# ICES WGIAB REPORT 2013

SCICOM STEERING GROUP ON REGIONAL SEA PROGRAMMES

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# Report of the ICES/HELCOM Working Group on Integrated Assessments of the Baltic Sea (WGIAB)

8-12 April 2013

Chioggia, Italy

ICES International Council for the Exploration of the Sea

CIEM Conseil International pour l'Exploration de la Mer

**International Council for the Exploration of the Sea**
**Conseil International pour l'Exploration de la Mer**

H. C. Andersens Boulevard 44–46
DK-1553 Copenhagen V
Denmark
Telephone (+45) 33 38 67 00
Telefax (+45) 33 93 42 15
www.ices.dk
info@ices.dk

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## Contents

## Executive summary

The ICES/HELCOM Working Group on Integrated Assessments of the Baltic Sea (WGIAB) is a forum for developing and combining ecosystem-based management efforts for the Baltic Sea. The group is intended to serve as a scientific counterpart and support for the ICES Baltic Fisheries Assessment Working Group (WGBFAS) as well as for efforts and projects related to integrated ecosystem assessment (IEA) within HELCOM. The group works in cooperation with similar groups within the ICES SCICOM Steering Group on the Regional Seas Programme (SSGRSP). The group was established in 2007.

The WGIAB 2013 meeting was held 8-12 April in Chioggia, Italy, with 14 participants from five Baltic countries. The meeting was chaired by Lena Bergström, Sweden, and Maciej Tomczak, Sweden. With a special aim to support experience exchange among regions, the meeting benefited from additional participation from six experts on integrated ecosystem analyses in the Mediterranean area. The joint meeting is expected to further facilitate integration and extension of core IEA concepts among regions.

Within the first year of its three-year terms of references, the main working activities of WGIAB 2013 were

i ) synthesizing results from subregional integrated trend analyses into a common assessment of drivers at different geographical scale;

ii ) developing environmental indicators for Baltic Sea fisheries assessment, including contribution to Baltic Sea Ecosystem Overview subsection 2; and

iii ) further developing tools and models applicable to an adaptive ecosystem based management framework, including sharing results of recently published papers and planning future activities. WGIAB 2013 also provided input on two additional terms of reference; regional observing assets necessary to support development of Baltic Sea ecosystems assessments, and the identification of anthropogenic pressures on ecological characteristics to be prioritized for future assessment and development of management advice.

A central point of the meeting was to consider recent strategic initiatives within ICES to strengthen ecosystem based management advice. The group considered it essential to a successful future development that the regional IEA groups, including WGIAB, are involved in the process, specifically due to the central role of the regional IEA groups currently being indicated. The group encompassed the main preliminary ideas outlined by WKBEMIA as a useful framework for communicating and integrating ecosystem-based management concepts among scientists and users. The group discussed the main outcomes of WKECOVER and took a general standpoint to follow the suggested path and timeline for the development of a Baltic Sea Ecosystem Overview. However, a potential difficulty in achieving the plan was seen in limits to data availability and in willingness of member countries to allocate time for the data preparations needed. Progress should be facilitated by as far as possible coordinating data collation activities with other expert groups within ICES and HELCOM.

# 1 Administrative details

**Working Group name**

Working group on integrated assessment of the Baltic Sea

**Year of Appointment**

2007

**Reporting year within current cycle (1, 2 or 3)**

1

**Chairs**

Lena Bergström, Sweden

Maciej T. Tomczak, Sweden

**Meeting venue**

Chioggia, Italy

**Meeting dates**

8-12 April 2013

**Figure 1. Part of the participants at WGIAB 2013. Upper row from the left: Anna Gårdmark, Pavel Afanasyev, Heikki Peltonen, Jens Olsson, Bärbel Müller-Karulis, Alessandra Conversi, Andrea Rau, Muriel Kroll, Ute Jacob. Front row: Outi Heikinheimo, Laura Uusitalo, Maciej T Tomczak, Lena Bergström, Saskia A Otto, Alberto Barausse, Ivars Putnis, Giovanni Galli**

# 2 Terms of Reference a) – e)

| ToR | Description |
|---|---|
| a) | Increase understanding of Baltic Sea ecosystem structure and functioning, with a focus on species interactions and trends over different temporal and spatial scales, and the identification of key species and processes for maintaining functioning ecosystems and sustainable use of these; |
| b) | Support development of a framework for integrated advice for fisheries management, by data exchange, model evaluation and scientific interaction with the Baltic Sea assessment working groups. |
| c) | Further develop the integrated ecosystem assessment cycle, and apply case studies to investigate trade-offs between different management objectives, including effects on ecosystem services and effects at different spatial and temporal scales. |
| d) | Identify potential regional observing assets (both inside and outside ICES) necessary to support development of regional ecosystems assessments. |
| e) | Produce an approach for monitoring and developing assessment methods for the top three anthropogenic pressures on ecological characteristics described in the national MSFD reports (submitted in October 2012) for the appropriate regions. |

# 3 Summary of Work plan

| | |
|---|---|
| 2013 | Annual meeting, intersessional work on research articles, Focus on ToR a and b<br>Additional ToR d and e |
| 2014 | Annual meeting, intersessional work on research articles, Focus on ToR b and c |
| 2015 | Annual meeting, intersessional work on research articles Focus on ToR b and c |

# 4 List of Outcomes and Achievements of the WG in this delivery period

## 4.1 Publications based on WGIAB activities, published 2012-2013

Casini et al. 2012. Predator transitory spillover induces trophic cascades in ecological sinks. Proceedings of the National Academy of Sciences, 109(21), 8185–8189. doi:10.1073/pnas.1113286109

Gårdmark et al. 2013. Biological Ensemble Modelling to evaluate potential futures of living marine resources. Ecological Applications. In press

Lindegren et al. 2012a, Early detection of ecosystem regime shifts: a multiple method evaluation for management application. PLoS One, 7(7), e38410. doi:10.1371/journal.pone.0038410

Lindegren, M., et al. 2012. Nutrient reduction and climate change cause a potential shift from pelagic to benthic pathways in a eutrophic marine ecosystem. Global Change Biology, 18: 3491-3503.

Möllmann C, Lindegren M, Blenckner T, Bergström L, Casini M, Diekmann R, Flinkman J, Müller-Karulis, B, Neuenfeldt S, Schmidt JO, Tomczak M, Voss R, Gårdmark A. Implementing ecosystem-based fisheries management – from single-species to integrated ecosystem assessment and advice for Baltic Sea fish stocks. Accepted pending revision ICES J Mar Sci

Niiranen, S., T. Blenckner, O. Hjerne, and M.T. Tomczak. (2012) Uncertainties in a Baltic Sea foodweb model reveal challenges for future projections. AMBIO 2012, 41:613-625 . doi:10.1007/s13280-012-0324-z.

Olsson, J., Bergström, L., Gårdmark, A. (2013) Top-down regulation and climate as drivers for temporal development of as drivers of multidecadal changes in coastal zoobenthos communities. PLOS ONE

Olsson, J., Bergström, L., Gårdmark, A. (2012) Abiotic drivers of coastal fish community change during four decades in the Baltic Sea. ICES J Mar. Sci. doi:10.1093/icesjms/fss072

Tomczak, M. T., Dinesen, G. E., Hoffmann, E., Maar, M., and Støttrup, J. G. (2012) Integrated trend assessment of ecosystem changes in the Limfjord (Denmark): Evidence of a recent regime shift?. Estuarine, Coastal and Shelf Science.

Tomczak, M.T., S. Niiranen, O. Hjerne, and T. Blenckner. (2012) Ecosystem flow dynamics in the Baltic Proper—using a multitrophic dataset as a basis for foodweb modelling. Ecological Modelling 230: 123–147. doi:10.1016/j.ecolmodel.2011.12.014.

An overview of how these, and earlier publications based on WGIAB activities, relate to the WGIAB work on developing Integrated Ecosystem Assessments is presented in Annex 8.

## 4.2 Advisory products

Analyses of indicators of recruitment environment for Eastern Baltic cod, for input to WGBFAS (Section 5.2.2 in this report)

Input on ToR d [Produce an approach for monitoring and developing assessment methods for the top three anthropogenic pressures on ecological characteristics described in the national MSFD reports (submitted in October 2012) for the appropriate regions] are reported in section 5.4.

## 4.3 Datasets

One core activity of the group is to maintain and regularly update datasets representing open sea and coastal foodwebs, including biotic variables, environmental varia-

bles and anthropogenic pressures. A summary of available datasets was presented by WGIAB 2102 (see section 5 in this report, and Dieckmann and Möllmann 2010). A synthesis of main trends and drivers in Baltic Sea open sea and coastal foodwebs are currently under development (Blenckner et al., in prep.; Olsson et al., in prep, respectively. The open sea datasets are planned to be updated next time in 2014.

The relationships between WGIAB datasets and indicators for environmental status developed within the BSAP and the MSFD are reviewed in section 7.

In relation to ToR e [Identify potential regional observing assets necessary to support development of regional ecosystems assessments], WGIAB provided an overview of datasets currently used (thus, identified as continuously needed) and dataset that would additionally support further development (Section 5.4).

## 4.4 Methodological developments

WGIAB continuously develops tools and models to support the evolution of a Baltic Sea Integrated Ecosystem Assessment framework. Progress in relation to this activity is further reported in section 5.3.

Particular areas of focus in 2013 were: i) Developing indicators of the recruitment environment of Gulf of Riga herring and of Baltic Sea cod, ii) Potential uses of Bayesian Belief Networks to support Baltic Sea IEA, and iii) Widening the scope of WGIAB to increasingly incorporate historical information to assess and identifying reference values for management targets, to include datasets applicable to management in relation to the MSFD and the BSAP, as well as ecosystem functions. The initiatives will be continued between meetings and re-assessed at WGIAB 2014.

## 4.5 Modelling outputs

Not included as a planned activity in 2013

# 5 Progress report on ToRs a)-e)

## 5.1 Progress report on ToR a –Baltic Sea ecosystem structure and functioning

***Tor a) Increase understanding of Baltic Sea ecosystem structure and functioning, with a focus on species interactions and trends over different temporal and spatial scales, and the identification of key species and processes for maintaining functioning ecosystems and sustainable use of these***

The ToR was addressed by presentation and dicsussion of results so far by meeting participants (see Annex 2), and by planning of common activities for proceeding. Some main focal points were:

### 5.1.1 Historical regime shifts in the Baltic Sea

A summary of current understanding on long-term temporal patterns in the Baltic Sea open sea foodweb was presented by Bärbel Müller-Karulis. Analyses of changes in foodweb components over time clearly show the presence of long-term changes and regime shifts, relating to climate-related drivers and fishing pressure (Möllmann et al. 2009a, b). The results also show links between changes in fish stocks and eutrophication symptoms (Casini et al. 2012), since eutrophication first caused a productivity increase, which only after a time-lag decreased bottom-water oxygen concentrations sufficiently to impair cod recruitment.

However, as the currently used WGIAB datasets typically extend only back to the 1975, it is usually not possible to assess trends occurring earlier than that, or to identify any potential historical regime shifts prior to the 1970s. It would be of great value to increase knowledge also on past events, in order to support the assessment of reference states in Baltic Sea marine management. In some cases, historical information can be improved by data collation, if information is available but not yet accessible longer back in time (e g Baltic Sea fish stocks, macrozoobenthos). In other cases, modelling is the most useful approach.

Integrated analyses based on reconstructed time-series on hydrographical and biogeochemical variables (using the BALTSEM model; Gustafsson et al. 2012) in combination with historical data, when available, may be useful for assessing long-term trends and regime shifts further back in time, and to provide information on the stability of past and potential future ecosystem configurations (Müller- Karulis *et al*., in prep). The approach was considered promising to support the identification of management targets and WGIAB will continue to explore a combination between modelling and data analysis to expand the present analysis to higher trophic levels.

### 5.1.2 Ecosystem functions and services

Ecosystem services, broadly defined as benefits human societies obtain from natural ecosystems (Daily et al. 1997) can be distinguished into four different categories: Provisioning services, ensuring the provision of basic material for human survival and a good life; regulating services, securing a stable environment to live; cultural services, supporting cultural identity and development; and supporting services, maintaining all other services, all of which are essential to human wellbeing (MA 2005). There is increasing evidence that disturbances on ecosystems, via changes in species richness, species composition and community structure will affect important ecosystem functions and service provision. Characterizing the relationship between ecosystem functioning and biodiversity is a challenging task and raises issues on how best to classify a functional species and how to assign functional traits.

Ecological functions and the provisioning of ecosystem services in the Baltic Sea can be evaluated and modelled based on a core feeding network from a large trophic dataset. This is based on a compiled species list that encompasses more than 800 consumer and resource species from different areas in the Baltic Sea (over 500 publications were analysed and standardized)[1]. For the foodweb construction, a directional feeding link was assigned to any pair of species A and B whenever A consumes B (*cf* Martinez 1991).

A new trait classification system (Jacob et al. 2011) was used to identify for the first time how the environmental gradients affect the functional structure of the Baltic Sea communities. Consumers were classified by feeding mode, and by the general nature of the interaction (i.e. herbivorous, carnivorous or omnivorous) between predator and prey species. By applying the classifications to all species, different functional groups were derived in terms of trophic ecology, taxonomy, and functional ecology. These provide useful additions to traditional descriptions of community structure that will aid in linking foodweb structure to ecosystem functioning. To analyse possible consequences of species loss or gain for the provision of ecosystem services supplied at the species level, species traits can be correlated with the number of ecosystem services provided. Additionally the susceptibility of each service to biodiversity loss could be analysed and ranked. This should indicate whether the extinction of certain species is likely to entail loss of certain ecosystem services, too.

### 5.1.3 Cross-basin comparisons of Baltic Sea open sea foodwebs and the assessment of main drivers

A synthesis of main trends and drivers in Baltic Sea open sea and coastal foodwebs are currently under development (Blenckner *et al*., in prep.; Olsson *et al*., in prep, respectively; Annex 5). In 2014, WGIAB will proceed with analyses to cross-compare areas and identify main drivers of changes in the foodweb at different scales (see also section 5.5).

In order to support the analyses, the group decided to update the open sea datasets before the 2014 meeting. This update will also incorporate the Western Baltic Sea wich has not been previuosly included. Intiatives were also put forward to revise the Gulf of Finland datasets in recognition of, and by potentially mutual benefit from, the Gulf of Finland Year 2014 programme that is currently conducted in co-cooperation by Finland, Russia and Estonia (www.gof2014.fi). Preliminary information from these two areas are presented in Annex 4.

In order to facilitate the development of ecosystem-based marine management, WGIAB also concluded that the datasets should increasingly include data representing anthropogenic pressure factors and socio-economical drivers. To achieve this, however, additional data collation efforts and expertise are needed. The most efficient way of achieving this is most likely by increased cooperation with other relevant expert groups within the Baltic Sea region, or by stimulating new research projects.

[1] Diet composition of each species was observed from a combination of field observations and stomach content analyses. Expert ecologists specialized in different species assisted with identification and sample provision. In some species, such as benthic grazers and suspension feeders, poor taxonomic resolution of prey items would have biased estimates. Here, we used information obtained in the laboratory about these species' size, behaviour and stable isotope signatures (Brose et al., 2005a) to deduce their feeding habits.

### 5.1.4 The ecosystem overviews

A summary of the WKECOVER workshop and the plans for Ecosystem Overviews (EO) were presented by Lena Bergström and discussed. WGIAB took a general standpoint to follow the suggested path and timeline for the development of a Baltic Sea EO. This was taken on in 2013 by the assessment of available data in relation to subsection 2.1-3 (See section 5.2). The context of this subsection will be further developed in coming years in parallel with the development of WGIAB ToR b. At coming meetings, WGIAB will take on updating the Baltic Sea EO by subsections, concerning areas indicated as WGIAB priorities by WKECOVER (ICES 2013a). A prerequisite for achieving this is to update data for the Baltic Sea open sea foodwebs, which is planned to place the next time in 2014.

The main difficulties for fully completing subs-sections 3-4 were seen in current limits to data availability, and in willingness of member countries to allocate time between meetings for the data preparations needed. Progress in the further development of Baltic Sea EO should be facilitated by as far as possible coordinating data collation activities with other expert groups within ICES and HELCOM.

A weakness in the suggested EO structure was seen in that there is no evident place in the overview for assessing interactions among variables or cumulative effects. WGIAB identified as a potential role of the group to identify main variables to be highlighted in the EO, and thereby provide a basis for identifying management priorities. This type of output was foreseen to be potentially useful both within ICES and at a regional level by HELCOM.

A potential problem for WGIAB in taking on any formalized role, however, was seen in that there is a risk that this will reduce the capacity of the group to perform method development and evaluation, which is the WGIAB core task. Adding regular tasks to the group might lead to reduced participation rates, as WGIAB functions on a science-base and participation by experts typically have diverse funding, in many cases through own research projects. To ensure continuity in the development, mutually constructive ways of strengthening the links between SCICOM and ACOM groups within ICES should be identified.

A potential benefit for WGIAB in taking on a central role in the EO structure was seen in that this would potentially improve data provision and connections with other regional scientific expert groups, especially within fields where gaps are currently being identified (see also section 5.4).

## 5.2 Progress report on ToR b - Support integrated advice for fisheries management

***Tor b) Support development of a framework for integrated advice for fisheries management, by data exchange, model evaluation and scientific interaction with the Baltic Sea assessment working groups.***

The ToR was met by providing input to the Baltic Fisheries assessment working group (WGBFAS) concerning indicator of recruitment environment for Eastern Baltic cod (Annex 4), provided also as part of a first version of the Baltic Sea Ecosystem overview subsection 2.1-3 (Annex 3 in this report). Intersessional developments of such indicators were presented (section 5.2.2) and WGIAB decided on the selected indicator of the cod recruitment environment to be provided as key signals in the Ecosystem overview and to WGBFAS stock advice. Additionally, intersessional research of environment-dependent recruitment relationships for Gulf of Riga herring were discussed (section 5.2.1) and will be further developed to provide input to the short-term forecasts for this stock by WGBFAS and in future versions of the Baltic Sea Ecosystem overview. Details are given in the stock-specific sections 5.2.1 and 5.2.2, below.

Activities during the upcoming years will include further method development to include environmental indicators for additional fish stocks and further indicator development and analyses of environmental dependent stock recruitment relationships.

Additional potential ways forward are to be identified together with WGBFAS chairs.

### 5.2.1 The Gulf of Riga herring recruitment

Relationships between the Gulf of Riga herring recruitment (age 1) and environmental factors were analysed. Historically the Gulf of Riga herring recruitment assessment is performed by RCT3 analysis at WGBFAS working group by using two factors - zooplankton *Eurytemora affinis* average biomass (mg/m3) in May and upper layer (0-20 m) water temperature in May. However it was found that during the last years RCT3 poorly predicts recruitment, especially the rich year classes. Our results suggest that there should be more additional significant environmental drivers affecting formation of the new year classes, particularly related to feeding conditions during the summertime. The aim is that WGIAB 2014 will provide updated information on the most important environmental predictors of herring recruitment, based on these new results, to WGBFAS for use in the short-term predictions of the Gulf of Riga herring.

*Summary, Gulf of Riga herring:* Eurytemora affinis *biomass in May and average water temperature in August*

Recruitment model using two factors - zooplankton *Eurytemora affinis* biomass in May and average water temperature in August showed some improvement in prediction of herring recruitment in the Gulf of Riga (R2 = 0.535). These types of relationships could exist due to favorable feeding conditions when water temperature in summertime is higher. We suggest that it is also useful to take density-dependent effect of the Gulf of Riga herring into account. In future it is planned to implement herring condition factor (Fulton's coefficient) of particular year classes into recruitment forecast.

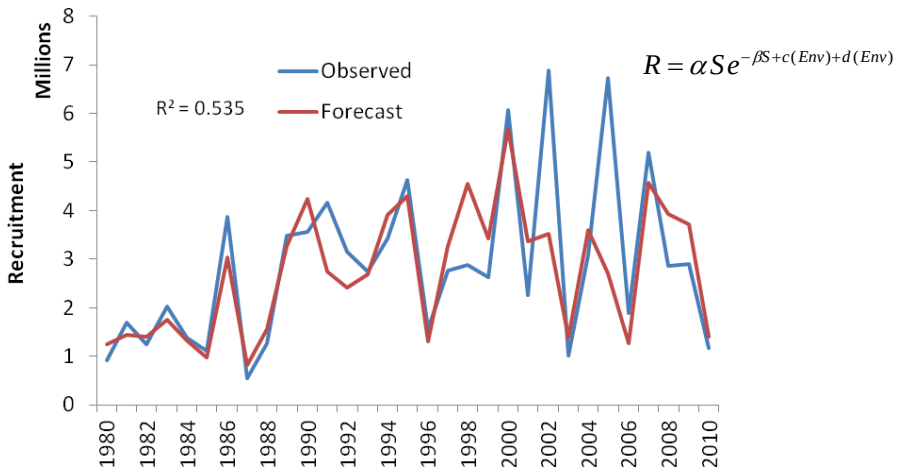


**Figure 2. Relationship between observed herring recruitment (ICES WGBFAS) and forecast using Ricker model approach by using two factors - zooplankton Eurytemora affinis biomass in May and average water temperature in August.**

### 5.2.2 The Baltic cod recruitment environment

Analysing meaningful thresholds for successful recruitment based on environmental indicators was another approach to understand and predict drivers of the recruitment dynamics of the Eastern Baltic cod stock.

Relevant abiotic (e.g. Reproduction volume (RV), salinity, temperature, O2; in total 11 factors) and biotic factors (e.g. mean weight of adult cod, sprat biomass, *Pseudocalanus acuspes*; in total 8 factors) were tested regarding their relationship with abundance of cod recruits (time-lag 0/ time-lag 2 years) obtained from SGMAB (2012) and WGBFAS (2012), respectively. Response variables (recruitment residuals) were derived using GAM of recruitment vs.SSB, and linear and polynomial models of recruitment residuals and each abiotic and biotic factor where tested. Factors showing significant relationships to the recruitment residuals were identified as potential indicators of the recruitment environment. Thresholds for these indicators were derived from mean (0) and standard deviation (±) of response variables and the impacts of type of threshold on classification of the status of the recruitment environment was discussed. Possible future environmental conditions for cod recruitment were calculated by relating indicator values for 2010 and 2011 to the thresholds. The present results show the possible important abiotic pressures relevant to successful recruitment (RV, salinity), while no biotic factors were found to have significant relationships with recruitment residuals. Furthermore, some abiotic factors were found to be significant only at regional (RV) or basin scale (O2) and it also becomes clear that the choice of thresholds is essential to providing predictions of environmental conditions for recruitment in different regions, species and methods, respectively.

The RV of the Central Baltic (summed over Bornholm, Gdańsk, and Gotland basins) showed a significant relationship for with the recruitment residuals of Eastern Baltic cod and encompasses the aspect of salinity. It is therefore suggested as a suitable indicator of important environmental drivers of recruitment of this cod stock.

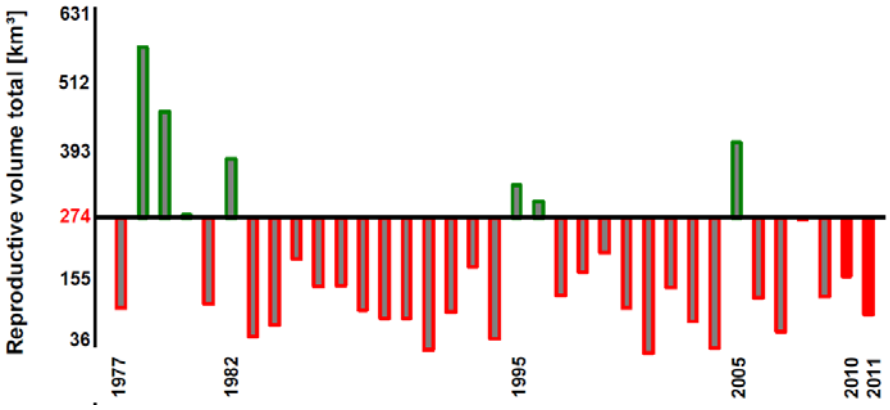


**Figure 3. Time-series of a key indicators of the abiotic recruitment environment for Eastern Baltic cod, reproductive volume (summed across the three deep basins in the Baltic Sea), assembled by WGIAB 2013 (ICES 2013). Relationships between each variable and residuals from cod recruitment (backshifted) vs. cod SSB were derived during WGIAB (ICES 2013, Kroll et al in preparation), using linear models of first or second-order polynomials for year classes 1977-2009. Bars indicate the values relative to the reference value of each variable (derived from the fitted relationships on cod recruitment residuals, as the point where there is no environmental effect on recruitment); green bars indicate beneficial environmental conditions and red bars poor conditions for cod egg survival. This shows the poor conditions for cod recruitment for the year classes 2010-2011 (corresponding to recruitment of age 2 in 2012-2013).**

## 5.3 Progress report on Tor c - Develop the integrated ecosystem assessment cycle

***Tor c) Further develop the integrated ecosystem assessment cycle, and apply case studies to investigate trade-offs between different management objectives, including effects on ecosystem services and effects at different spatial and temporal scales***

A summary of the workshop for benchmarking integrated advice (WKBEMIA, 27-29 Nov, 2012 at ICES HQ) was given by Lena Bergström. The group encompassed the preliminary ideas outlined by the workshop as a useful framework for communicating and integrating ecosystem-based management concepts among scientists and users, and considered it to be in line with ongoing activities of WGIAB. In relation to this, the group also took part of and discussed the ICES future strategy for implementing the ecosystem approach (based on information provided by Mark Dickey-Collas), especially concerning potential roles and formats of integrated ecosystem assessments and advice within the ICES structure.

A summary of the current status of Baltic Sea integrated ecosystem assessment and advice with respect to fisheries management was given by Anna Gårdmark. The presentation provided a background to achievements so far, and a basis for identifying further development priorities in order to support a Baltic IEA framework.

The main points identified were to increasingly include other management sectors in the assessment and to expand on model and tool development where gaps were identified. It was seen that available tools and models in many cases can already be used within fisheries management in the Baltic Sea, for providing strategic advice (MSE, long-term effects and limit reference points) and tactic advice (annual advice on catch and effort limitations), and are ready for implementation within regular advice for management. The further development of ecosystem-based management in a wider context may be supported by an adaptive IEA framework (Levin et al. 2009), in which fish stock advice can be integrated with other management advice. For achiev-

ing this, the introduction of the MSFD was identified as a window of opportunity to move forward.

Additional focal points of the meeting are presented below. An overview of planned activities to develop the IEA framework was prepared, in order to identify main focal areas and existing gaps, and is to be developed further continuously (Annex 8).

### 5.3.1 Integration of management indicators in the IEA framework

Building on initiatives taken during the WGIAB 2012 meeting, the group further developed on routines for harmonizing tools and models within the developing Baltic Sea IEA framework with MSFD indicators. Specifically for the Baltic Sea area, the indicators also apply to Baltic Sea Action Plan (BSAP), which was introduced as a pilot area for implementing the MSFD. A comparison of indicators and terms used within these is presented in Annex 6.

WGIAB 2013 revisited the evaluation of relationships among the HELCOM core set indicators and models/data of WGIAB 2012 (*cf* Table 4.3.2.1-2 in the WGIAB 2012 report; ICES 2012), in order to account for new information on core indicators (HELCOM, in prep; Annex 6). In 2013, HELCOM MONAS accepted 17 indicators as core indicators (and 4 more as "pre-core indicators" to be developed further in the next few years), which are to be considered for acceptance by HELCOM HoDs later in 2103. Although data on Baltic Sea MSFD indicators are not yet available, it is envisioned that data will be first made available for the core indicators and that this may occur in time for the WGIAB 2014 meeting.

WGIAB suggests that, when available, the core indicators could be analysed together with the WGIAB datasets, to compare trend and status assessment according to different datasets and combinations of these. The analyses would explore compatibility in trends indicated and contribute to a general gap assessment. The setup is also expected to provide for exploring pressure-state relationships in an integrated context as well as the identification of target levels and trade-offs, and would be a first attempt to integrate the CORESET indicators in one analysis.

WGIAB recognized potential benefits from coordinating its activities in this respect with the DEVOTES project. The DEVOTES project (EU FP7 research project, http://www.devotes-project.eu/) is currently compiling a catalogue and performing gap analysis on indicators of biodiversity, alien species, foodwebs, and seabed integrity (MSFD descriptors 1, 2, 4, 6). In the Baltic Sea, this includes the HELCOM core indicators and all published national indicators. The first results will be available for the WGIAB 2014 meeting. The DEVOTES project aims to improve existing and develop new indicators based on the gap analysis. The gap analysis is also expected to indicate where the WGIAB work could fill in some of the perceived gaps in the European indicator suite.

### 5.3.2 Method development in Integrated Trend Analysis

A part of method development within integrated trend analyses (ITA), the currently applied methods (ICES 2012) will be evaluated in relation to other multivariate approaches, in order to identify suitable ways of assessing features that are currently not being assessed. This is planned to take place in connection to activities described in section 5.1.4 (and potentially 5.3.1, provided data availability). Examples of features to be assessed are non-linear trends and exploring multivariate approaches to explore the relationship with drivers. Potential additional methods include CCA, RDA-PCNM, Complex PCA, PCO, CAP. Initiatives will also be continued (*cf* Section

5.3) to harmonize approaches among datasets, such as critically looking at lengths of time-periods analysed. Also, the possibility to include spatial processes in our current methods, e g basin specific EWE foodweb models will be explored.

### 5.3.3 Potential use of Bayesian Networks in the Baltic Sea IEA framework

An introduction to Bayesian Networks (BN) and the potential usages of Bayesian approaches within the Baltic Sea IEA Framework was given by Laura Uusitalo. These were discussed further in subgroup.

BN are potentially useful for various purposes. Examples include integrating knowledge from various sources and building meta-models to combine results from various studies and models, as well as explicit treatment of uncertainty, such as making cascading effects of uncertainty visible. They can also be used for identifying critical knowledge gaps ("which information would help most in understanding or managing the system?", and as a decision support tool to see the range of outcomes related to each decision. BN can also be useful in any planning stage, for communication and clarifying concepts and make visible knowledge needs and potential points of agreement/disagreement.

WGIAB will continue the development of Bayesian approaches to support the Baltic Sea IEA framework. The most immediate usages will be to test the combining of input and output from existing models and link them together in a Bayesian framework, aiming to apply these to estimate the effects of different management strategies. The approach can also be used to test the sensitivity and stability of foodwebs, as well as the sensitivity of foodweb models to assumptions in lower trophic levels and the sensitivity of low-troph models to foodweb processes.

## 5.4 Report on ToR d - Regional observing assets to support development of regional ecosystems assessments.

***Tor d) Identify potential regional observing assets (both inside and outside ICES) necessary to support development of regional ecosystems assessments.***

Variables currently included in the regularly updated ITAs of WGIAB are summarized in Table II, including a tentative recommended update interval. More detailed accounts of the variables are found in Dieckmann and Möllmann (2010) for open sea data, Olsson et al. (in prep.) for coastal data, and ICES (2012) for an overview. The open sea datasets are planned to be updated and slightly revised in 2014 (see section 5.1.3).

All datasets currently used are collected within ongoing international and national monitoring programs, or are derived from monitoring data. However, the level of data availability is variable. Some parameters are routinely reported to existing databases (ICES or national) and downloadable from there, whereas others are obtained only by directly contacting regional or local conductors of monitoring surveys. Most variables require additional data handling by WGIAB in order to secure time-series that can be used for standardized comparison over time.

A number of additional variables could be beneficial to include in the work of WGIAB, but are not available/made available to the group today. These are also indicated in table II. The main biotic variables requested are on zooplankton, zoobenthos and fish/seal diet data. The main variables requested on human activities are on nutrient loading from land, data on fishing effort (commercial and non-commercial) and on socio-economic drivers relating to fisheries.

Datasets on spatial aspects are currently scarce or only show maps over current/recent situations. However, these can be used to identify appropriate spatial resolution or geographic delimitation of analyses based on time-series, as well as for developing models and tools which include spatial aspects. Also, data collation activities initiated today will eventually develop into time-series, if continued, and many of the most important variables on human activities can also probably be historically reconstructed.

Data provision to support the development of regional ecoystem assessments could be facilitated by formally supporting and establishing links among relevant expert groups within ICES/HELCOM and WGIAB. The path for this development could start by data required for the Baltic Sea EO (ICES 2013a), and the HELCOM core set indictors (HELCOM, in prep). Potentially, many of the datasets needed could be stored at the ICES data centre (or at corresponding sites at HELCOM) and in this way be made readily useable by expert groups.

**Table II. Variables useful to support the the development of regional ecosystems assessments by WGIAB. X = variable used today, - = variable not used due to not existing, not made available, lack of quality or lack of awareness/ connection between data holder and WGIAB. Column II shows a tentative recommended update interval.**

| X= used; - =Not used | Years between updates | Botnian Bay | Botnian Sea | Gulf of Finland | Central BS, Gotland B | Central BS, Bornholm B | Gulf of Riga | Western BS | The Sound | Limfjord (DK) | Vendelsö (SWE) | Gulf of Gdansk (PL) | Vistula Lagoon (RUS) | Curonian Lagoon (RUS) | Kvädöfjärden (SWE) | Gulf of Riga SW (LAT) | Gulf of Riga NE (EST) | Narva Bay (EST) | Gulf of Finland W (FIN) | Archipelago Sea (FIN) | Forsmark (SWE) | Holmön (SWE) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Temperature | 1 | X(1) | X(1) | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | - | X | X |
| Oxygen | 1 | X | X | X | X | X | X | X | X | X | - | X | X | X | - | - | X | X | X | - | - | - |
| Climate | 1 | X | X | X | X | X | X | X | X | | | | | | | | | | | | | |
| Salinity | 1 | X(1) | X(1) | X | X | X | X | X | X | | | | | | | | | | | | | |
| Phyto-plankton | 3 | X(1) | X(1) | X | X | X | X | X | X | X | - | X | - | - | - | - | X | X | X | X | - | - |
| Zoo-plankton | 1 | X(1) | X(1) | X | X(2) | X(3) | X | X | X | - | - | X | X | X | - | X | X | X | - | - | - | X |
| Zoobenhos | 3 | X | X | X | - | - | - | - | X | X | X | - | X | X | X | - | X(5) | X | X | - | X | X |
| Fish | 1 | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | - | X | X | X | X |
| Birds | 3 | - | - | X | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Seals | 1 | X | X | X | - (4) | - | - | - | - | - | - | - | - | - | X | - | - | - | - | - | X | X |
| Diet data | 3 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Fishing effort | 1 | X | X | X(4) | - | - | - | X | X | X | X | X | X | X | X | - | - | - | - | - | X | X |
| Nutrient conc. | 3 | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |
| Nutrient loads | 3 | X | X | - (3) | - | - | - | - | - | - | X | - | - | - | X | - | - | - | - | - | X | X |
| Repr. volume cod | 1 | - | - | - | X | X | - | - | - | X | - | - | - | - | - | - | - | - | - | - | - | - |
| Area anoxic sea-floor | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Contaminants | 3 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Soc-Econ pressures | 1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Habitat quality | 3 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Protected areas | 3 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Wind farms | 3 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |

Main requested biotic variable

Main requested pressure variable

1=Data quality issue: data is lacking for most relevant season
2= Unsecure funding
3=Limited accessibility
4=Scale issue:existing data is not considered spatially representative
5=and phytobenthos

## 5.5 Report on ToR e - Anthropogenic pressures on ecological characteristics described in the national MSFD reports

***Tor e) Produce an approach for monitoring and developing assessment methods for the top three anthropogenic pressures on ecological characteristics described in the national MSFD reports (submitted in October 2012) for the appropriate regions***

WGIAB obtained the national MSFD reports from Germany, Sweden[1], Finland[2], Latvia[3] and Denmark[4], as brought to the meeting and reviewed by meeting participants and from Estonia and Lithuania, as obtained by correspondence (reviews obtained from Henn Ojaveer and Martynas Bucas, respectively). No information could be obtained from Poland due to delay in reporting at national level. For Russia, information from corresponding assessments was included[5].

An overview of anthropogenic pressures as reported by these countries is provided in table IIIa. Some countries reported both pressures and activities; because of this, complementary information on activities is provided in table IIIb. The intention of the group was to subsequently compile the obtained information further to provide a summary. However, it became evident at an early stage that this was not achievable for many reasons. There was a strong incongruence in the way of reporting of different countries. In some cases, only a few pressures were listed, whereas in others, comprehensive lists were provided with pressures reported in relation to statements of data availability rather than to priority. There were also differences in the level of scale subject to evaluation. Because of this, it was not considered appropriate to provide any "meta-analyses" based on the information in the reports.

WGIAB suggests that the most useful way forward for an immediate statement would be rely on the holistic assessment proved by HELCOM HOLAS (HELCOM 2010). According to this assessment, the Baltic marine environment is most prominently under pressure by anthropogenic loads of **nitrogen, phosphorus, organic matter,** and **hazardous substances**. In addition, commercial fishing was considered a strong pressure, especially due to the effects of bottom trawling on sea-floor integrity. Construction works, dredging and the disposal of dredged material were seen to have large impacts mainly on a local scale. WGIAB is also aware of the ongoing activities of HELCOM MORE to assess current gaps in environmental monitoring at Baltic Sea level, and the potential benefits for ICES and WGIAB to coordinate further activities with this.

WGIAB still acknowledged the need to harmonize information among countries in relation to the MSFD further, and to make regionally important data accessible for

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[1] https://www.havochvatten.se/om-oss/publikationer/publikationer/12-20-2012-god-havsmiljo-2020--marin-strategi-for-nordsjon-och-ostersjon--del-1-inledande-bedomning-av-miljotillstand-och-socioekonomisk-analys..html

[2] http://www.ym.fi/download/noname/%7B7D23C52C-5EAA-43C3-90A3-FD8797490508%7D/34441

[3] www.lhei.lv/lv/jurasdirektiva.php

[4] www.naturstyrelsen.dk/NR/rdonlyres/58F2036C-403A-4D06-A241-E705B8736E41/0/Havstrategi_Basisanalyse.pdf

[5] The report of GosNIORKh to the Conference of Heads of Government of the Baltic region to protect the ecology of the Baltic (Letter 14-B, 25.03.2013); Report of AtlantNIRO on the state of the ecosystem south-eastern part of the Baltic Sea (Letter 32/506-F, 25/03/13).

this purpose. WGIAB also noted that there is a lot of quantitative information in the countries reports that might warrant quality assessment.

In relation to the problem of assessment being provided at different scales, WGIAB noted that the developing Baltic Sea IEA framework includes tools and models useful for identifying the relative importance of anthropogenic drivers at different spatial scale. Conducting such analyses, for example in connection to planned activities described under section 5.3.1, would provide a potentially useful complement to the MSFD national reports, which generally are not in position to achieve regional considerations. Provided data are made available, pressure variables in relation to the MSFD could be included in the analyses. This would also provide input to Baltic Sea EO subsection 4.

**Table IIIa. Overview of anthropogenic pressures mentioned by the Baltic Sea countries in their MSFD reporting. P= mentioned as high priority, X=mentioned as important but less important than P, or without priority in relation to other pressures/activities, 0= mentioned in order to state that data are lacking/insufficient to make assessments, without statement of importance.**

| | DEN | SWE | GER | LITH | LAT | EST | FIN | | | | RUS | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | GoF | AS | BS | BB | GoF | CL | VL |
| PRESSURES | | | | | | | | | | | | | |
| Abrasion | X | X | X | X | X | 0 | | X | | | | | |
| Destr. spawning grounds | | | | | | | | | | | P | | |
| Smothering | P | | X | X | X | 0 | X | X | X | X | | P | |
| Substrate loss | - | X | X | X | | | | X | | | P | | |
| Death or injury | ? | | | | | | | | | | | | |
| Selective extract. non-living | 2 | | X | | | X | | | | X | | | |
| Selective extract. Species | P | P | X | P | | X | X | X | X | X | | | |
| Input of organic matter | P | | X | X | | X | | | | | | P | P |
| Introd. icrobial pathogens | 0 | | X | X | 0 | X | | | | | P | | |
| Underwater noise | 0 | X | X | X | 0 | 0 | X | X | X | X | | X | X |
| Water flow rate changes | - | | | | | | | | | | | | |
| Changes in wave exposure | - | | | | | | | X | | | | | |
| Barriers to species movement | - | | | X | | | X | X | X | X | | | |
| Changes in siltation | - | X | X | | X | 0 | | X | | | | P | |
| Electromagnetic changes | - | | | | | | | | | | | X | X |
| Emergence regime change | 0 | | | | | | | | | | X | | |
| Introd. non-indigenous species | - | P | X | P | X | X | X | X | X | X | | | |
| Introd. non synthestic compounds | X | X | X | X | X | X | X | X | X | X | | | |
| Introd. Radionuclides | - | | X | X | 0 | X | X | X | X | X | | | |
| Introd. synthstic compounds | P | X | X | P | X | X | X | X | X | X | | | |
| Marine litter | - | X | X | X | | 0 | X | X | X | X | | | |
| N and P enrichment | P | P | X | P | X | X | X | X | X | X | | | |
| pH changes | - | | | | | 0 | | | | | | P | X |
| Salinity regime changes | 0 | X | X | X | 0 | X | | | | | | | |
| Termal regime changes | 0 | X | X | | | X | X | | X | | | | |
| Sealing | | | X | | | X | | | | | | | |

| | DEN | SWE | GER | LITH | LAT | EST | FIN | | | | RUS | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | GoF | AS | BS | BB | GoF | CL | VL |
| Water transparency changes | | | | P | | | | | | | | | |
| Beach nourishment | | | | X | | | | | | | | | |
| Introd. pollutants (dumping etc) etc.) | | | | | 0 | | | | | | | | |

**Table IIIb. Overview of anthropogenic activities mentioned by the Baltic Sea countries in their MSFD reporting. P= mentioned as high priority, X=mentioned as important but less important than P, or without priority in relation to other activities/pressures, 0= mentioned in order to state that data are lacking/insufficient to make assessments, without statement of importance.**

| | DEN | SWE | GER | LITH | LAT | EST | FIN | | | | RUS | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | GoF | AS | BS | BB | GoF | CL | VL |
| SECTORS | | | | | | | | | | | | | |
| Fishing | P | P | | | | | X | X | X | X | | | |
| Coastal infrastructure | - | X | | | | | X | X | X | X | | P | P |
| Construction | | X | | | | | | | | | | | |
| Off shore wind farms | X | | | | | | | | | X | | | |
| Pipelines | X | | | | | | | | | | | X | |
| Ports | X | | | | | | X | X | X | X | P | P | |
| Cables | X | | | | | | | | | | | | |
| Maritime transport/Shipping | X | | | | | | X | X | X | X | | P | X |
| Extraction | | | | | | | | | | | | | |
| Oil and Gas extraction | X | | | | | | | | | | | P | |
| Sand extraction | X | | | | | | | | | X | P | | |
| Navigational dredging | X | | | | | | X | X | X | X | P | | |
| Deposition of dredged material | | | | | X | | | | | | | | |
| Tourism | - | | | | | | | | | | | | |
| Agriculture | | | | | | | X | X | X | X | | | |
| Wastewater | | | | | | | X | X | X | X | | | |
| Fish-farming | | | | | | | | X | | | | | |

# 6 Experience exchange IEA in the Baltic Sea and the Mediterranean/Adriatic Sea

With a special aim to support experience exchange among regions, the meeting benefited from the additional participation of six experts on integrated ecosystem analyses in the Mediterranean area. The joint meeting is expected to further facilitate integration and extension of core IEA concepts among regions.

Presentations were held by Alessandra Conversi, Alberto Barausse, Fabio Pranovi and Simone Libralato (Annex 2). The presentations gave an overview of main features governing temporal trends in the Mediterranean and the Baltic Sea, main factors affecting management approaches and the potential for performing integrated ecosystem assessments, and an overview of tools and models applied. Similarities and differences in applied approaches among regions were discussed. The conclusions are explained with further detail in Annex 7. The joint workshop is expected to bring forward future research collaborations within the field of integrated ecosystem assessments and also feed into the planned initiation of a working group on Comparative Analyses between European Atlantic and Mediterranean (WGCOMEDA) in 2014.

# 7 Revisions to the work plan and justification

No revisions of the work plan were made (Section 3)

# 8 Next meetings

WGIAB 2014 will meet 10-14 February, 2014.

Preliminary venue: To be decided.

The meeting will be chaired by Lena Bergström, Sweden; Maciej Tomczak, Sweden; and Christian Möllmann, Germany.

# 9 References

Casini, M. et al. 2009. Trophic cascades promote threshold-like shifts in pelagic marine ecosystems. Proc Natl Acad Sci USA 106:197–202.

Casini et al. 2012. Predator transitory spillover induces trophic cascades in ecological sinks. Proceedings of the National Academy of Sciences, 109(21), 8185–8189. doi:10.1073/pnas.1113286109

Diekmann, R., Möllmann, C. (Eds). 2010. Integrated ecosystem assessments of seven Baltic Sea areas. ICES Cooperative Research Report No. 302. 90pp

Diekmann et al. 2012…ITA Methods

Gustafsson, B., Schenk, F., Blenckner, T., Eilola, K., Meier, H. E. M., Müller-Karulis, B., Neumann, T., Ruoho-Airola, T., Savchuk, O. and Zorita, E. 2012. Reconstructing the development of Baltic Sea eutrophication 1850–2006. Ambio, 41, 534-548.

Gårdmark et al. 2011. Depleted marine fish stocks and ecosystem-based management: on the road to recovery we need to be precautionary. ICES Journal of Marine Science, 68, 212-220.

Gårdmark et al. 2013. Biological Ensemble Modelling to evaluate potential futures of living marine resources. Ecological Applications. In press.)Lindegren et al. 2010, Regime shifts, resilience and recovery of a cod stock. Marine Ecology-Progress Series, 402: 239-253.

HELCOM, 2010. Ecosystem Health of the Baltic Sea 2003–2007: HELCOM Initial Holistic Assessment. Balt. Sea Environ. Proc. No. 122.

HELCOM. 2012. Development of a set of core indicators: Interim report of the HELCOM CORESET project. PART A. Description of the selection process. Korpinen, S and Li Zweifeldt (eds). BSEP 129A

HELCOM. 2012. Development of a set of core indicators: Interim report of the HELCOM CORESET project. PART XXX

ICES. 2012a. Report of the ICES/HELCOM Working Group on Integrated Assessments of the Baltic Sea (WGIAB), 26-30 March, Stockholm, Sweden. ICES CM 2012/SSGRSP:02. 182 pp.

ICES 2012b Report of the Workshop on Integrated/Multispecies Advice for Baltic Fisheries (WKMULTBAL), 6–8 March 2012, Charlottenlund, Denmark. ICES CM 2012/ACOM:43. 112 pp.

ICES. 2013. Report of the Working Group on the ICES ACOM/SCICOM Workshop on Ecosystem Overviews (WKECOVER), 7 – 11 January 2013,ICES HQ Copenhagen Denmark

Levin, P.S., Fogarty MJ, Murawski SA, Fluharty D. 2009. Integrated ecosystem assessments: Developing the scientific basis for ecosystem-based management of the ocean. PLoS Biol 7(1): e1000014. doi:10.13s71/journal.pbio.1000014

Lindegren, M., C. Möllmann, A. Nielsen, K. Brander, and B. MacKenzie. 2009. Preventing the collapse of the Baltic cod stock through an ecosystem-based management approach Proceedings of the National Academy of Sciences USA 106:14722-14727.

Lindegren, M., et al. 2012. Nutrient reduction and climate change cause a potential shift from pelagic to benthic pathways in a eutrophic marine ecosystem. Global Change Biology, 18: 3491-3503.

Lindegren et al. 2012, Early detection of ecosystem regime shifts: a multiple method evaluation for management application. PLoS One, 7(7), e38410. doi:10.1371/journal.pone.0038410

Möllmann et al. 2009.Reorganization of a large marine ecosystem due to atmospheric and anthropogenic pressure: a discontinuous regime shift in the Central Baltic Sea. Global Change Biology, 15: 1377-1393.

Möllmann C, Lindegren M, Blenckner T, Bergström L, Casini M, Diekmann R, Flinkman J, Müller-Karulis, B, Neuenfeldt S, Schmidt JO, Tomczak M, Voss R, Gårdmark A. Implementing ecosystem-based fisheries management – from single-species to integrated ecosystem assessment and advice for Baltic Sea fish stocks. Accepted pending revision ICES J Mar Sci

Olsson, J., Bergström, L., Gårdmark, A. (2013) Top-down regulation and climate as drivers for temporal development of as drivers of multi-decadal changes in coastal zoobenthos communities. PLOS ONE

Olsson, J., Bergström, L., Gårdmark, A. (2012) Abiotic drivers of coastal fish community change during four decades in the Baltic Sea. ICES J Mar. Sci. doi:10.1093/icesjms/fss072

Tallis, H., Levin, P. S., Ruckelshaus, M., Lester, S. E., MaLeod, K. L., Fluharty, D. L., and Halpern, B. S. 2010. The many faces of ecosystem-based management: Making the process work today in real places. Marine Policy 34, 340 – 348.

Tomczak, M. T., S. Niiranen, O. Hjerne, and T. Blenckner. 2012. Ecosystem flow dynamics in the Baltic Proper - using a multi-trophic dataset as a basis for foodweb modelling. Ecological Modelling. In press. DOI: 10.1016/j.ecolmodel.2011.12.014

Voss et al. 2011. Temperature change and Baltic sprat: from observations to ecological-economic modelling. ICES Journal of Marine Science, 68: 1244-1256

## Annex 1: List of participants

| Name | Institute and address | E-mail |
|---|---|---|
| Pavel Afanasyev | Department of International cooperation<br>FGUP (VNIRO)<br>Moscow<br>Russia | afanasiev@vniro.ru |
| Lena Bergström | Swedish Univeristy of Agricultural Sciences<br>Department of Aquatic Resources<br>Skolgatan 6<br>SE-742 42 Öregrund<br>Sweden | lena.bergstrom@slu.se |
| Alberto Barausse | University of Padova<br>Environmental Systems Analysis Lab (LASA)<br>Department of Industrial Engineering<br>Via Marzolo 9<br>35131 Padova<br>Italy | alberto.barausse@unipd.it |
| Alessandra Conversi | (Marie Curie Experienced Fellow) Sir Alister Hardy Foundation for Ocean Science, Citadel Hill, The Hoe, Plymouth PL1 2PB, UK<br>(Senior Researcher), CNR-ISMAR, Forte S. Teresa, Loc. Pozzuolo, 19032 Lerici (SP), Italy | a.conversi@ismar.cnr.it |
| Anna Gårdmark | Swedish Univeristy of Agricultural Sciences<br>Department of Aquatic Resources<br>Skolgatan 6<br>SE-742 42 Öregrund<br>Sweden | anna.gardmark@slu.se |
| Outi Heikinheimo | Finnish Game and Fisheries Research Institute<br>POBox 2, Viikinkaari 4<br>FI-00791 Helsinki<br>Finland | outi.heikinheimo@rktl.fi |
| Ute Jacob | University of Hamburg<br>Institute of Hydrobiology and Fishery Science<br>Grosse Elbstrasse 133<br>D-22767 Hamburg<br>Germany | ute.jacob@uni-hamburg.de |
| Muriel- Marie Kroll | University of Hamburg<br>Institute of Hydrobiology and Fishery Science<br>Grosse Elbstrasse 133<br>D-22767 Hamburg<br>Germany | muriel.kroll@uni-hamburg.de |

| | | |
|---|---|---|
| Simone Libralato | OGS (Istituto Nazionale di Oceanografia e di Geofisica Sperimentale)<br>Borgo Grotta Gigante 42/C - 34010 - Sgonico ( TS )<br>Italy | slibralato@inogs.it |
| Carlotta Mazzoldi | University of Padova<br>Department of Biology<br>Via U. Bassi 58/B<br>35131 Padova<br>Italy | carlotta.mazzoldi@unipd.it |
| Bärbel Müller-Karulis | Bärbel Müller-Karulis<br>Baltic Sea Centre<br>Stockholm University<br>SE-106 91 Stockholm<br>Sweden | barbel.muller.karulis@su.se |
| Jens Olsson | Swedish Univeristy of Agricultural Sciences<br>Department of Aquatic Resources<br>Skolgatan 6<br>SE-742 42 Öregrund<br>Sweden | jens.olsson@slu.se |
| Saskia Otto | University of Hamburg<br>Institute of Hydrobiology and Fishery Science<br>Grosse Elbstrasse 133<br>D-22767 Hamburg<br>Germany | saskia.otto@uni-hamburg.de |
| Heikki Peltonen | Finnish Environment Institute<br>Marine Research Centre<br>POBox 140, FI-00251, Helsinki<br>Finland | heikki.peltonen@ymparisto.fi |
| Ivars Putnis | Institute of Food Safety, Animal Health and Environment,BIOR<br>Fish Resources Research Department<br>Daugavgrivas 8<br>LV-1048 Riga<br>Latvia | Ivars.putnis@bior.gov.lv |
| Giovanni Galli | OGS (Istituto Nazionale di Oceanografia e di Geofisica Sperimentale)<br>Borgo Grotta Gigante 42/C - 34010 - Sgonico ( TS )<br>Italy | ggalli@inogs.it |
| Andrea Rau | Thuenen-Institute of Baltic Sea Fisheries<br>Alter Hafen Süd 2<br>D – 18069 Rostock<br>Germany | andrea.rau@ti.bund.de |

| | | |
|---|---|---|
| Cosimo Solidoro | OGS (Istituto Nazionale di Oceanografia e di Geofisica Sperimentale)<br>Borgo Grotta Gigante 42/C - 34010 - Sgonico ( TS )<br>Italy | csolidoro@inogs.it |
| Fabio Pranovi | Centre for Estuarine and Marine Studies,<br>Ca' Foscari University, Venice.<br>Italy | fpranovi@unive.it |
| Maciej T. Tomczak | Baltic Nest InstituteStockholm University<br>SE-106 91 Stockholm<br>Sweden | maciej.tomczak@su.se |
| Laura Uusitalo | Finnish Environment Institute<br>Marine Research Centre<br>PO Box 140<br>00251 Helsinki<br>Finland | laura.uusitalo@ymparisto.fi<br>(laura.uusitalo@iki.fi) |

## Annex 2: Agenda of WGIAB 2013

FINAL AGENDA for WGIAB 2013

*The meeting will be held April 8-12, 2013 at Palazzo Grassi, Chioggia, Italy*

| | |
|---|---|
| **Monday 8th April** | |
| 12.30 | *Arrival of participants* |
| 13:00 | **Welcoming session**<br>Words of welcome by chairs and host, presentation of participants<br>Presentation of the Hydrobiological Station in Chioggia (Carlotta Mazzoldi)<br>Presentation of LASA (Alberto Barausse)<br>Introduction to WGIAB (Lena Bergström) |
| 14:30 | *Coffe & Tea* |
| 15:00 | **WGIAB Introductory session**<br><br>Update on integrated ecosystem assessments within ICES (Lena Bergström)<br>Introduction to the ToRs and aims of WGIAB<br>- Planning of work and activities of the week<br>- Revision (if needed) of the agenda<br>Group working |
| 18:00 | End of day |
| **Tuesday 9th April** | |
| 9:00 | Arrival and introduction to the day<br>-Adoption of final Agenda |
| 9:15 | ***Baltic Sea ecosystem structure and functioning (ToR a, mainly)***<br><br>Historical regime shifts in the Baltic Sea (Bärbel Muller-Karulis)<br>Integrated trend analyses in coastal areas (Jens Olsson)<br>The ICES Ecosystem Overview process (Lena Bergström)<br><br>Common discussion:<br>Short term and long term aims of the group in relation to ToR a and ToR b<br>Methodological developments in integrated assessment (ToR c; Saskia Otto)<br>Include spatial processes in our current methods, eg basin specific EWE foodweb-models (Saskia) |
| 13:00 | *Lunch* |
| 14:00 | Adriatic biodiversity (Carlotta Mazzoldi) |
| 15:00 | ***Anthropogenic pressures (****ToR e*)<br><br>Comparison of MSFD and BSAP objectives (Jens Olsson)<br>Specific group working in relation to ToR e: Reporting from different countries; Evaluation of contributions from different countries; Methods for monitoring, assessment and management of pressures |
| 17:00 | **Talks**<br>Environmental dependent recruitment indicators (Muriel Kroll)<br>Integrated trend analyses of the Western Baltic (Andrea Rau) |
| 18:00 | Round-up of progress and end of day |
| | *Workshop dinner* |

| | |
|---|---|
| **Wednesday 10st April** | |
| 9:00 | Arrival and introduction to the day |
| 9:15 | ***Integrated ecosystem assessments in the Mediterranean (ToR c)***<br>The Mediterranean, its dynamics and biology (Alessandra Conversi)<br>Regime shifts in the Adriatic (Alberto Barausse and Alessandra Conversi)<br>Ecosystem indicators, the CumB *vs* TL indicator (Fabio Pranovi)<br>IEA approaches – examples from the Venice Lagoon (Simone Libralato & Cosimo Solidoro) |
| 13:00 | *Lunch* |
| 14:00 | ***Fish market :*** Guided tour (Carlotta Mazzoldi ) |
| 15:30 | ***Developing the integrated ecosystem assessment cycle (ToR c)***<br>Potential use of Bayesian Networks in the Baltic Sea IEA framework (Laura Uusitalo)<br>Implementing ecosystem-based fisheries management – from single-species to integrated ecosystem assessment and advice for Baltic Sea fish stocks (Anna Gårdmark)<br>Common discussion:<br>How can we develop the Baltic Sea IEA framework (Learning from the Mediterranean; Short term and long term aims of the group in relation to ToR c) |
| 18:00 | Round-up of progress and end of day |
| **Thursday 11th April** | |
| 9:00 | Arrival and introduction to the day |
| 9:15 | **Preliminary results of the workshop**<br>Continued group working |
| 13:00 | *Lunch* |
| 14:00 | ***Data gaps and data needs (ToR d)***<br>Common discussion: Reporting of Tor d<br>Continued group working |
| 18:00 | Round-up of progress and end of day |
| **Friday 12th April** | |
| 9:00 | Arrival and introduction to the day |
| 9:15 | **Future plans and activities of WGIAB**<br>Intersessional activities, appointment of lead and time schedule<br>Plans for the next workshop; suggested activities:<br>Propose date and venue for next workshop |
| 10:30 | *Break* |
| 11:00 | **Final conclusions of the workshop**<br>Results of the week<br>Round up, and agree plans for completion of WGIAB 2013 report |
| 13:00 | Meeting close |

# Annex 3: Input to Baltic Sea Ecosystem Overview subsection 2

## Subsection 2: Key Signals

## Physical and chemical oceanography

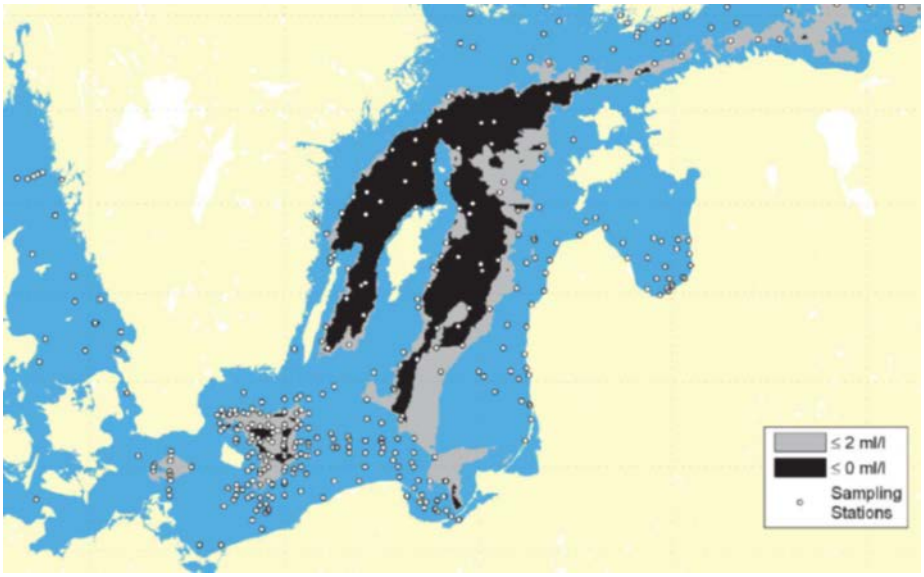


**Fig A3.1. Areal extent of hypoxia (grey), anoxia (black) and sampling stations (dots) in the Baltic Sea during autumn 2010; data from Swedish Meteorological and Hydrological Institute 2012; www.smhi.se)**

### Indicators of the recruitment environment for Eastern Baltic cod

Environmental conditions for Eastern Baltic cod recruitment of year classes 2010-2011 were assessed by the ICES/HELCOM Working Group on Integrated Assessments of the Baltic Sea (WGIAB; ICES 2013). This assessment was made based on an indicator of the limiting abiotic conditions for cod egg survival, the reproductive volume, found to be the most encompassing indicator of the significant indicators of environmental conditions of cod recruitment (as assessed by models on SSB-recruitment residuals; ICES 2013, Kroll *et al*. in prep.). The reference value of reproductive volume distinguishing positive from negative environmental influence on cod recruitment (Figure A3.2) was derived using the quantitative relationship between recruitment residuals and reproductive volume (ICES 2013).

**The reproductive volume integrated across all three basins (Bornholm, Gdańsk and Gotland) indicates poor abiotic conditions for cod recruitment of year classes 2010-2011, in terms availability of oxygenated saline water allowing for cod egg survival. This suggest that the abundance of 2-year olds recruiting to the fishable stock in 2012 and 2013 will be less than expected from SSB alone.**

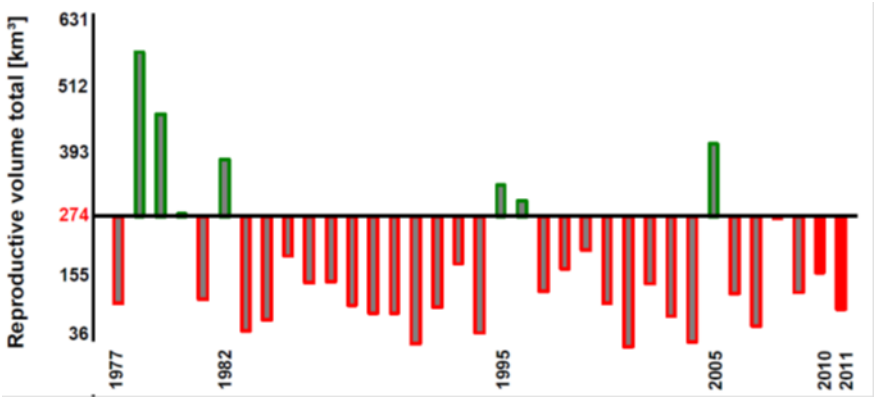


**Figure A3.2. Time-series of the key indicator of the abiotic environment for recruitment of Eastern Baltic cod, reproductive volume (RV; summed across the three deep basins in the Baltic Sea), assembled by WGIAB 2013 (ICES 2013). Relationships between RV and residuals from cod recruitment *vs.* cod SSB were derived (ICES 2013, Kroll *et al* in prep.) for year classes 1977-2009. Bars indicate the values relative to the threshold RV value (corresponding to the RV where there is no environmental effect on recruitment); green bars indicate beneficial environmental conditions and red bars poor conditions for cod egg survival. This shows the poor conditions for cod recruitment for the year classes 2010-2011 (corresponding to recruitment of age 2 in 2012-2013).**

**References:**

ICES. 2013. Report of the ICES/HELCOM Working Group on Integrated Assessments of the Baltic Sea (WGIAB), 8-12 April 2013, Chioggia, Italy. ICES CM 2013/ SSGRSP:xx; in preparation.

## Biotic processes

*This subsection should identify 1) biodiversity aspects below target, to be lifted up from section 4 as information develops, and 2) main biotic components potentially influencing fisheries management advice*

Example of information to include

- Temporal development of grey seal, to be considered in fisheries assessment and ecological status assessment.
- Temporal development of the copepods, indicating the recruitment environment of 1) Eastern Baltic cod (*Pseudocalanus biomass*), 2) Gulf of Riga herring stocks (*Eurytemora affinis*), and 3) and Bothnian Sea herring stock (*Eurytemora, Bosmina*).

## Human impacts

*This subsection should identify 1) pressures and activities below target, to be lifted up from section 3 as information develops, and 2) main activities and pressures potentially influencing fisheries management advice*

Example of information to include

- Temporal development of variables indicating eutrophication.
- Temporal and spatial development of variables indicating fishing activities in relation to different gear types.

**Potential references:**

EERO, M., MACKENZIE, B. R., KÖSTER, F. W. and GISLASON, H. 2010. Multi-decadal responses of a cod (*Gadus morhua)* population to human-induced trophic changes, fishing, and climate. Ecological Applications, 21, 214-226.

EERO, M., VINTHER, M., HASLOB, H., HUWER, B., CASINI, M., STORR-PAULSEN, M. and KÖSTER, F. W. 2012. Spatial management of marine resources can enhance the recovery of predators and avoid local depletion of forage fish. Conservation Letters, 5, 486-492

HELCOM 2010. Ecosystem Health of the Baltic Sea. HELCOM Initial Holistic Assessment. Baltic Sea Environment Proceedings No. 122

OJAVEER, H. and EERO, M. 2011. Methodological Challenges in Assessing the Environmental Status of a Marine Ecosystem: Case Study of the Baltic Sea. PLoS ONE, 6, e19231.

WGSPATIAL 2012 Report

## Annex 4: The WGIAB datasets

### Integrated trend analysis for the Western Baltic Sea

In recent years WGIAB performed several integrated trend analyses for most of the subsystems within the Baltic Sea; this will now be extended to the Western Baltic Sea (WBS), encompassing ICES subdivisions 22 and 24. The area in itself is very heterogeneous due to highly variable topography; generally it is relatively shallow with the deepest areas in the Arkona basin reaching up to 65m depth. Furthermore the WBS is characterized by comparatively high salinity conditions due to close spatial connection to the North Sea and resulting inflow events.

Since the recent WGIAB ITA outcomes detected contemporaneous regime shifts within the whole Baltic Sea by the end of the 1980s / beginning of the 1990s, it may be suggested that also the WBS area could have been influenced by simultaneous ecosystem changes. This theory will be tested by an integrated analysis of trends in the main WBS basins. The first step, performing an inventory of available time-series, is in progress, aiming for data of several parameters such as hydrographic, climatic and nutrient conditions as well as of biological components such as phytoplankton, zooplankton and fish community and of direct anthropogenic influences like fishing pressure. Further progress in the WBS ITA is intended to be available for the next 2014 WGIAB meeting.

### Description of the update of the progress for ITA for the Gulf of Finland (Heikki Peltonen)

The integrated trend analyses for the Gulf of Finland ecosystem were discussed and agreed on. Recently, it has become apparent that there are needs for updating the trend analyses for the Gulf of Finland which were conducted in 2009. For example, the intensive exploitation of this basin on one hand and the recent extensive reductions in the anthropogenic nutrient load, as well as information from some recent monitoring suggest that rapid changes in the state of the Gulf of Finland ecosystem are likely and are indeed taking place. An additional motivation for updating the Gulf of Finland assessment is the Gulf of Finland year 2014, which will include several scientific, management-related and public relations activities which would benefit from having access to the integrated trend analysis. To support the update of the trend analysis for the Gulf of Finland several data sources to be incorporated were identified. The data will be updated, completed and partly replaced based on recent research efforts to include hydrography, water quality, and several trophic levels of biota. The working group has an aim to conduct the integrated trend analyses associated with the year 2014 WGIAB meeting.Gulf of Finland (metadata from Laura - ask Laura)

## Annex 5: Integrated trend analyses in coastal areas

During 2011 and 2012, the first integrated trend analyses of coastal areas in the Baltic Sea within WGIAB have been undertaken (ICES 2011; 2012). Currently, data from 13 different areas has been collated, including both biotic response variables and abiotic pressure variables. The spatial coverage is rather extensive, from the Limfjord in the western parts of Denmark to Holmön in the northern parts of the Bothnian Sea. The data does to some extent differ across areas with respect to temporal coverage and number of trophic levels included. The majority of the time-series (seven out of 13) starts in the early 1990s, but in few areas the data dates back to the 1980s. Between two and five trophic levels are included in the different areas including phytoplankton, zooplankton, macro zoobenthos, fish and seals. With the exception of one area (Narva Bay, Gulf of Finland) all datasets included variables related to fish stocks or communities.

Preliminary results show that the assessed coastal systems have undergone structural changes in all but one area (Kvädöfjärden). There are, however, differences across areas if and when significant changes in the structure of the assessed ecosystem components have occurred. Overall, changes mainly occurred in the mid-late 1990s and mid 2000s, but no obvious pattern across systems in when changes have occurred is discernible with regards to geographic location or number of trophic levels assessed. In the current analyses, the temporal development of the assessed systems and their relation to abiotic variables does not show any coherent pattern, suggesting to some extent unique development trajectories across areas.

In all, these preliminary results suggest that coastal ecosystem in the Baltic Sea have undergone structural changes since the early 1990s, but that development trajectories and association to abiotic variables are unique across system. These findings do to some extent support that coastal ecosystems are rather local in their appearance and response to environmental change, and as such that some of the ecosystem components assessed could serve as good indictors of the state of the area assessed. Given that there are differences across areas in the temporal coverage and numbers of trophic levels assessed, we can, however, at the moment not estimate the influence of this on the overall results.

The next step in this exercise will be to make the datasets more comparable by e.g. balancing the number of variables assessed across systems and to assess similar periods (i.e. from early 1990s and onward) across areas. Following this, analyses of common development patterns across datasets and association between biotic variables and manageable and non-manageable abiotic variables will be assessed.

## Annex 6. Currently applied indicators of environmental status within the Baltic Sea region

Currently, several international political directives concerning the state of the environment in the Baltic Sea are under implementation. Two of these are the Baltic Sea Action Plan (BSAP) and Marine Strategy Framework Strategy (MSFD). Below, some general aspects mainly concerning the similarity and differences of these two directives are presented.

The BSAP vision is "*A healthy Baltic Sea environment, with diverse ecological components functioning in balance, resulting in a good ecological status and supporting a wide range of sustainable human economic and social activities*" (HELCOM 2007). This vision should be met by three goals on *Eutrophication, Hazardous substances* and *Biodiversity* (Figure A5). For each of these goals there are several *Ecological objectives* that should be used to assess if these goals are reached. The lowest level in this hierarchy is the metrics to serve the follow up *Ecological objectives*, by HELCOM defined as HELCOM CORE indicators (HELCOM 2012).

In all, there are no critical differences between the two directives since they are both covering the same aspects of the marine environment and should be assessed using indicators (Figure A3). Generally, however, the GES descriptors cover a wider definition of good environmental status than the BSAP goals and ecological objectives. The BSAP has been acknowledged as a pilot project for the implementation of the MSFD, and the Baltic Sea as a pilot area for the MSFD. In the Baltic, HELCOM are developing Baltic-wide indicators for the two directives within the HELCOM CORESET - (descriptor 1, 2, 4, 6, 8 and 9) and TARGREV - (descriptor 5) projects. ICES are developing indicators for descriptor 3 (WKMSFD), and descriptors 7, 10 and 11 are considered by technical subgroups within WG GES at the EU commission.

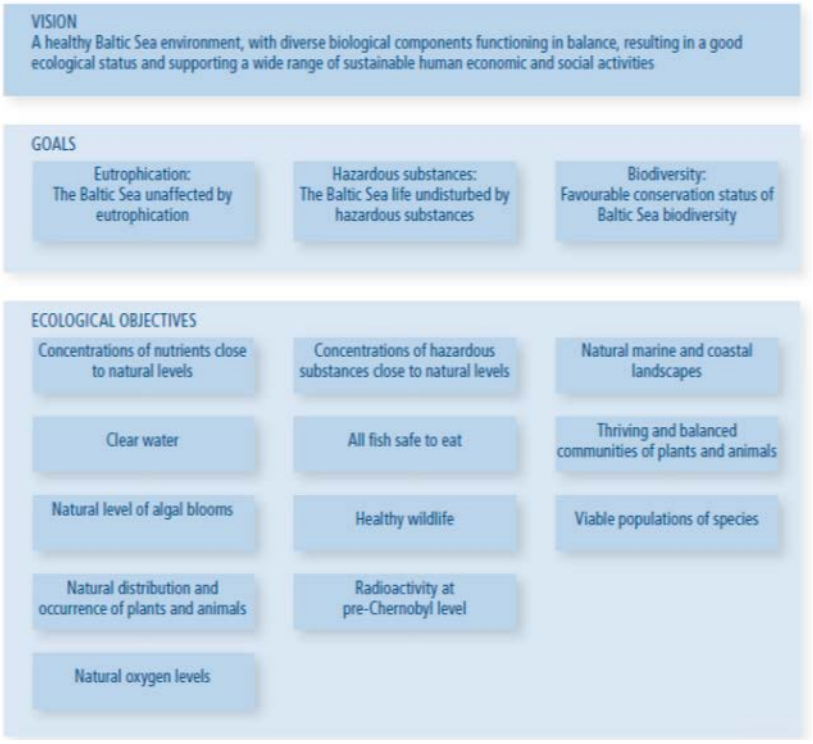


**Figure A 1. Outline of the BSAP (From HELCOM 2012).**

| Qualitative descriptors for determining good environmental status |
|---|
| 1) Biological diversity is maintained. The quality and occurrence of habitats and the distribution and abundance of species are in line with prevailing physiographic, geographic and climatic conditions. |
| 2) Non-indigenous species introduced by human activities are at levels that do not adversely alter the ecosystems. |
| 3) Populations of all commercially exploited fish and shellfish are within safe biological limits, exhibiting a population age and size distribution that is indicative of a healthy stock. |
| 4) All elements of the marine food webs, to the extent that they are known, occur at normal abundance and diversity and levels capable of ensuring the long-term abundance of the species and the retention of their full reproductive capacity. |
| 5) Human-induced eutrophication is minimised, especially adverse effects thereof, such as losses in biodiversity, ecosystem degradation, harmful algae blooms and oxygen deficiency in bottom waters. |
| 6) Sea-floor integrity is at a level that ensures that the structure and functions of the ecosystems are safeguarded and benthic ecosystems, in particular, are not adversely affected. |
| 7) Permanent alteration of hydrographical conditions does not adversely affect marine ecosystems. |
| 8) Concentrations of contaminants are at levels not giving rise to pollution effects. |
| 9) Contaminants in fish and other seafood for human consumption do not exceed levels established by Community legislation or other relevant standards. |
| 10) Properties and quantities of marine litter do not cause harm to the coastal and marine environment. |
| 11) Introduction of energy, including underwater noise, is at levels that do not adversely affect the marine environment. |

**Figure A2. The 11 MSFD descriptors according to Anon. (2008)**


**Figure A3. Schematic comparison between BSAP and MSFD (from HELCOM 2012).**

## References

Anon. 2008. Directive 2008/56/ec of the European Parliament and of the Council of 17 June 2008 establishing a framework for community action in the field of marine environmental policy (Marine Strategy Framework Directive).

HELCOM. 2007. HELCOM Baltic Sea Action Plan.

HELCOM. 2012. Development of a set of core indicators: Interim report of the HELCOM CORESET project. PART A. Description of the selection process. Korpinen, S and Li Zweifeldt (eds). BSEP 129A

**Table A7. Evaluation of HELCOM core indicators (HELCOM in prep.) in relation to models used within WGIAB. X = included in model, pot. = can potentially be included. EwE = Ecopath with Ecosim model of the Central Baltic Sea (Tomczak, *et al.* 2012), SMS = Stochastic multi-species model of cod-sprat-herring in the Central Baltic Sea (ICES 2012d), and BALMAR (Lindegren et al. 2009).**

| HELCOM Number | HELCOM PROPOSED CORE INDICATOR | EwE | SMS | BALMAR |
|---|---|---|---|---|
| | Populations (D1.2) | | | |
| 2 | Pregnancy rates of marine mammals | | | |
| 6 | Abundance of waterbirds in the breeding season | | | |
| 9 | Abundance of key species of coastal fish | pot. | | |
| 4 | Drowned marine mammals and waterbirds in fishing gears | pot. | | |
| 7 | Proportion of oiled waterbirds in the Baltic Sea | | | |
| 13 | Abundance of salmon populations | | | |
| 12 | Abundance of sea trout in the Baltic Sea | | | |
| | Communities and habitats (D1.4) | | | |
| 19 | Extent, distribution and condition of benthic biotopes | | | |
| 15 | State of soft-bottom macrozoobenthic communities | | | |
| 16 | Size frequency distribution of bivalves in the benthic community | | | |
| 17 | Lower depth distribution limit of macrophyte species | | | |
| 18 | Cumulative impact on benthic habitats | | | |
| 11 | Proportion of large fish in the fish community | X | X | X |
| | Foodwebs (D4) | | | |
| 14 | Mean size and abundance of zooplankton | | | |
| 8 | Productivity of White-tailed eagle | | | |
| 10 | Abundance of key functional groups of coastal fish | | | |
| 5 | Abundance of waterbirds in the wintering season | | | |
| 1 | Population growth rate, abundance and distribution of marine mammals | pot | | |
| 3 | Nutritional status of marine mammals | | | |
| | D3 COMMERCIAL FISH AND SHELLFISH | | | |
| | Level of pressure of the fishing activity (D3.1) | | | |
| | Primary indicator: Fishing mortality (F) | X | X | X |
| | Secondary indicator: Ratio between catch and biomass index | X | X | X |
| | Reproductive capacity of the stock (D3.2) | | | |
| | Primary indicator: Spawning-stock biomass (SSB) | X | X | X |
| | Secondary indicator: Biomass indices | X | X | X |
| | Population age and size distribution (D3.3) | | | |
| | Proportion of fish larger than the mean size of first sexual maturation | | | |
| | Mean maximum length across all species found in research vessel surveys | | | |
| | 95% percentile of the fish length distribution observed in research vessel surveys | | | |
| | Size at first sexual maturation (secondary indicator) | | | |

## Annex 7: Baltic Sea and Mediterranean/Adriatic IEA - Exchange of ideas

This section represents a summary of the exchange of ideas which took place between the participants to the WGIAB meeting in Chioggia from Baltic countries, and those participants from Italy carrying out research on the Mediterranean ecosystems.

The ecosystem assessment loop, as it is being applied in the Baltic Sea, has only partially been applied in the Mediterranean Sea. The IEA framework appears an interesting and advanced framework to the Mediterranean participants. However, several potential problems concerning the application of it to the Mediterranean may be identified, among them data availability and access. The Mediterranean Sea is not as data-rich as the Baltic Sea, especially as far as higher trophic level organisms are concerned, and data gaps exist in several Mediterranean sub-basins. Yet, some of the sub-basins (e.g. Adriatic Sea, Catalan Sea, Aegean Sea), or coastal sites (e.g. the lagoon of Venice, the lagoon of Thau) appear sufficiently data-rich that it seems feasible to start such kind of analyses there. Much less information is available for the southern Mediterranean Sea areas as compared to northern Mediterranean areas. Also, in the Mediterranean, knowledge of key ecological processes at the sub-basin scale as well as environmental monitoring data are not always easy to access, for example because these information are sometimes published in the grey literature. A second weakness to apply the ecosystem-based management cycle to the Mediterranean relies on the typically less advanced stage of collaborations occurring among Mediterranean research institutions with respect to the Baltic, particularly the difficulty to maintain continuative collaborations. The establishment of scientific collaborations and networks, such as the ICES regional IEA working groups, and their integration with important existing scientific efforts and networks (e g CIESM, GFCM etc), is regarded as crucial to solve this issue and to foster the application of ecosystem based management.

Several of the tools used by WGIAB appear to be fit for application to Mediterranean sub-basins, and some are indeed applied, e g statistical time-series analysis. Research in the Mediterranean Sea could also be a source of inspiration to the WGIAB group for their work in the Baltic Sea. In particular, some tools applied in the Northern Adriatic/Venice lagoon areas, where the workshop was held, have been discussed during the workshop. Indeed, the Northern Adriatic Sea appears to share some similarities with the Baltic Sea, for example high exploitation, importance of pelagic foodwebs, key influence of nutrients on ecosystem productivity and dynamics, tight coupling between watershed processes (nutrient generation) and the marine ecosystem, although the systems are overall quite different. Some examples of such possible source of inspiration from the Northern Adriatic area to WGIAB include the work on regime shifts in marine ecosystems by Conversi et al. (2010), the statistical analyses on long-term community changes in the Northern Adriatic Sea and their relationship with nutrient inputs to the system, climate and fishing shown by Barausse et al. (2011), the coupling of foodweb models such as Ecopath with Ecosim and biogeochemical models (Libralato and Solidoro, 2009), the integration of physiological experiments on marine fauna with time-series analysis to provide process-based predictions on the effect of climate change on marine ecosystems (Bartolini et al., 2013), the new indicators useful to analyse time-series of biological data, also applied at the scale of the Mediterrranean sea (Pranovi et al.,2012; Pranovi et al in prep), genetic algorithm, self organizing maps and fuzzy logic methods to analyse large datasets (Bandelj et al; Solidoro et al). The list is, however, focused on the Adriatic Sea, where the workshop was hosted, and reflects the expertise and research activities of

local Mediterranean participants, without covering the whole, large body of relevant marine research going on in the Mediterranean.

#### References

Barausse A., A. Michieli, E. Riginella, L. Palmeri, C. Mazzoldi. 2011. Long-term changes in community composition and life-history traits in a highly exploited basin (northern Adriatic Sea): the role of environment and anthropogenic pressures. Journal of Fish Biology 79: 1453-1486. doi:10.1111/j.1095-8649.2011.03139.x

Bartolini F., A. Barausse, H-O. Pörtner, F. Giomi. 2013. Climate change reduces offspring fitness in littoral spawners: a study integrating organismic response and long-term time-series. Global Change Biology 19: 373-386. doi: 10.1111/gcb.12050

Conversi A., S. Fonda Umani, T. Peluso, J.C. Molinero, A. Santojanni, M. Edwards. 2010. The Mediterranean sea regime shift at the end of the 1980s, and intriguing parallelisms with other European basins. PloS ONE 5, e10633. doi: 10.1371/journal. pone.0010633

Libralato S., C. Solidoro. 2009. Bridging biogeochemical and foodweb models for an End-to-End representation of marine ecosystem dynamics: The Venice lagoon case study. Ecological Modelling 220: 2960-2971. doi: 10.1016/j.ecolmodel.2009.08.017

Pranovi F., Link J., Fu C., Cook A., Hui Liu H., Gaichas S., Friedland K., Utne K.R., Benoit H., 2012. Trophic level determinants of biomass accumulation in marine ecosystems. Marine Ecology Progress Series, 459: 185-201.

## Annex 8. Details of plans forward in relation to ToRs a-c and the Baltic Sea IEA framework