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Executive summary

The third and final study group meeting of SGBEM took place from 24 to 26 April 2006 in Helsinki. Due to incomplete attendance of members of the SG and the attendance of only one member of other SG's of the BSRP, a part of the tasks formulated in the Terms of Reference could not be fulfilled.

The SG discussed several developments regarding modelling of the Baltic Sea system and highlighted the need for a new generation of models. In particular the issue of ecosystem-based research and advice the linkage of biogeochemical and fish production model is an important issue. A substantial part of the meeting was devoted to the presentation and discussion of future model approaches which encompass a substantial part of the marine food web and allow quantification of bottom up and top down the propagation of signal through the foodweb.

The discussion of the critical review of the SGBEM Report 2005 led to some critical analysis of the conduction of the BSRP. The aims of the SG can only be reached if motivated people attend the meetings. But western experts had to come with their own funding while the attendance from the recipient countries was only marginal. There were doubts as to whether the mechanism of ICES Study Groups (one meeting a year, and a short presentation in the Baltic Committee) represents the best practice to conduct programs like the BSRP.

1 Opening of the meeting

The Chair, Wolfgang Fennel, welcomed the participants. A total number of nine scientists attended the meeting, but two of them only part of the time. Among the participants were only three nominated members. Again some of the terms of reference could not be dealt with since the responsible members did not attend. Fortunately, the Chair of the Study Group on Baltic Sea Productivity Issues (SGPROD) and the Chair of the Study Group of Multispecies Assessment in the Baltic (SGMAB) were actively participating.

SGBEM Terms of Reference:

a) Review new developments in Baltic ecosystems modelling. Identify models to support the other SG's of the BSRP;

b) Identify data sets of high priority for modelling issues and ensure a bi-directional exchange of information with the other SG's of the BSRP;

c) Review the knowledge of the effects of fish acting down the foodweb to nutrients, and to which extend variations in nutrients may act up the foodweb to fish;

d) Establish methods to bridge the gap between fish stock models and ecosystem models for the Baltic (prepared intersessionally);

e) Report on spatial distribution of fish (prepared intersessionally);

f) Provide input and specific contributions to the 2006 ASC Theme Session on "Integrated assessments in support of regional seas ecosystem advice - beyond quality status reporting";

g) evaluate and comment on the external review on the 2005 SGBEM report in general and with regard to the objectives of the SG;

h) take into account the recommendations of the Workshop on Developing a Framework for Integrated Assessment for the Baltic Sea [WKIAB].

2 Adoption of the agenda

The meeting was structured in presentations of modellers dealing with different parts of the marine foodweb, reports related to one of the BSRP SG's and to SGMAB. Moreover, issues of the review of the report at the meeting in 2005 and general aspects of the management of the BSRP in terms of study groups were discussed. Some time was set aside for drafting parts of the report.

3 Aspects of the modelling of the Baltic Sea

3.1 Biochemical modelling and population models

Thomas Neumann gave a short presentation on eutropication models and modelling activities within the German GLOBEC project. As part of the German IKZM-Oder project a hindcast study fort he last 40 years of the Baltic Sea with the aid of a 3D biogeochemical model will be done. The project itself aims on the complex interaction between Oder catchment, estuary and coastal zone. Environmental as well as social sciences are included.

In the first part of the project forcing data were collected and compiled. The data set from ERA40 project seems to be a good choice for the atmospheric forcing. It covers the period from 1960 until 2002 and is based at a consistent re-analysis.

For nutrient loads from atmosphere, rivers, point and diffusive sources the situation is much worse. No consistent data sets are available. We compiled data sets with data from different

sources, different spatial and temporal resolution. For some river loads we also considered simulated data from catchment models.

A first model run has been performed and the physical part shows promising results. Also the main features of the oxygen dynamics are represented well. Nevertheless, nutrient dynamics need some calibration. Especially during the high loading in the 80ies the increase in open sea nitrogen concentrations is to strong.

In the German GLOBEC project a model system for the simulation of copepods life stages has been developed, (Fennel 2001, Neumann and Kremp 2005). It includes a 3D GCM, a biogeochemical model and a stage resolving copepods model. The copepods model describes development, behaviour and aspects of the lifecycle of the three dominate copepods species in the Baltic Sea, *pseudocalanus spp., acartia spp. and temora spp.* The model development is now in the phase of model calibration. Basics of the copepods model are published in:

Fennel, W. 2001. Modeling of copepods with links to circulation models. Journal of Plankton Research, 23: 1217–1232.

Neumann, T., and Kremp, C. 2005. A Model Study with Light-Dependent Mortality Rates of Copepod Stages. Journal of Marine Systems, 56/3-4: 416-434.

3.2 Biochemical modelling

Oleg Savchuk (St. Petersburg State University) has presented new developments in three biogeochemical models. Dependent on objectives, the models have different resolution in the space-time-variables domain.

1) The 3D coupled physical-biogeochemical model **SPBEM** (**S**t. **P**eters**B**urg' **E**utrophication **M**odel) has been implemented to study the effects of nutrient reductions in the eastern Gulf of Finland, the area of steep horizontal environmental gradients due to large freshwater and nutrients input from the River Neva and St. Petersburg. In all the numerical experiments, including the "standard run", the model has been run with the recurrent boundary conditions to get quasi steady state seasonal dynamics, achieved in 3 years. The experiments have shown that the large N and P reductions would be compensated by increased nutrient import from the open Gulf of Finland and result in insignificant changes of eutrophication.

2) The horizontally integrated but finely vertically resolved **BALTSEM** (**B**altic **L**ong-**T**erm large-**S**cale **E**utrophication **M**odel) model, developed at the Stockholm and Gothenburg universities, simulates realistic dynamics of hydrographic, nutrient, and planktonic variables during 1970-2003 with daily resolution for six interconnected basins: the Bornholm basin, the rest of Baltic Proper, the Bothnian Sea, the Bothnian Bay, the Gulf of Finland, and the Gulf of Riga. The model will be used to study the scenarios of nutrient reductions and climatic variations on the basin-wide scales.

3) The box SANBaLTS (**S**imple **A**s **N**ecessary **BA**ltic **L**ong-**T**erm large-**S**cale) model as a part of the DSS MARE's NEST developed at the Stockholm University simulates the highly aggregated, basin-wide and annually averaged fluxes and variables of nitrogen, phosphorus, and silica in interconnected major basins of the Baltic Sea. As demonstrated by a hindcast for 1970–2003, SANBaLTS is both fast and plausible. By its temporal and spatial scales the SANBaLTS is rather suitable for a direct linkage to similarly resolved fish models as a source of fish food and a tool to study consequences of eutrophication and climatic scenarios.

3.3 A Cyanobacteria life cycle model

Inga Hense reported on a work, which was done together with Aike Beckmann, on a new approach to model cyanobacterial life cycles. Cyanobacteria blooms are a common phenomenon in aquatic environments but although considerable effort has been devoted to

study various aspects of bloom formation, the processes involved are still not fully understood. Most of the factors that have been investigated can be categorised as external (e.g., N/P-ratio, temperature), whereas internal factors on the generation of cyanobacteria blooms through their distinctive life cycle have not yet been sufficiently considered. To fill this gap and to investigate the dynamics of cyanobacteria life cycles, a numerical model has been developed. The model assumes that the life cycle is governed by the internal energy and nitrogen quotas of the cells, and discriminates four different stages: vegetative cells, vegetative cells with heterocysts, akinetes and recruiting cells (including germinates). The seasonal succession of life stages is simulated in a one-dimensional framework, and a typical bloom is successfully simulated with a set of plausible parameters.

Observed interannual variations in the relative proportions of different life cycle stages can be explained as the direct result of life cycle dynamics. The results show that life cycle simulations are feasible and can be used to test hypotheses and to determine sensitivities and uncertainties of the role of cyanobacteria life cycles in marine and limnic environments. Our study also indicates that prediction of cyanobacteria blooms has to be based on a detailed knowledge of all stages of the life cycle.

3.4 Biochemical and fish-stock models

Some discussed aspects to the linkage of biogeochemical modelling to fish-stock models were provided by Ken Anderson and Markus Schwartau.

3.4.1 State of the art

The current state of the art in modelling fish are physiologically based models, where either the cohorts or the whole size spectrum of each species are explicitly resolved. These are used as basis for statistical modelling (MSVPA) and for simulating the development in the ecosystem (MSFOR, Horbowy, 1989). In principle the modelled species depend on the lower trophic levels for food in the larval phase, and for clupeids also as adults. Currently these models are not linked to the lower trophic levels, and the food is just prescribed, or in the case of statistical models, growth is estimated.

To date, biogeochemical models (BGCM) are aimed to resolve variations in carbon, nitrogen, and phosphorus fluxes (variations in C:N, C:P, or C:N:P stoichiometric ratios). Phytoplankton's productivity is controlled by the stoichiometry of nutrients. Furthermore, size-based relationships are often introduced in order to better account for metabolic scaling effects, but also for devising improved descriptions of the plankton community structure. All new approaches still face difficulties in their mass closures. Current closure terms are kept very simple while implicitly regarding higher trophic effects.

Perspectives of linking BGCM to fish-models

One of the main weaknesses in the fish models is the specification of the recruitment. Linking recruitment success to the availability of food, as provided by BGCMs would be a strong improvement of the fish models. Furthermore, if a variable stoichiometry is resolved in the BGCM then the food quality can be determined. The study group has identified some perspectives for establishing a link between BGCM and fish-models. Suggested arguments that can be brought forward for establishing linked models:

1) the reduction of uncertainties in fish recruitment estimates
2) an improvement of the biogeochemical mass closures
3) a higher resolved spatial distribution pattern for fish
4) it provides the tool for investigating the sensitivity of fish-stocks to biogeochemical variations

The Issue of Scales

When coupling BGCMs to fishery models, the issue of different scales, both in time, space and size of individuals have to be considered. At the lower end of the size scale are the BGCMs, linking the input of sunlight and nutrients to production of plankton and in most cases including closure terms with zooplankton being explicitly resolved. These models can be generally linked to higher trophic levels by specifying a grazing mortality from fish larvae and clupeids.

At the upper end of the size spectrum, the juvenile and adult stages of fish are estimated and simulated, using statistical models like MSVPA. These models typically treat recruitment through stock-recruitment relationships. The "missing link" between these models are larval drift models, where larvae are introduced into a circulation model and drift according to the velocity fields. Food for the larvae is provided by a BGCM. In this way recruitment does not have to be estimated using an unreliable stock-recruitment relationship, but can be calculated explicitly. Ideally, a BGCM is also used to provide prey field for the juvenile and adult clupeids.

Technically, the coupling of a BGCM to a fish-model is feasible. However, the actual scientific problem is to determine a representative interaction structure. The plankton, larvae, and fish interaction is proposed to be either expressed on the basis of size or in terms of weight-classes. Thus, a major aim is to identify characteristics of the size-based (or weight-based) interactions, from which transfer functions can be constructed for the exchange of mass from one size/weight class to the others.

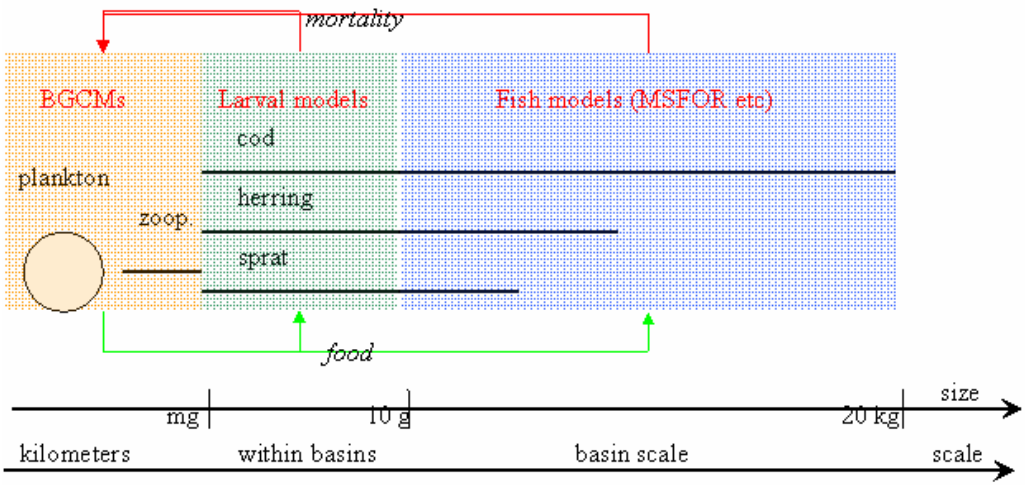

Figure 3.4.1.1: Illustration of the different kinds of models of the Baltic ecosystem.

3.5 Attempts to bridge the gap lower and higher food-web models

Ken Anderson and Markus Schwartau suggested approaches and ideas for linkage.

5) Typical inverse fish-models (like MSVPA) for stock assessment provide optimal estimates on fish mortalities (on a seasonal basis). Instead of estimating parameters of fish net growth (as a function of feeding) the BGCM output, could be coupled to the inverse model with a higher temporal resolution. Rather than estimating fixed feeding rates at the lower end of the trophic scale, in the BGCM the loss to higher trophic levels is used (so to say as a mass "forcing" input/inflow).

6) Set up a hierarchy of models, where the models remain effectively uncoupled but where the output of one model can be directly applied for the model of the next trophic level. A hierarchical structure of independent models remains applicable

on different time-space scales (e.g. spatio-temporal integrals of the BGCM output can be used). An expedient subdivision of models can be done:

a) BGCM (with fine resolution);

b) recruitment model;

c) fish-stock models.

Wolfgang Fennel reported about intersessional work of a model approach which has the potential of a direct coupling of biogeochemical models with stage resolving zooplankton and fish production models. The basic idea is to formulate explicitly the prey predator interaction of sprat, herring and cod in the Baltic. This requires the assignment of mass classes and state variables of biomass concentration and abundance for each mass class. The growth of the average individual mass is calculated from biomass and number of individuals within each mass class. If the average individual mass approaches the upper limit of a mass interval then the state variables a rapidly transferred into the equations for the next larger mass class. The growth equation is linear, but with different rates for different mass interval. The rates are derived from the standard Bertalanffy equation, which contains fitted parameters. Thus the parameters represent a compact observational knowledge in terms of data used for the parameter estimation. It was also highlighted that the enlarged number of state variables is not just a proliferation of variables, because the dynamics of the different mass classes are constraint by the Bertalanffy growth equation, which was mapped onto the liner stage dependent growth equations.

First test results were presented and demonstrated that the approach can be performed in a consistent manner. Further steps are the explicit inclusion of reproduction and the linkage of the model to the lower part of the food web. A series of experimental simulations are planned to consolidate the model parameters and to include step by step important aspects, such as fishery mortality, cannibalism and species interaction. Moreover, a close cooperation with experienced fish biologists is required to ensure a consistent further development of the theory.

Horbowy J. 1989: A multispecies model of fish stocks in the Baltic Sea year. Dana 7: 23–43.

4 The background of multispecies fish modelling in the Baltic

4.1 Introduction

In the Baltic Sea, the interacting fish community in the open sea is dominated by three species namely cod, herring, and sprat. The abundance of cod stock in the Main Basin is currently low, herring stocks are slightly increasing, and the sprat stock is at high level. The effect of cod on prey species (herring and sprat) is now low level. Multispecies interactions are present and they will become important, when predator population recovers. While cod biomass is low, there is the potential for herring and sprat to have an adverse effect on cod recruitment, through consumption of eggs and larvae.

The multispecies interactions in the Baltic are rather clear and strong, Thus it is relative easy to demonstrate how species interactions effect our assessments of the state of the stocks and our perception of the interactions.

Baltic multispecies assessment process started about 20 years ago and presently the following multispecies assessments and data are available for the Baltic Sea according to ICES sub-divisions (Figure 4.1.1):

- Baltic Main Basin: Years 1974–2004
  - cod in Sub-divisions 25–29+32
  - sprat in Sub-divisions 25–32,
  - herring in Sub-divisions 25–29+32,
- Western Baltic: Years 1977–1999
  - cod in Sub-divisions 22+24 (sub-division 23 included in 1996-1999),
  - sprat in Sub-divisions 22–24,
  - herring in Sub-divisions 22–24 including Division IIIa.
- Baltic Main Basin: Years 1976–2003, area dis-aggregated MSVPA:
  - cod in Sub-divisions 25, 26 and 28
  - sprat in Sub-divisions 25, 26 and 28
  - herring in Sub-divisions 25, 26 and 28

The current catch at age in numbers database for cod in the Baltic Main Basin (SD 25–32) for the years 1974–1976 is based on very limited age distribution data, most of the landings have been split into age groups based on the data from only one country. Several datasets concerning the age distribution of the landings that have been collected by national laboratories for 1977–1985 are also not included in the current database. The work for compiling these additional data series for 1974–1985 has been ongoing and the data that have been made available are planned to be included into the database in the nearest future (by the next meeting of the Study Group).

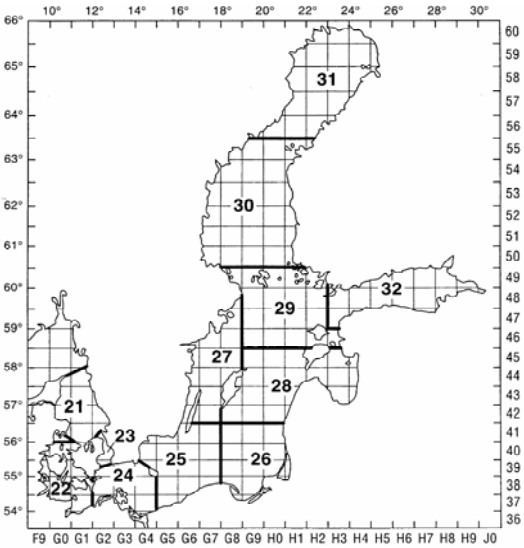

Figure 4.1.1: ICES Sub-divisions in the Baltic.

In the case of Main Baltic herring, the multispecies assessment unit is directly comparable to the units used by the Baltic Fisheries Assessment Working Group, excluding Gulf of Riga herring from the multispecies assessment. As the sprat population in Sub-division 30 is low and in sub-division 31 almost non- existing, the Baltic Main Basin stock estimates are basically also referring to Sub-division 25-29, and 32.

Consequently the effect of ignoring the two Sub-divisions should not hamper a direct comparison between single species and multispecies assessment output in the case of cod, herring and sprat in the Baltic Sea Main Basin.

4.2 Overview of Baltic Sea multispecies modelling

It is obvious that there is a need for specific work to keep the capability of running updated multispecies models for the Baltic within the ICES community and to ensure further progress in multispecies modelling in the Baltic. Updated multispecies model results are used by WGBFAS annually and the new predation mortalities are used for Baltic herring and sprat assessments. These single species assessments for cod, herring and sprat are presently the basis for management advice for European Community.

The maintenance of the data-base, data-base revision and updates, which incorporate basic multispecies products, need input from various institutes and working and study groups. Backwards extension of the MSVPA to periods before 1977 with the aim to enlarge the time series on stock developments especially for stock-recruitment modeling purposes is proved to be difficult because of lack of proper documentation and dis-aggregation of the primary data. The data base has been, however completed now to the year 1974. The Eastern Baltic MSVPA covers years 1974-2004 and spatially dis-aggregated model years 1976–2003. To update data-bases backwards to 1960s and early 1970s may not be possible, and there might be severe problems compiling quarterly data by sub-divisions. In this process the most obvious limiting factor will be the poor quality quarterly catch at age and weight at age data, especially before 1974.

There are considerable amounts of stomach content data for the 1960s and 1970s and this information would be very useful for estimation of consumption rates and understand cod cannibalism. We can foresee that some new stomach data will be sampled in the nearest future under the umbrella of BSRP ("Baltic Sea Regional Program" on Large Marine Ecosystems).

From inspection of the original stomach content data, cannibalism appears to be related both to the prey sizes and spatial overlap. However, cannibalism is most likely also related to shifts in the distribution of predator and prey in response to changes in hydrographical conditions, resulting in a pronounced changes in the spatial overlap of predator and prey. This part of exploratory work is ongoing and there are plans to tackle these issues both in BECAUSE and BSRP.

Our predictive models are sensitive to structural uncertainty. For example, with inclusion of weight at age and maturity at age being dependent on the food supply, the projected medium-term yield at various combinations of fishing effort directed to both cod and clupeids stocks change considerably in comparison to ordinary standard multispecies predictions.

Spatially dis-aggregated MSVPA runs have been updated for the Central Baltic up to 2004. The results support the theory that passive transport of youngest life stages of cod and migration by juveniles into/out of their nursery areas as well as spawning migrations of adults between different Sub-divisions are likely to occur. The intensity between years varies and there is not for time being clear estimates throughout the years and nor spawning seasons about the extent of these movements. Similarly for herring and sprat, the MSVPA output do not match the distribution pattern obtained from research surveys, indicating conflicting results caused probably by migration and movements. However, the integrated results over the whole area coincide with the results of the assessed stock.

The 4M programme, which contain MSVPA and it's routines including the tuning module, have been run without problems. The present programme package enables for example WGBFAS to run MSVPA's on a regular basis. An updated user manual giving specification and documentation of the 4M package is also available.

For development, application and validation of different types of multispecies prediction models, one of the key element seems to be environmental variability. For example Baltic cod

recruitment, feeding, growth and maturation processes are very much influenced by the heterogeneity of the physical environment.

In the Baltic Sea environmental variability is strongly linked to the meteorological-, hydrological-, and hydrographical processes and their interaction. As a result, the impact or change of one factor may well be correlated with that of others. How they interact has been considered in some occasions in CORE and STORE projects, but the relationships between various processes and hydrodynamics need still some exploring. Baltic Sea oceanographic data usually consist of indices that reflect and integrate multiple processes. They often contain indices that reflect the influence of remote forcing over a broad geographic area, direct measurements that reflect measured variables on a local scale or predicted elements generated from detailed models of an specific area. The use of these indices instead of local observations is often the result of limited monitoring resources or limited knowledge at the local scale. How to use these values or indices properly has not been explored.

Reference points, stated in terms of fishing mortality rates or biomass and management plans are key concepts in implementing ecosystem and precautionary approaches in fishery management. It has been agreed, but not fully understood, that reference points should be regarded as signposts giving information of the status of the stock. It has been possible to develop rather clear concepts and a “quantitative framework” with reference points and management models for single stock sustainability and precautionarity. For multispecies situations the sustainability concept seems to be very different and difficult. Although Baltic Sea is considered to be a simple ecosystem, there is still little clarity on the conceptual level given the complexity and natural variability of that environment. Reference points are far away from being defined given the limited understanding of the processes in the environment, of the effects of human interaction and of what comprises a perturbation of the environment which is unsustainable or perhaps irreversible.

Medium- to long-term projection methodology is a problem for single species approach and for multispecies as well. However, the present version of 4M programme package is able to handle a variety of stock recruitment relationships with and without stochasticity, as well as stochastic recruitment derived from normal or log-normal distributions. However, the programme is not able to incorporate environmental processes into stock recruitment relationships. The inclusion of environmental variability in predictions is worthwhile when assessing the impact of various management and fishing strategies on the stock development under different environmental conditions.

Presently the multispecies reference points missing, although strategies defined for Baltic cod, herring and sprat (new harvest control rules for cod in 2005, management plans and objectives in force for cod, herring and sprat). However, interaction between predator and pray are taking into account in Baltic Main Basin by single species assessment group, because a strong coupling is showed. Despite this it is not implemented in management. The environmental issues have been largely disregarded in the management advice. In present multispecies modeling the environmental-biological interactions (i.e. growth-maturity-juvenile survival) and new species interactions have been largely disregarded i.e. Baltic herring-seals, salmon and seals, etc.

5 Data requirements

5.1 Upgrade of data needs

Thomas Neumann reviewed the general aspects of the data requirements. At the last year workshop of the SG, data sets required for biogeochemical models were grouped according to tasks, which are calibration, validation, initialization and forcing of models. A new aspect, the spatial data distribution was discussed at the recent workshop. Usually data sets from the central parts of the Baltic Sea are available for scientific purpose. That is not certainly true for coastal waters and inner waters. In this area of the Baltic Sea strong gradients in nutrient concentrations as well as the elemental N to P ratio exists. For a further improvement of the process description in biogeochemical models data from nutrient sources to central part, which resolve the off-shore gradient are essential. Data from those areas exist but are not always available for the scientific community. A common agreement how to make those data accessible or at least to gather some meta-information would be helpful for progress in modelling the Baltic Sea ecosystem.

Bärbel Müller-Karulis reported on data describing the horizontal and vertical distribution of zooplankton and pelagic fish in the Baltic. In May 2005, the BSRP took part in the Latvian/Polish hydraccoustic survey for herring and sprat in the Eastern Gotland Basin, adding a lower trophic level (nutrients, phytoplankton, zooplankton) monitoring programm. The joint open sea survey aimed at testing the technical feasibility of joint fisheries - ecosystem surveys as well as on investigating the coupling between different ecosystem components, especially planktivorous fish and their zooplankton prey as well as zooplankton – phytoplankton. In the context of SGBEM, the BSRP joint open sea data were shown as a typical example for the spatial information available from a routine fisheries hydroaccoustic survey.

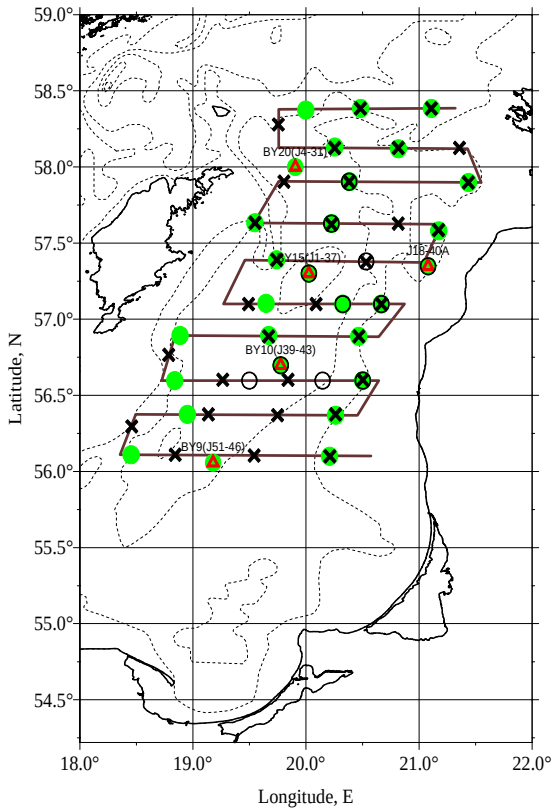

Figure 5.1.1: Combined fishery – ecosystem survey track, including trawl stations (crosses), nutrient/plankton stations (green circles), additional LFRA zooplankton stations (hollow black circles, and HELCOM COMBINE monitoring stations (red triangles)

The survey track (Figure 5.1.1), covered in north – south direction within ten days, provides a dense spatial coverage of the Eastern Gotland basin. Trawl stations are required at regular intervals to check the species composition of the pelagic targets detected in the hydroacoustic signal. On ships equipped with a CTD, the trawl stations can also be easily used to give a detailed picture of the hydrodynamic situation in the survey area.

The spatial distribution of pelagic fish, shown here for sprat (Fig. 5.1-2) is recorded continuously along the survey track. The horizontal distribution of sprat during the survey was patchy, with dense aggregations interchanging with low sprat biomass. There was only very weak relationship to hydrographic factors (temperature and salinity at 75 m depth), and no statistically significant relationship to the zooplankton prey field or phytoplankton concentrations. Hydroacoustic survey data also provide continuous information on the vertical distribution of targets. In case of sprat, the joint survey results confirmed the typical vertical distribution pattern of sprat at the beginning of spawning in Mid-May, with sprat focused in the Baltic intermediate water with oxygen (O_2 > 1 ml/l) and temperature (t > 3.5 °C)

conditions defining the lower and upper bound of the distribution, respectively. Due to the low oxygen concentrations in the Eastern Gotland Basin, sprat was focused in a narrow layer, on average 15 m thick around the 75 m isobath.

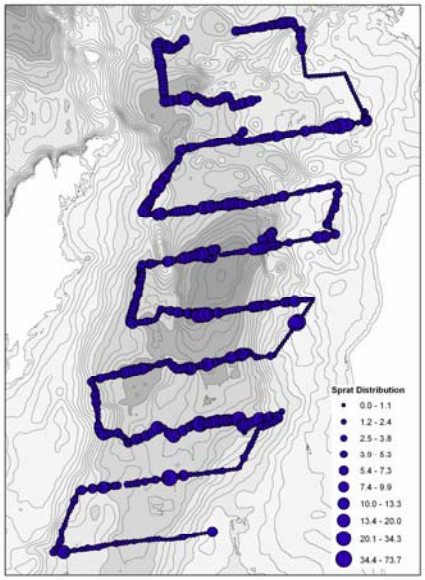

Figure 5.1.2: Horizontal distribution of sprat (Mio nm^{-2}) in the joint open sea survey May 2005

Eero Aero reported on activities regarding surveys spatial fish distributions in the frame of the EU project BECAUSE and provided results in form of maps, which were made available to the SGBEM.

5.2 Framework for Integrated Assessment for the Baltic Sea

Bärbel Müller-Karulis reported of the workshop on developing a Framework for Integrated Assessment for the Baltic Sea [WKIAB]. The ICES/BSRP/HELCOM Workshop was a joint effort to test approaches that integrate climatic and hydrographic conditions, nutrient status, as well as information from lower (phytoplankton, zooplankton) and upper trophic levels (fish, birds) into a status description and assessment of the Baltic Sea. Focusing on two trial areas, the Baltic Proper and the Gulf of Riga, the workshop was a first step in combining information

from all trophic levels into a more integrated description of the Baltic Sea ecosystem. Principal component analysis of 39 (Gulf of Riga) and 90 (Baltic Proper) time-series on biological, physical and chemical variables, covering in maximum the period 1973 (1974 for Baltic Proper) to 2004, were used to identify major shifts in the Baltic Ecosystem, following e.g. the approach used by Link *et al*. (2002) for the North-East US continental shelf.

Principal component analysis showed distinct regime shifts for both the Baltic Proper (Fig. 5.2.1) and the Gulf of Riga. In the Baltic Proper, the system moved from a high salinity/low temperature state with high biomass of from cod (*Gadus morhua*), herring and the large copepod *Pseudocalanus acuspes* in 1974–1987 to a low salinity/high temperature state with large populations sizes of sprat (*Sprattus sprattus*) and *Acartia* spp. observed from 1994 until the end of available time series in 2004. The period 1988–1993 represents a low salinity/high temperature intermediate regime.

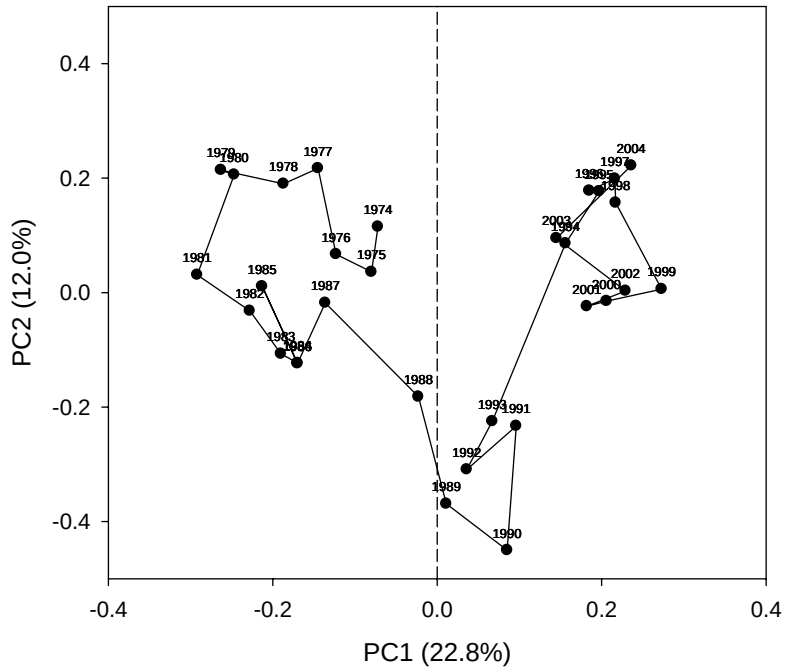

Fig. 5.2.1: Time scores of principal components 1 and 2 (PC1 and PC2) in the Baltic Proper; variance explained by PCs in brackets.

Link, J.S., Brodziak, J.K.T., Edwards, S.F., Overholtz, W.J., Mountain, D., Jossi, J.W., Smith, T.D., and Fogarty, M.J. 2002. Marine ecosystem assessment in a fisheries management context. Canadian Journal of Fisheries and Aquatic Sciences 59: 1429–1440.

A workshop on Developing a Framework for Integrated Assessment for the Baltic Sea [WKIAB] has been held in Tvärminne, Finland, from 1–4 March 2006. 18 scientists from seven countries, well representing the participating organisations/projects, attended the meeting.

6 Evaluation and comments on the external review on the 2005 SGBEM report

The report of the SGBEM 2005 was sent to an external reviewer. The reviewers' comments are attached in Annex 3.

To evaluate and comment on the external review of the last SGBEM report the group looked at the general aspects of SG reports and with regard to the objectives of SGBEM with respect to outside readers. SG reports usually have a different standard compared to peer reviewed publications.

The reports of SG's in general, but in particular of SG's of the BSRP should be considered in the context of the four SG's within the BSRP. Thus, outside readers should at least be familiar with the BSRP. The work of the SGBEM covered exiting models, visions, needs for data including concepts for data management. There were several obvious drawbacks for the work of the SG. Among them not the full scale of cooperation and interaction between the groups.

There were essential problems, which were not explicitly mentioned in the report, but addressed by the Chair internally inside the BSRP, regarding participation, lack of support of western participants, only a part of potential integration and cooperation between the groups. A few problems are highlighted below:

6.1 Membership and participation

- In the recipient countries, there are almost no modellers, or potential member were not nominated. Opportunities to train people were not used.
- Western experts were required to find their own travel funding, implying a limited participation.
- This implies also a week interaction with the 'parent' group, the WGPBI
- The study group on fish issues was not represented in the meetings of the model group.

6.2 Leadership and supervision by the BSRP directors

- The leaders of the BSRP failed to play an active role in developing cooperation, integration and interaction of the four Study Groups.
- The scientific responsibility for the work of the SG's was transferred to the Baltic Committee, which discussed only briefly the reports at the annual ICES meetings.

This leads to the conclusion that running BSRP in terms of ICES Study Groups might not be the best practice. The mechanisms are slow and too formalised. The membership cannot be maintained due to funding problems. Hence the commitment of members was not adequately encouraged and therefore inappropriate.

Annex 1: List of participants

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Annex 2: Review of the ICES SGBEM report 2005

The report starts with listing the terms of reference of the meeting. However, the overall objective of the work of the Study Group is unclear and does not become much clearer as the reading proceeds. A plausible outline of the expected goal of the work would, therefore, be most useful for the outside reader when evaluating the current work in relation to the set goal.

Section 2 deals with modelling of the Baltic (ToR a). Two of the physical models seem quite specialized (oil spill, eutrophication) and localized (Gulf of Finland, Lake Ladoga). A summary of the main virtues of the models with respect to the objectives of the study group would have been appropriate. The Ecopath model is not specifically designed for the Baltic and there are many other fish models which might have been considered in this context. A comment on why this model was selected before others would be illuminating.

Section 3 seems to deal with Tor d) to bridge "the gap between fish stock models and ecosystem models". It might have been useful to define this gap somewhat further and explain why it would need this extra treatment beyond other trophic links. The sections are mainly devoted to describing distribution patterns of sprat and recruitment problems of perch and pike, in relation to environmental aspects. There are undoubtedly many other relevant data sets that would be useful for the "understanding of the reasons for the spatio-temporal distributions". So the question is to which extent this understanding has been fulfilled by the findings presented. In the final paragraph of the section the dynamics between the pelagic and the coastal ecosystems are suggested as "a challenging task for future work". This task seems different from the one set out at the beginning of the section.

Section 4 handles data needed for modelling, Tor b). It is a worth while exercise to define the data and data sets needed for given a model. Apparently, however, the final selection of appropriate model or models is not yet done and, therefore, the need for specific data may not be entirely clear. Furthermore, the question of which of the needed data are available for the Baltic should be dealt with to some extent.

The largest Section 5 deals with links to other projects, Tor e). There seems to be an impressive amount of activity going on in ecosystem research in the Baltic. In fact, the question seems justified if the deliberation of this report have not already been dealt with, and even partly or fully solved, within some of the other Working and Study Groups presented in the section or within aquatic institutes in the Baltic active in this field?

Apparently, Tor c) is not covered in this report.

The task of ecosystem modelling in the Baltic, or any other marine ecosystem, is clearly a commendable effort, which has been in progress for many year or even decades within scientific circles in the Baltic area. The question whether the SGBEM may contribute significantly to the advancement of this work remains unclear, based on the present report of the SG. The objectives of the SG are not stated and progress of the work within the group is not appropriately covered. Finally, the question remains to which extent the current report may be a repetition of what has already been done in other Study or Working Groups in this field in the Baltic.

Annex 3: Recommendations

The main recommendation of the Expert Group is that efforts to link and integrate models of different levels of the food web, i.e., biogeochemical and fish production models, should be an issue in other Expert Groups, e.g. WGPBI and /or SGMAB.