;
- contact with water;
- inhalation of aerosols.

Indirect health effects are related to the changes in marine environment and/or ecosystem caused by pollution and/or eutrophication of the sea. These effects have been mediated to humans by:

- consuming fish and marine products;
- algal blooms;
- aesthetic value.

Direct adverse health effects

Infectious diseases

The most important public health concern is the spreading of infectious and parasite diseases. Water is the common vehicle of the pathogens. Vectors can be in the form of filter-feeding organisms, biological transporters, and winds and sea currents.

Most pathogens come from human and animal faeces and contaminate coastal and estuarine areas through freshwater runoff from sewers, rivers and streams. Marine pathogen bacteria and parasites can invade new areas through the transport of organisms in the ballast water of ships.

Information on survival of these pathogens in seawater is limited. Very little information exists for protozoa and their potential impact on marine environment and human health.

Infectious diseases associated with water are classified into five groups according to the various aspects of the environment that human intervention can alter (WHO, 1992). These groups are as follows:

- Water-borne diseases. These arise from contamination of water by human or animal faces or urine infected by pathogens, which are directly transmitted when water is swallowed. Cholera, typhoid, and cryptosporidiosis are typical examples.
- Water-privation diseases. This category of diseases is affected more by the quantity of water rather than by quality. These diseases spread through direct contact with infected people or materials contaminated with the infectious agent. Inadequate personal hygiene is the main factor in these types of diseases, such as diarrhoeal diseases, helminthases, and skin and eye infections.
- Water-based diseases. In these diseases, water provides the habitat for intermediate host organisms in which some parasites pass part of their life cycle. These parasites are later the cause of disease in people as their infective forms find their way back to humans by being ingested with water plants or raw or inadequately cooked fish. Helminthes and parasites are the examples.
- Water-related diseases. Water may provide a habitat for insect vectors of water-related diseases. Mosquitoes breed in water and the adult mosquitoes may transmit parasite diseases, such as malaria, and some viral infections.
- Water-dispersed infections. Pathogens can proliferate in water and be dispersed as aerosols and enter the body through the respiratory tract and cause a serious disease. An example of this type of disease is legionellosis.

In general, infections appear to have increased among individuals recreationally and occupationally exposed to seawater (Henrickson *et al.*, 2001), including gastrointestinal, dermal, respiratory, eye, ear, nose and throat infections. Children are at greater risk due to greater exposures and they are uniquely susceptible because of their physiology and development.

Non-infectious diseases

Many types of chemical contaminants in marine environment threaten the ecosystem as well as human health (Box 2). Substances of particular concern are synthetic organic chemicals, specific heavy metals, marine (algal) toxins, and possibly genetically modified organisms.

Box 2. Health effects caused by chemical contaminants

- Remote effects (genotoxicity)
  - Mutagenic effects (gene disturbances)
  - Teratogenic effects (malformations)
  - Reproductive effects (infertility)
  - Carcinogenic effects (cancer)
- <u>Chronic diseases (cytotoxicity)</u>
  - Systemic toxicity
  - Organ-specific toxicity
- Local effect
  - Skin irritation
  - Allergic reaction

Genotoxic substances of major concern are synthetic organics, many chlorinated micro-organics, some pesticides, and arsenic. They are able to induce mutations, chromosomal aberrations, and other effects indicative of heritable genetic damage. Cancer arises as a consequence of multiple genetic and nongenetic events that might lead to uncontrolled proliferation of cells. Genotoxic substances are said to produce a non-hreshold effect: any exposure could result in the effect. There is no level for genotoxic substances that would be considered safe. That is, no safe dose or exposure can be established, and any exposure is associated with some risk.

Cytotoxic substances may cause systemic or organ-specific effects. Systemic effects result from absorption of a chemical and its spread by the blood to different body systems. They may also create allergic diseases through altering the immune system. Certain chemicals have target organ specificity (i.e. they harm a certain organ rather than others), often because of biotransformation or bioaccumulation. Most chemicals are metabolized in the liver. Therefore, the liver becomes the target organ for many chemicals. Chemicals with kidney toxicity include mercury, lead, cadmium. Local reactions affect only the organ where the chemical first made contact with the body.

Cytotoxic compounds are said to produce a threshold effect: the effect occurs only at certain level of exposure. Below the threshold exposure the effect does not occur. These compounds have dose-response effects: as the concentration increases, so does the severity of health effect.

Indirect adverse effects

In other cases the health effects are less direct, but not less serious. Major patterns of indirect health effects mediated by marine environment are presented in Box 3.

A major concern for public health is the ingestion of contaminated seafood. Human health effects (infections) from exposure to marine food chain have been highlighted by a number of studies. No specific test exists for detecting contaminated fish. At the same time fisheries products are transported and sold worldwide.

Box 3. Major patterns of indirect health effects

- Fish and other marine products
  - Infectious diseases
  - Non-infectious diseases (poisonings)
  - Remote effects
  - Malnutrition
- Algal blooms
  - Loss of recreational value
  - Algal toxins

The impact of chemical contaminants on our health (poisonings, remote effects) is aggravated by biotransformation and bioaccumulation of chemical compounds in the marine food chain. Our diet from land sources is dominated by plants and by animals that eat plants, whereas the part of our diet from the sea is primarily animals that eat animals, thereby concentrating toxic compounds to a greater extent.

As the seas become increasingly barren, human nutrition suffers.

Algal blooms are increasingly common in the coastal areas worldwide. They decrease the recreational value of the sea. The toxins from algal blooms can cause health problems, first of all, through skin and aerosol contact. Symptoms include nausea, respiratory problems and even memory loss. The toxins are concentrated as they move up the food chain.

Pollution of the sea and public health effects

Pathogens in the marine environment are a significant human health concern. The primary sources of human pathogens are untreated human and animal wastes, although transmission can occur between swimmers or, potentially, from seabirds or other wildlife organisms. We know relatively little about the fates of most pathogens in marine environments, but we know they are present.

Most contamination is concentrated in the coastal zone of the sea; however, long-range transport can deliver contaminants to great distances and affect the health of remote human populations.

Routes of human exposure include direct ingestion of water and dermal contact with both water and sediments in the case of recreational and occupational activities. One of the major causes of infections is the consumption of raw shellfish contaminated by sewage. Viruses and bacteria of faecal origin become concentrated in filter-feeding shellfish.

Box 4. The main effects of sea pollution on human health and quality of life

- Water recreation
  - Increased infectious diseases
  - Loss of beaches and recreation activities
  - Loss of aesthetic values
- Lowered quality of fish, aquaculture and other marine products
  - Infectious and parasitic diseases
  - Poisonings, remote and chronic effects
- Reduction of commercial fish stocks
  - malnutrition

Among the microbial agents related to seafood-borne illnesses, viruses are the most common form of infection, followed by bacteria and then protozoa. The major vectors of viral infection are marine bivalves such as oysters and clams, and the effects are numerous and vary by virus. Among the bacteria, *Vibrio vulnificus* has been implicated in a number of shellfish poisonings and wound infections. Very little information exists for protozoa and their potential impact on sea and human health. Approximately 10 % of people in Scandinavia are reportedly infected with *Diphyllobothrium* or fish tapeworm (Fleming *et al*, 2001).

Chemical pollutants result from industrial activities. Their introduction to the marine environment arises from direct discharge (point sources), discharge to municipal sewage systems or rivers, and venting to the atmosphere. These compounds are best classified in terms of their persistence, bioavailability, tendency to bioaccumulate, and toxicity.

A major concern for public health is the ingestion of contaminated seafood, putting those humans who eat contaminated seafood over time at the greatest risk.

Substances of particular concern are chlorobiphenyls, chlorinated dioxins, and some industrial solvents. Pesticides and herbicides also pose potential hazards to human health. Polychlorinated biphenyls (PCBs) have a variety of effects on human reproduction, neurobehavioral development, liver function, birth weight, immune response, and tumorigenesis (Dewailly *et al.,* 2000). Some synthetic organic chemicals have been linked to possible endocrine disrupting functions. Herbicide and pesticide exposure may be linked with reproductive and developmental problems seen in humans. The health effects associated with polycyclic aromatic hydrocarbons (PAHs) exposure include lung cancer, low birth rates, and decreased fecundity. Methyl mercury causes cytotoxic, kidney, and brain damage.

Over two billion people worldwide rely on seafood as a major source of protein in their diet, and seafood consumption continues to increase worldwide. Natural stocks of seafood have been supplemented by the aquaculture industry. However, marine aquaculture may cause habitat destruction and pollution of the local environment through the production of waste products. It has aggravated the threat. For example, farmed salmon have significantly higher concentrations of organochlorine contaminants than do wild salmon. European farmed salmon had the highest concentrations (Hites *et al*., 2004).

Eutrophication and public health effects

Eutrophication of the sea may cause several indirect human health effects (Box 5).

Box 5. Major patterns of health effects that may be caused by eutrophication

- Algal toxins
  - Acute poisonings
  - Chronic effects
  - Chronic liver injury (microcystin)
  - Carcinogenesis (hepatocellular carcinoma)
- Severe neurotoxic effects
  - Increased allergy, skin irritation
- Loss of food (fish and marine products)
- Depletion of oxygen
  - Loss of recreation activities
  - Loss of aesthetic value

There is a strong evidence that coastal eutrophication contributes to the incidence of algal blooms. Over the past three decades, the frequency and distribution of toxic algal incidents appear to have increased. Certain marine algal groups, the dinoflagellates and diatoms, produce toxins that impact human health (Dolah, 2000). Filter-feeding shellfish, zooplankton, and herbivorous fishes ingest these algae and act as vectors to humans either directly or through further food web transferring the sequestered toxin to higher trophic level.

Humans may be exposed through the consumption of seafood or through dermal contact from occupational or recreational exposure to a toxin. In some cases transfer of toxins to humans may also occur through inhalation of aerosols containing the toxin.

Different toxins have different effects. Consumption of seafood contaminated with algal toxins results in five seafood poisoning syndromes: paralytic shellfish poisoning (caused by saxitoxins), neurotoxic shellfish poisoning (brevetoxins), amnesic shellfish poisoning (domoic acid), diarrhoetic shellfish poisoning (okadaic acid), and ciguatera fish poisoning (ciguatoxins). Most of these toxins are neurotoxins and are temperature stable, so cooking does not ameliorate toxicity in contaminated seafood (Dolah, 2000). Occupational exposure to the dinoflagellate Pfiesteria has been linked to nausea, respiratory problems, and severe memory loss with fatality rates exceeding 10 % in some cases (Grattan *et al.*, 1998). In the case of recreational exposure marine toxins may cause: skin irritation, deep blistering under the bathing suit, gastrointestinal symptoms, skin allergy and naso-bronchial allergy.

Algal toxins represent the greatest concern to human health also because of potential risk of long-term exposure to comparatively low concentrations of the toxins in fish and other marine products. Accurate assessment of overall health effects from exposure to algal toxins is virtually impossible, because few data exist on their transfer through the food web, primarily because many of the milder cases go unreported and thus are not recorded in databases.

The way forward

EU Marine Strategy (2004) states: "We and future generations can enjoy and benefit from biologically diverse and dynamic oceans and seas that are safe, clean, healthy and productive".

Pollutants shall not affect directly and indirectly the human health and not affect the quality of life of human population. All fish and other marine products should be safe for human consumption.

It is clear that environmental changes do affect human health, and it is important to identify which indicators have enough sensitivity and specificity to detect these changes. Human mortality and morbidity registries alone are not likely to help monitor these changes, because most chronic human diseases are multifactor and involve genetic, lifestyle, and environmental factors. It is therefore unlikely that cancer registries or mortality rates will provide a useful indication of changes for ocean-related illnesses because of issues regarding specificity and the long delay (10–20 years) between exposure to the environmental risk factors and detection of disease. However, morbidity registries on acute diseases such as marine toxin poisoning and other seafood-borne diseases (infections), reporting of which is mandatory in most countries, could provide useful information on any changes in incidence over time. Because these diseases are largely underreported, there is urgent need to improve and validate these surveillance systems (Knap *et al*, 2002). Health registries are also very useful for monitoring shorter latency events such as pregnancy complications (low birth weight, congenital malformations, and the like).

Issues of principal importance for microbial contamination of populated coastal regions include detection and quantification of the pathogenic species (not of indicator species), their distribution patterns, virulence, and antibiotic resistance. Specific clinical effects related to chemical contaminants have been the subject of numerous epidemiologic studies. In general populations exposed to low doses, only subtle effects are expected to occur. Unfortunately, epidemiologic cohort studies are extremely expensive in both time and resources and require large multidisciplinary scientific groups. In order to complement standard disease registries and epidemiologic cohort studies, scientists have tried to develop early response biomarkers to detect any reversible or irreversible adverse health effects. Potential early warning signal markers deal with immune system, endocrine activity, genotoxicity, and enzyme induction. Some biomarkers are already in use (aminolevulinic acid dehydratase for lead), but most still need to be validated. More work is needed to link the health of the marine environment to that of humans.

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Annex 5: Strategy for developing socio-economic indicators (D-type indicators) for managing human impacts on the ecosystem of the Baltic Sea

(Draft discussion/facilitation paper by Eugeniusz Andrulewicz)

1 Introduction

The ICES/BSRP/HELCOM/UNEP Regional Sea Workshop on Baltic Sea Ecosystem Health Indicators, 30 March – 1 April 2005, Sopot, Poland (ICES, 2005), recognized and emphasized the need for a greater focus in the BSRP on socioeconomic indicators, noting the following:

"Up to now, the four Sub-Groups of the SGEH have worked primarily on exploring the biological, chemical and physical aspects of indicator selection. However, the work of the subgroups has now progressed sufficiently for greater emphasis to be placed on socioeconomic aspects of indicators. It was underlined that strengthening the socioeconomic focus of the individual subgroups will result in greater interactions between the various subgroups (e.g. eutrophication and fisheries, fisheries and biodiversity, harmful substances and fisheries, etc.). In concluding the discussion on this topic, it was agreed to add an obligatory term of reference, emphasizing the socioeconomic aspect of indicators, for all Sub-Groups concerning intercessional work to be conducted before the proposed 2–4 November 2005 SGEH meeting to be held in Kaliningrad, Russia. For this ToR, attention was called for the need for collaboration with, and participation of, socioeconomists – especially the BSRP Socioeconomic Lead Laboratory (Estonia). The Co-Chairs of the subgroups agreed to identify appropriate socioeconomists or socioeconomic working groups in ICES for consultation and collaboration".

There are many different aspects of socio-economy in relation to marine environment. Most of the developments are regarded to valuation of goods and services of the oceans (e. g. Constanza 1999). There are also attempts to valuate natural amenities, such as sandy beaches, MPAs, biological processes (e.g. Weslawski *et.al*., 2005)

ICES, at its 2005 ICES Baltic Committee Meeting in Aberdeen discussed this matter and issued the following recommendation, to be considered by SGEH 3 in Kaliningrad.

"to identify existing developments on socio-economic driving forces for pollution in the Baltic Sea. On the basis of this identification recommend strategies for further development" (ToR g)

2 Existing developments regarding general socio-economic description of the Baltic catchment area

Developing D-type indicators should start with economic, social and environmental characteristics of the Baltic Sea drainage area. This description can be adopted from one of already existing characteristics. They cover political division, distribution of population, distribution of arable land, industrial centres, map of hot spots etc. (VASAB 2010, UNEP/GIWA, HELCOM PITF MLW, and HELCOM PLCs).

The Baltic Sea environmental concerns are also well recognised and defined. Some arguments may be raised when ranking the importance of these concerns. The SGEH adopted the following scheme:

- Eutrophication
- Contamination by harmful substances
- Overfishing

- Destruction of habitats and loss of diversity (including problems of xenodiversity)

Some other issues, such as oil pollution, dredge spoils dumping, extraction of sand and gravel, dumped chemical weapon can be considered as well.

3 Existing developments regarding D-type indicators

3.1 Developments by governmental organisations

HELCOM

During summit meeting in Ronneby, 1998, HELCOM Program Implementation Task Force (HELCOM PITF) was created. HELCOM PITF (later Joint Comprehensive Programme (JCP) has created a Map of (Baltic Sea) Hot Spots (1992) distributed in the Baltic drainage basin. Decision on phasing-out of these hot-spots is probably the most important management activity for improvement of the health of the Baltic Sea.

Element 4 of HELCOM PITF – Management Plans for Lagoons and Wetlands (HELCOM MLW) attempted the development of sustainable development indicators to be used as management tools by decision makers to improve environmental conditions of selected Baltic lagoons.

HELCOM Pollution Load Compillartion (PLC) programme includes also characteristics of the drainage basin and pollution load to Baltic sub-basins.

ICES

ICES Working Group on Ecosystem Effects of Fishing Activities (WGECO) is developing indicators for fishery management framework. However, until now socio-economic issues are not included in the ICES developments (ICES WGECO, 2005).

IBSFC

International Baltic Sea Fisheries Commission (IBSFC) recommended several indicators for management Baltic fishery; however, these are mostly the pressure indicators.

GIWA

Global International Water Assessment (GIWA) has developed important description of the Baltic Sea catchment area and developed casual chain analyses methodology for D-type indicators (UNEP, 2005).

OECD

Organisation for Economic Cooperation and Development (OECD) has mainly developed PSR framework. However, in some OECD reports, driving force indicators are mentioned as well (OECD, 1993).

3.2 Developments by NGOs

Baltic 21

Baltic 21 is a component of Agenda 21. The Baltic 21 develops indicators for different sectors affecting the health of the Baltic Sea (Baltic 21, 2003). The World Wide Found for Nature (WWF) has developed indicators for the loss of marine biodiversity (WWF, 2000).

3.3 Scientific projects

MARE

Marine Research on Eutrophication – a Scientific Base for Cost-Effective Measures for the Baltic Sea (MARE). The aim of this project was to give advice on cost effective measures for a cleaner Baltic Sea in relation to eutrophication.

EU projects

EU projects which are touching socio-economic issues, also in relation to the Baltic Sea are: EU ELME and EU INDECO.

ELME (European Life Styles and the Marine Environment) has adopted Conceptual Model Drivers-Pressures-State-Impacts-Responses (DPSIR) indicators (D and P indicators in particular) in case of eutrophication and harmful substances.

INDECO (Development of Indicators of Environmental Performance of the Common Fisheries Policy (FP6) has adopted PSR framework of indicators and created on WP for developing of socio-economic issues.

First Annual INDECO Conference was held at the Sea Fisheries Institute in Gdynia, 5–8 September, 2005. The aim of this Conference was to develop indicators for the EU Common Fisheries Policy. The results of this conference related to socio-economic issues will be presented and discussed during the SGEH 3 meeting in Kaliningrad.

4 Illustrative examples of D-type indicators

These illustrative examples were partly taken from above mentioned sources:

Eutrophication

- Fertilizer use per ha
- NOx emission from stationary sources
- NOx emission from mobile sources
- Supply or sale of mineral fertilizers
- Livestock density
- Manure tanks/reservoirs

Contamination

- Generation of industrial and municipal solid waste
- Household waste/garbage disposed per capita
- Generation of hazardous wastes
- Import/export of hazardous wastes
- Oil discharges into coastal waters
- Use of agricultural pesticides
- Number of cars per 100 inhabitants

Overfishing

- Number of full time fisherman engaged in the Baltic Sea, per country
- Landings per country
- Number of fishing vessels per country
- Average engine power per country
- Fish consumption per capita per country

- Fishing subsidies and market failure
- Fishing gear modernisation
- Privatisation in former socialist countries
- Inappropriate assessment methods
- Inadequate fishery control
- Biased fishing statistics

Biodiversity

The driving forces for "Loss of biodiversity" are excessive eurtrophication, contamination by harmful substances as well as fishing activities. However some other human activities are driving loss of biodiversity, such as:

- Population growth rate in coastal areas
- Habituated coastal line
- Change of coastal line usage
- Destruction/drainage of coastal wetlands
- Coastal constructions
- River damming
- Marine habitat change or alterations

5 Suggested strategy for further developments

D-type indicators can be developed for different economical sectors affecting the ecosystem health of the Baltic Sea:

- Energy
- Agriculture
- Industry
- Transport
- Tourism
- [Other]

However, already existing SGEH indicator developments (PSR) are related to the main environmental concerns/problems, such as: eutrophication, contamination, overfishing, habitat destruction and loss of diversity (including xenodiversity).

To begin with D-type indicator developments, it is proposed to apply "casual-chain analysis", in order to determine what the social/political/legal/economic reasons for the existing pressure are. These developments may differ from one country to the other. However, for the start a "shopping list" of indicators can be produced and structured according to their importance [as well as related to different countries].

6 Comments and conclusions

D-type indicators are an indispensable tool for decision makers who can apply them in order to combat pollution of the Baltic Sea.

Developments of socio-economic issues will be the long term process requiring participation of experienced economists as well as environmental scientists. Therefore this can not be done in a short time. However, identification of existing developments on socio-economic driving forces for marine pollution, as requested by ICES BCC 2005 (ToR g), is a realistic task.

Developments of D-type indicators should also be based on socio-economic characteristic of the Baltic catchment area, recognising political divisions, population, land use, industry, distribution of hot spots, economic conditions as wells as lifestyles.

Development of D-type indicators within SGEH should be connected to the already developed EcoQOs and PSR indicators. This will enable to achieve the full DPSIR framework of indicators. Therefore, socio-economic indicators should be developed for the most important Baltic concerns identified by SGEH:

- Effects of Eutrophication
- Effects of Hazardous Substances
- Effects of Fishing Activities
- Habitat Destruction and Loss of Biodiversity

It is proposed to adopt so called “casual-chain analysis” for the above mentioned Baltic concerns.

Development of socio-economic indicators (D-type indicators) for pollution of the Baltic Sea is the challenge for the ICES/BSRP SGEH experts as well as for Baltic science. Other proposal for strategy to develop socio-economic indicators should be discussed and adopted during the SGEH 3 meeting Kaliningrad.

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Annex 6: The external review of the 2005 SGEH Report

"Study Group on Baltic Ecosystem Health Issues in support of the BSRP (SGEH)" ICES CM 2005/H:01

General

This study group is apparently set up to facilitate the development towards a more integrated and ecosystem based approach for management of human activities in the Baltic. The ToRs are set up by ICES, and the Study Group reports to the Baltic Committee and ACE. For an outsider, the number of organizations and institutions mentioned, and the flora of acronyms (which meanings are partly not explained) seem overwhelming. However, this report is not primarily written for outsiders and for people involved, the roles and involvement of all the institutions and organizations are probably well known and understood. Nevertheless, it appears to me that the complexity of involvements in the so-called ecosystem approach to management in the Baltic and elsewhere well reflects the complex nature of the concept itself. There is, apparently, no well-defined roadmap towards the achievement of a management that takes into account both the continuation of a traditional management of exploitation of fish stock, and in addition takes into account the need to protect the health of not only the parts of the ecosystem harvested today, but of the totality of the environment and the living resources forming the ecosystem.

Does this report contribute to the making of such a roadmap? I think it does, in various ways. Before coming into that I want to comment upon the report as such.

I find the report well organized and well written. The inclusion of the relevant ToRs in the section headings was extremely helpful when navigating through the report, both for structuring the reading and for checking that the SG adequately handled all ToRs. The structuring of each section into a summary, recommendation, and a short account on the group discussion added to the clarity.

The question appears, whether the content of the report really helps in moving the project into a practical mode. To be a bit impudent, the most important decision made by some SGs and WGs are to meet again in a year or so, to continue an endless discussion about what to do or which advice to give. I do not think that this SG has fallen into that ditch. On the contrary, in the various sections are recommendations of practical measures to take to move further on towards the achievement of the final goal.

The various parts of the report

The overview given in Section 3 is well structured, and seems to meet ToR a). The recent development of ecosystem health assessment and ecosystem-based approaches to management within HELCOM, OSPAR, EU, US EPA, MMED and elsewhere is pointed out in a clear and consistent way.

Section 4 is probably the most important part of the report, since this is where the most concrete and practical suggestions for follow-up is given. ToR b) is well covered. When it comes to ToR c), to propose reference levels, an even more direct approach could be hoped for. However, this is clearly the most difficult task given to the SG, since moving from a qualitative to a quantitative approach in many cased need more knowledge than what is presently at hand. In any case, the SG has presented proposed actions and suggestions for further work for all the environmental concerns covered by ToR c).

ToR d is covered in Section 5, seemingly in a proper way.

An updated work plan for the SG is given in Section 6, covering ToR e).

The concrete planning of further work meeting ToRs f), g) and h) is covered in Sections 7, 8, and 9.

Section 10 is a summary with emphasis on recommendations and follow-up. The Section is clear, both when it comes to recommendations for upcoming meetings and intercessional activities.

Conclusions

I find the report mostly intended for “insiders”, but the approaches appear reasonable and sensible. It is well organized and well written, and might be useful even for persons/groups working with similar problems in other areas.