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Executive Summary

The meeting brought together modellers working on biogeochemical models and stock assessment fish and fishery models, i.e., at different trophic levels of the marine foodweb, to discuss their approaches. Two types of models were considered: 1) Coupled physical-chemical-biological models, which provide consistent descriptions of bottom up effects and included nutrient and oxygen dynamics, but which see the action of fish in terms of prescribed mortality rates. 2) Fish stock models without spatial resolution that see lower trophic levels in terms of prescribed prey biomass, or implicitly through data from surveys or landing reports.

The development of model systems which cover the foodweb (nutrients to fish) is a major challenge but seems to become feasible in the coming next years. The SG discussed theoretical difficulties associated with the problem of incorporating fish in spatially resolved model systems. Although such models become rather complex, they can be considered as a theoretical pillar for ecosystem based advice.

There are requirements for further theoretical research towards new generations of models, but also an urgent need for better data sets, in particular with respect to the spatial distribution patterns of the key species of fish, and a better understanding of the driving mechanisms, which control the changes of the patterns.

1 Introduction

1.1 Opening

The Chair, Wolfgang Fennel, and the host, Jan Horbowy welcomed the participants. The meeting was well visited with 14 participants, although several nominated members were unable to come. Some items could not be addressed appropriately because the responsible members withdrew their participation at short notice. The Chairs of the Study Group on Baltic Sea Productivity Issues and the Study Group on Baltic Ecosystem Health Issues attended the meeting.

1.2 Terms of Reference

a) Review existing community models for the Baltic ecosystems and new developments also in other areas through cooperation with and active participation in the WGPBI.

b) Identify data sets of high priority for modelling issues and ensure a bi-directional exchange of information with the monitoring group 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) Discuss and initiate attempts to bridge the gap between fish stock models and ecosystem models for the Baltic.

e) Establish contacts to relevant projects, such as the German GLOBEC, BECAUSE, etc.

f) Provide input and specific contributions to the Theme Session on Regional Integrated Assessments in 2006.

1.3 Agenda

The meeting was structured in talks of modellers dealing with different parts of the marine foodweb, reports related to data management and executive summaries of two of the BSRP SG's. Some time was set aside for discussing and drafting parts of the report.

2 Aspects of the modelling of the Baltic Sea

With respect to the task of a reviewing existing community models for the Baltic ecosystems, it should be stated that the SG is aware of several existing advanced model systems, in particular for the Baltic. During the meeting, the study group looked specifically at the following modelling activities: a physical model on surface drifts in the Golf of Finland, an overview on new ecosystem models in Russia, and the ECOPATH model.

2.1 Physical modelling

The key factors in drifter simulations

The Gulf of Finland is an actively investigated sea-area which is under heavy sea traffic that is one of the main risk areas for oil accidents in the Baltic. The amount of oil transportation in the Gulf is estimated to rise further and will come to more than 100 million tons in 2005. Increased risk of oil accidents leads to a need to further develop operational oil spill forecasting systems, the need of such forecasts due to the small size of the Gulf. Even if an oil spill would occur in the middle of the Gulf, the oil is expected to reach coastal areas within at least a couple of days. Hence, operational forecasts with a length of 1–2 days are useful in this area. To ensure the high quality of the forecasts, field experiments with drifting buoys are needed to provide verification material for numerical models.

The conclusions and recommendations given here are based on a three-day drift experiment which was carried out in May 2003 in the Gulf of Finland. The studies, conducted onboard R/V Aranda, were performed using GPS-positioned surface floating buoys which follow the flow of the uppermost approximately 1 m layer of the sea. Model simulations, both in forecast and hindcast modes, were carried out by various hydrodynamic models, the results of which are evaluated by comparing the calculated drifts with observations. The flow models were driven by HIRLAM (High Resolution Limited Area Model) and ECMWF (European Center for Medium Range Forecasting) meteorological fields.

Results and conclusions

Operational drift forecasts as well as hindcast simulations were compared with the drift of the Current Spy buoys. Preconditions for good simulation results are meteorological forecasts that describe correctly the main features of the weather and a hydrodynamic model that reproduces sea currents. The simulated drift of the buoys was in good agreement with observations, especially when the latest meteorological forecasts were used. Hindcast simulations fitted better to the observations than operational forecasts because in the latter the wind or current forecasts were fixed in a routine service. There are several sources of differences in the results produced by three different model system are several.

The experiment stressed the influence of the wind factors used in drift calculations. Nowadays many numerical models are technically easy to use and several calculation results can be achieved within a few minutes. A good common practice is to repeat drift simulations with different wind factors to quantify the role of factors on the simulations.

In future, better results in operational drift forecasting could be achieved if one or more hydrodynamic models applied to a certain area could be run simultaneously as parallel version with input from several atmospheric models. The final result of the calculation would be a set of drift forecasts instead of one, and the model user would immediately gain information if the forecast runs differ significantly or produce very similar results. The usefulness of using several models with several drivers at the same time is that the probable area of spreading is determined.

Recommendations

- In operational oil spill forecasting regular updates of wind forecasts (e.g., four times/day) are needed, because sometimes the meteorological forecasts change considerably during short time periods;
- Special attention should be paid to atmospheric forcing, e.g., in IBM's. The role of accurate atmospheric forcing is very important for particle drift simulations;
- As future work forecasts from several models should be combined, parallel runs should be carried out and thus produce ensemble drift forecast;
- Increase the communication between oceanographic and meteorological modellers, e.g., by organising common workshops where key issues for co-operation should be considered.

2.2 Some recent Russian ecosystem modelling studies

A 3-D regional-scale hydrodynamic-biogeochemical model for the Gulf of Finland was developed (Neelov, 2003). The hydrodynamic module is a coupled ocean-sea ice model developed by Neelov (1996). The biogeochemical module describes biogeochemical nitrogen and phosphorus cycling in the coupled pelagic and sediment sub-systems (Savchuck and Wulff, 2001). Comparisons of the observations available showed that the model simulates satisfactorily typical features of the seasonal variability in the Gulf of Finland system, especially in the surface layers. The results imply that the contribution of atmospheric physical forcing to the inter-annual variability of the biogeochemical nutrient cycling in the Gulf is small. However, the model driven by atmospheric forcing for 1995–2000, but by climatically average river runoff and nutrient loads, was unable to reproduce the exact succession of events that occurred in the deep layers of the Gulf during this period. Therefore, time-series of data are needed both for prescription of boundary conditions and as a validation criteria in order to further test the model performance, before it can be applied for studies of the effects of nutrient load reductions.

A 1-D ecosystem model allowing for the dissolved organic matter (DOM) cycling in water column and the exchange of detritus, DOM and nutrients between the water column and the benthic layer has been developed for the sea coastal zone (Ryabchenko *et al.*, 2004). This ecosystem model is coupled into a 1-D physical model calculating the vertical structure of current velocity, temperature, salinity, turbulent mixing coefficients as well as snow and sea ice thickness. To take the horizontal transport of substances into account, which is especially important near the river estuaries, the relaxation of model solution to available observations in the modelled location is parameterized as transport due to the horizontal diffusion. The model simulates correctly the principal features of seasonal variations in physical and biogeochemical characteristics at a location near the Lena river delta in the Laptev Sea. Numerical experiments with the model show that the basic influence of river run-off on the marine ecosystem reduces to strong increase in the light extinction, decrease the PAR, lessening the primary production, and subsequently significant changes in other ecosystem state variables. At the same time, the functioning of the ecosystem depends weakly on river inputs of dissolved forms of inorganic nitrogen. The river input of dissolved inorganic carbon strongly affects only its concentration in the coastal zone while the CO_2 exchange with the atmosphere and is small.

A new 3-D models of the Lake Ladoga ecosystem was developed and used to model the phytoplankton succession during eutrophication processes, (Astrakhantsev *et al.*, 2003; Rukhovets *et al.*, 2003). The anthropogenic eutrophication of the lake started in 1962 when the phosphorus load began to increase. Since 1962, during the evolution of the lake's state from an oligotrophic to a mezotrophic one, its total productivity and the structure of phytoplankton community dominating species was changed significantly. The model system in the model is described by 14 state variables: nine phytoplankton complexes, zooplankton, DOM, detritus, dissolved mineral phosphorus and dissolved oxygen. The relative dynamics of phytoplankton complexes in the lake's ecosystem evolution was simulated. Despite the absence of interannual changes of climatic conditions (circulation, temperature, illumination), the model reproduces the general tendency of the year-to-year succession of the dominant algae as a response to the changes of phosphorus loading. The model results imply that the main reason for the eutrophication and the changes in the phytoplankton succession is the increase of phosphorus loading.

2.3 ECOPATH modelling approach

Ecopath is a program for balancing steady-state models. It is freely available from http://www.ecopath.org. Originally proposed by Polivina (1984), and has been combined with network analysis based on approach of Ulanowicz (1986). Trophic interactions among the functional groups (*i*) of the ecosystem can by described by a set of linear equations:

$$P_i = Y_i + B_i + M2_i + E_i + P_i * (1-EE_i)$$

Where P_i is the total production of *i*; *Y* is the total catch of *i*; B_i is the total biomass of the group *i*; E_i is the migration rate; EE_i is the ecotrophic efficiency of *i*, (the fraction of production of *i* that is consumed with in system, exported or harvested).

It could be also expressed as:

$$B_i*(P/B)_i * EE_i - \Sigma B_j * (Q/B)_j * DC_{ji} - Y_i - E_i = 0$$

where $(P/B)_I$ is the production/biomass ratio; $(Q/B)_j$ is the consumption/biomass ratio; DC_{ji} the fraction of the prey (*i*) in average diet of predator *j* (Christiansen and Pauly, 1992). For each functional group of the ecosystem the following data are needed to run the model:

B Biomass

P/B Production / Biomass

Q/B Consumption / Biomass

Diet composition of every group

Fisheries data (e.g., landing, discard)

Potential of model results

The Ecopath model allows analyzing the foodweb structure and functioning in the following way:

Comparison of modelled networks with respect to productivity and functioning; calculation of indicators, such as:

- The total primary production of the analyzed trophic networks;
- The total system throughput following the primary production pattern;
- Total biomass/total throughput ratio (expected to increase for the most mature stages of a system and shows a recognizable trend of increase towards coastal systems vs. open sea);
- System connectance index being mainly determined by the level of taxonomic detail used to represent prey groups;
- Gross efficiency (catch/net primary production);
- Biomass of top predators - important in terms of fish production;
- Transfer efficiency from primary production to top predators.

The Ecopath model allows to compare modelled systems with respect to important components and flows. Comparisons between different Baltic Sea ecosystems showed that coastal systems, which often comprise also benthic producers, differ from open sea systems, as macorphyte biomass is not channeled into foodwebs efficiently. For efficient model analysis, input parameters have to be selected carefully and consistency between models has to be assured. Often, analysis of foodweb changes over time is easier to achieve than comparison of different ecosystems.

3 Fish Modelling

3.1 New integrated modelling approaches

One way towards bridging the gap between ecosystem models and fish models could be the definition and incorporation of state variable (abundance and biomass concentration). A formal application of state resolving Eulerian zooplankton modelling (Fennel, 2001) on fish models may provide some guidance This approach includes the omission of growth equations with non-linear dependence on mass (allometric exponent). This could be replaced by age dependent growth rates for different year classes.

The preparation of some theoretical studies to investigate whether such an approach is consistent will be done intersessionally. A second important issue regarding the encounter with such complex model systems is the need for data on the spatial distribution of fish biomass and to develop an understanding of the reasons for the spatio-temporal distributions.

3.2 Distribution and migration pattern of sprat

Eastern Baltic

Hydroacoustic and bottom trawl surveys are the main source of data to investigate the distribution pattern of pelagic bottom species (sprat, herring and cod) in the Baltic proper.

From data on Sprat abundance and biomass distribution by subdivision and seasons, a shift in the distribution between Subdivision 26 and 28 in the last half of the 1990s is obvious. In the first half of the 1990s, the population in Subdivision 26 formed the major part of the stock, constituting about 70% of total biomass, but in recent years the importance of this Subdivision decreased while the proportion of the sprat population biomass in Subdivision 28 increased to 56% (a map showing the subdivisions can be found at the web site:

http://www.ices.dk/aboutus/icesareas/ICES_areas_Arc9_Baltic_300.pdf).

The increasing proportion of sprat in Subdivision 28 may have the following reasons:

1) improvement in the reproductive and feeding conditions for sprat, due to warm inflows of North Sea water into the Gotland Deep (Zezera, 2001);

2) low predation mortality of adult sprat due to very low abundance of cod in that area.

The estimated number of sprat in Subdivision 26 in May–June 1994–1995 and 1999–2000, disaggregated by statistical rectangle and age group, clearly shows that the structure of sprat stock in the considered subsequent years was rather different, depending mostly on the recruits abundance at age 1.

An analysis of the age composition of sprat population separately in the “deep-water” and “shallow-water” rectangles, associated with depth-specific hydrography (water temperature and salinity by depth strata and statistical rectangles) revealed significant differences between sprat distribution according to age in deep water areas (Vasilieva and Feldman, 2001).

In rectangles where sprat were abundant, the 1-year old sprat exhibit a clear affinity to upper warm water layers (T > 4.0 °C) down to 40 m (above the thermocline or the cold intermediate water layers).

On the other hand, the adult and spawning sprat demonstrate a clear affinity to the saline and warm deeper water layers below the halocline. In most shallow water rectangles, characterised by depths of 37–50 m, the described clear differences in young and adult sprat distribution was not detected. The one-year old sprat was distributed more evenly through the water column with a preference to the warm water in the sub-surface layers in 2000.

Only a minor part of the adult sprat stayed in the shallow water for feeding, and was in less mature conditions than in the deep-water rectangles (Alekseeva and Alekseev, 2002). The reason for this is the absence of the halocline and warm saline water as environmental preconditions for the fast ripening, spawning and successive reproduction of sprat. In 1994, characterized by a low contribution of one-year old sprat to the stock, almost all adults concentrated in two deep-water rectangles 3864, 3954 where salinity and temperature conditions were the most favorable for sprat spawning.

The conducted analysis of long-term seasonal distribution patterns of sprat in the Eastern Baltic revealed two basic types of spatial distribution:

- *Winter-spring (January to May*), when major sprat aggregations were distributed mostly over the deep-waters of the Gotland Basin and the Gdansk Deeps in the layer from 60 to 100m depths.
- *Summer-fall (June to December*), when sprat migrate closer to the coast and occur in depths of 30-40 to 100 m. In this period a certain portion of a sprat migrates into the warmer surface water layer while the other fish remain in the deepwater layer.

The distinction in these two types of distribution pattern rather convincingly illustrated the pattern of sprat distribution. It is evident, that in May the densest sprat concentrations were in the western part of SD26, and in September - in the eastern part of SD26 and 28 in the shallower coastal zone. During the autumn sprat was distributed in the eastern part of Subdivision 26 and 28.

Apparently the distribution of sprat is highly patchy. It is possible to identify locations with stable dense fish concentration in the areas:

- North of Ventspils in the Irben Strait traverse;
- off Liepaja;
- off and southwards of Klajpeda;
- periodically in the Gulf of Gdansk.

However, even within these areas, the sprat distribution is patchy. Obviously other factors, e.g. zooplankton availability, affect the distribution of sprat.

The sprat distribution pattern in October in the surface and deep-water layers was analyzed separately in relation to habitat layer thickness (Shvetsov *et al*., 2002). The thickness of the surface layer is assumed to define the upper habitat layer. The bottom layer is defined as the depth interval below the cold intermediate layer, with temperatures above 3.5 °C, down to the depth where the oxygen concentration decreases to 1 ml/l. From the analysis it is evident that sprat aggregations occur both in the upper and the bottom layers if the vertical extension of the habitat exceeds 30 m.

The comparison of hydroacoustic survey results obtained in May/June and September/October showed: i) a migration of sprat into shallow water areas of Subdivision 26 at the end of the spawning season; and ii) a northward migration into Subdivision 28 and further north into Subdivision 29 south, which showed the highest densities of sprat during autumn. A comparison of the results of hydroacoustic survey in spring and autumn from 1978 to 2000 allowed an analysis of long-term changes in interannual variability in the horizontal distribution of different components of the stock, such as recruits and spawning stock (at least within Subdivision 26). This analysis revealed a different distribution pattern of sprat during spawning and feeding periods, which might be related to seasonal spawning and feeding migrations, and may further be influenced by the depth-specific hydrography. Thus the short-term observations are in accordance with a general trend detected by the long-term analysis of seasonal patterns.

In general, results of the hydroacoustic surveys provided a good opportunity to analyse qualitatively the seasonal and interannual distribution patterns of sprat. The analysis of such data, in combination with corresponding data on environmental conditions, allowed to show the particular fish distribution and to indicate the role of environmental factors determining fish migration and distribution pattern.

Distribution of cod from the survey

An extensive analysis of cod survey data for the Baltic has been performed by Sparholt *et al.* (1991). The analysis comprised data from six countries surveys in 1982–1989, Subdivisions 25, 26, and 28, quarters 1, 2, and 4. The authors used general linear model on log-transformed data, assuming normally distributed error. The analysis showed that the cod was distributed mainly in Subdivisions 25, 26, and 28. The cod density in Subdivision 26 was lower than in Subdivisions 25 and 28, and the optimal depth for both young and adult cod was 60–70 m. Significant relationships between quarters, depth, and subdivision were observed.

The analysis of cod distribution by Horbowy *et al.* (2003) based on Polish survey data to a large extent showed results similar to Sparholt *et al.* (1991) study. The negative binomial errors were assumed for the analysis of young fish numbers (age 1 and 2) while gamma error distribution was applied in case of the analysis of adult fish biomass. The abundance of young fish was significantly dependent on year of birth, depth, longitude, latitude, quarter, and gear used in the survey. The highest numbers were caught in area constrained by 15°50′–16°10′ while the lowest in area constrained by 17°00′-17°30′. The optimal depth range was 50–70 m. Cod at age 2 were more available to survey catches than 1 age fish. The survey biomass of adult cod was significantly dependent on year, depth, longitude, and gear. The highest biomass concentration were at area constrained by 15°50′–16°50′ and depth of 70-90 m. The determined indices of adult stock size correlate relatively well with spawning stock biomass from analytical models (R2=0.57).

3.3 Recruitment problems of coastal fish populations in the Baltic

During the last decades, declining catches of perch and pike have been reported from several coastal areas around the Baltic. The reason for this has been unclear. To summarise the present knowledge about the problem, the Swedish National Board of Fisheries arranged a workshop in 2002. Based on the recommendations from this a field survey was undertaken in 2003. The goals of the survey were to:

1) analyse the geographical distribution of the recruitment problems;
2) identify the most critical life stage;
3) analyse if there is a relationship between recruitment failure and –
    - habitat changes (i.e., vegetation coverage and abundance of filamentous algae);
    - food availability (i.e., zooplankton availability at onset of feeding);
    - predation (i.e., abundance of sticklebacks).

Data on abundance of juvenile freshwater species during the last ten years revealed that most of the outer archipelago areas along the coast of the Baltic proper had low or no recruitment of perch. The most affected areas in the Baltic proper were the Kalmar sound, the Stockholm archipelago, and the coastal areas of Gotland. In the Bothnian Sea and in the inner archipelagos of the Baltic proper the recruitment was normal. The situation is similar for pike and other freshwater species, with exception for sticklebacks. In the most severely affected areas, the juvenile fish community was dominated by sticklebacks. Data from commercial landings of perch and pike and an inquiry among commercial fishermen support the geographical pattern of the problem. These data indicates that the changes took place during the 1990s, but there are long time-series from Gotland that show that the decline in catches could have started already during the 1970s. The origin of the declining coastal fish stocks should be sought in the offshore areas of the Baltic proper. Based on the abundance of early life-stages of perch, we can state that it is during the larval or early juvenile stages that the problem appears, and that it most probably is the early larval stages that are most critical. No correlation was found between recruitment failure (of perch and pike) and vegetation community composition or vegetation coverage, neither was there any correlation between recruitment failure and abundance of filamentous algae. There was, however, a clear relationship between abundance of adult sticklebacks in the spring and recruitment failure. Further analyses of a broader dataset of juvenile surveys reveal that high abundance of sticklebacks does not necessarily mean a negative effect on the recruitment of perch and pike. Neither does data from the Kalmar Sound before the decline of the stocks support sticklebacks as the main reason to the decline of the other species. However, there was a strong correlation between food abundance (zooplankton) at the time of onset of feeding and recruitment success of perch. Common for all stations with recruitment problems was significantly lower abundance of zooplankton compared to reference areas.

Conclusively, these results, together with the changes in the zooplankton- and clupeid communities reported from the pelagic areas of the Baltic indicate that the recruitment of the coastal species might be affected by large-scale changes in the pelagic ecosystem. Further, this suggests that a challenging task for future work will be to identify the dynamics between the pelagic system and the coastal ecosystems.

4 Data needed for modelling

4.1 Data sets of high priority for ecosystem models

Modelling of ecosystems requires the integration of observational data and modelled data. The amount of data, demands for quality standards as well as for the type of required parameter sets may differ for different models. Here data for 3D biogeochemical models (e.g., Neumann 2000) of the Baltic Sea ecosystem are considered. In general, data are needed for following tasks:

- Calibration;
- Validation;
- Initialization;
- Forcing.

The first three issues refer to data from the inner model domain, the last task item define data needs data from the borders or outside of the model domain. Calibration and validation is in particular relevant for the development of models.

Calibration

Data sets for calibration are necessary for all sub-models: The circulation model, the biogeochemical model and the sediment model. The most important parameters are:

Circulation model:

- Sea levels;
- Temperature;
- Salinity;
- Currents.

Biogechemical model:

- Nutrients: nitrogen, phosphorus, silica;
- Phytoplankton: biomass;
- Zooplankton: biomass.

Higher trophic levels:

- Zooplankton: abundance, biomass, at species level.

Sediment:

- Fluxes.

Resolution in time and space

Measurements of oceanographic parameters in high variable systems, such as the Baltic Sea, are likely to be obscured by aliasing. Hence some statistical requirements have to be fulfilled by the data sets. As a rule, longer time-series contain the necessary properties like mean, annual cycle, variability, etc. A compromise on sampling frequency is about monthly sampling.

Spatial sampling should resolve the first baroclinic Rossby radius, which is in the order of a few kilometres. Such data are not obtained at a regular basis. For campaigns within projects this spatial resolution requirement should be considered. Other sources of spatially highly resolved data sets are satellite images.

Important data sets are:

- Multi-year time-series;
- Regularly observed cross sections along gradients (from coast to centre);
- Spatial grids at synoptic scale.

Validation

For validation the same requirements apply as for calibration. But data sets have to be independent.

Initialization

Data for initialization should ideally fill the model grid for each parameter at the initial time. For the physical part this is usually easier to achieve than for biogeochemical and fish data. For example, strong gradients of nutrients profiles imply that more data points are needed. Since this is unrealistic, a longer spin-up period of models can be helpful to construct data sets which are at least consistent with the model dynamic.

Forcing

A high quality of forcing data is essential for reasonable simulations. These needs are more or less satisfied for the atmospheric forcing. The situation is quite different for run-off data and nutrient loads, for which the availability and quality is often poor. A way out can be the simulation of those data. Some effort is made in BOOS, which distributes online operational data sets and products, such as run-off data.

Data requirements from the point of view of the presented Russian studies

For initialization and validation of benthic submodels, benthic layer data are needed on:

- dissolved inorganic nutrients (phosphorus, nitrogen, carbon);
- particulate organic matter;
- dissolved organic matter;
- fluxes of DOM and nutrients at the water-bottom boundary.

Specific information (biomass, growth rates, and others) on phytoplankton community dominating species are needed to successfully model the phytoplankton succession in the eutrophication process.

List of Ecopath data gaps for the Baltic

In discussion, a list of gaps in data and knowledge was identified for the Baltic Sea Ecopath modelling:

- Biomass, consumption rate for non-commercial species;
- Consumption for commercial species;
- Biomass of commercial species in costal areas;
- Production and consumption rate for micro-, mezo-, makro - zooplankton, zoobenthos, meiobenthos, bacteria;
- Transfer between microbial loop and classic trophic foodweb;
- Migratory (e.g., salmon sp., smelt) species problem.

4.2 Data needs for Fish stock assessment models in the Baltic

Generally, fish stock dynamics models can be classified into two groups: age-structured models and stock-production models. In the age-structured models basic biological processes of stock dynamics (growth, mortality, and recruitment) are modelled separately. In stock-production models the change in biomass is function of biomass itself and fishing effort. Besides the size-structured and difference models exist but these have not been largely applied for the Baltic.

The application of the age-structured models usually requires the following data:

- Catch-at-age in numbers;
- Weight-at-age in the stock and in the catch;
- Natural mortality (may be at age);
- Maturity ogives.

In case of stock-production models the basic data come from catch statistics: it is catch volume and fishing effort.

Both types of models need auxiliary data for their calibration (tuning in fishing nomenclature). The tuning data may come from two sources - survey and/or commercial CPUE:

Survey data

These data are often used as indices of stock size. It may be acoustic estimates of stock numbers at age, bottom trawl survey indices of stock size distributed to age or size groups, number of eggs and/or larvae from oceanographic survey. Common problems with these data are often high variance, changes in survey coverage, calibration of equipment and methods when several countries take part in the survey.

Commercial CPUE (catch per unit of effort) and effort data

The use of these data is usually more difficult as in the case of Baltic data, which suffers from incomplete catch statistics (mainly cod). In addition, the catchability of commercial fleets may change markedly and these changes need to be included in the models.

The fishery models may also be classified into single- and multi-species models. The multi-species models include species interactions, which in the Baltic fish is mainly cod predation on clupeids. In some models the effects of food resources on growth rate are simulated. The multi-species models use data on food composition of cod (stomach contents) on a quarterly basis as cod feeding varies seasonally. An important parameter for estimation of predator pressure is the daily ration or fraction of consumed food assimilated for growth.

The data for fishery models are generally available for main Baltic fish stocks. They have been collected for many years and most of data can be taken from the ICES working group reports. They usually cover 2–3 recent decades. Some data are maintained in ICES data bases (e.g., survey data).

5 Links to other activities

5.1 An overview of international data exchange and management with focus on the Baltic Sea

Exchange of data between institutes and countries is a basic requirement for a sustained production of marine information and services. An increased demand for services and information is pushing a continued development of data exchange. For operational oceanography the present meteorological data exchange serves as a model.

5.1.1 Data

Data can in this respect be divided into different groups:

1) Real time data;
2) Delayed mode data;
3) Archived data;
4) Data achieved from data archaeology.

1. Real time data are used for assimilation in forecast models, for forecast validation, and in nowcasting. Systems for exchange are being developed in international organisations and projects as GOOS, JCOMM, EUMETNET, ARGO, GODAE, EuroGOOS, BOOS, ...

2. Delayed mode data are exchanged after hours and days for use in nowcasting, regular products and for archiving. This exchange has existed for many years in e.g.: WMO/IOC IGOSS (today in JCOMM) in the Bathy-TESAC programme, and also in the ARGO and SOOP programmes.

3. Marine data archives are built for analyses and studies of climate trends and scenario modelling, environmental trends and changes, production of statistics and design criteria, and for research and development Organised exchange and management of marine databases started for more than 100 years and exists today in organisations as ICES, WMO, IOC, WDC, IODE, and HELCOM. Database projects of interest for the Baltic are SeaSearch, Seadatanet, BED, and Baltex.

To satisfy community requirements, operational oceanography, including exchange of data and forecasts, is today developed through research projects and implementation projects to sustained system. Of particular interest for the Baltic area is the EU FP5 PAPA project and an expected implementation project prepared under the working name “ECOOP”. The sustained system to be further developed is the Baltic Operational Oceanographic System, BOOS, which is based on a MoU between national oceanographic institutes in the countries surrounding the Baltic Sea.

5.1.2 Observations

Observations and collection of marine data is in the Baltic is mainly carried out on the national level. A substantial part of the monitoring is internationally co-ordinated or at least includes agreed data exchange. The monitoring is organised in different programmes, mainly with relation to the use of data. The early monitoring for exploration and for protection of the marine environment and natural resources was designed and managed through ICES. The environmental monitoring has been inherited, improved and revised by HELCOM. Sea ice and temperature monitoring have been developed for safe and efficient shipping and navigation. Real-time monitoring of sea level, current and waves is basically supporting safety but has value for a large group of users. Algal bloom monitoring is relatively young and mainly required by the public. Monitoring of discharge from ships for evidence in court and for combating operations is co-ordinated under the umbrella of HELCOM. Sensors carried by satellites give additional information on SST, sea ice, algal blooms, waves and sea surface height.

5.1.3 Exchange

Most data in these monitoring programmes are exchanged in different systems and archived in different databases, e.g., ICES-HELCOM, WMO/GTS, Baltic Ice Service, HIROMB, BOOS, GEWEX/Baltex, between institutes, between scientists (BED), and within projects.

Technology for data exchange

Almost no data are today exchanged on paper. WMO-related real-time data are exchanged via the Global Telecommunication System (GTS) which is an efficient method but usually not available for oceanographic institutes. Magnetic tape and CD ROMs are used for secure transfer of data sets but are more and more substituted by the use of Internet. BOOS has established an ftp-box system for data exchange in the Baltic area. Real-time observations made by the participating institutes are currently put into ftp-servers for regular automatic collection by other members. Each member is responsible for the quality and archiving of their own data. Archived data sets can when required be ordered from other members. These data sets are temporarily put on an ftp-server for collection. Meta data formats are presently developed to support interoperability.

5.1.4 Data policies

The uses of exchanged data are regulated by different policies:

WMO Resolution 40 (meteorology and marine meteorology) and 25 (hydrology); free and open exchange of essential data, and data for non-commercial research.

IOC Resolution XXII-6; free and open exchange of data related to IOC projects, and non-commercial research, encouraging free and unrestricted exchange but originators may put conditions on the use.

ICES; data open after five-year moratorium

HELCOM; completely open

EuroGOOS, BOOS; as IOC

Project related; GOOS, WOCE, ….; delivered data are open.

5.2 Study Group on Baltic Sea Productivity Issues in support of the BSRP (SGPROD)

Bärbel Müller-Karulis, Chair of the Study Group on Baltic Sea Productivity Issues in Support of the BSRP (SG PROD) reported on the second meeting of SGPROD.

SGPROD was formed to assist the BSRP productivity module. SGPROD met in Klaipeda from 2–4 December 2004 to discuss the definition of productivity indicators, conduct a comparative analysis of Baltic Sea foodwebs, and review cost-effective methods for productivity monitoring.

Productivity indicators should:

- Have a measurable impact on the next trophic level. (changes in indicator value cause significant measurable change of quantitative parameters on next trophic level);
- Respond to productivity conditions (changes in productivity conditions e.g. nutrient conditions cause significant change in indicator value);
- Response specific for different conditions (the response of the indicator to changes in productivity conditions is specific for certain described conditions);
- Represent key species within a community (characterise changes in abundance or behaviour of key species in the community).

The group agreed that productivity indicators can and should be based on existing, routinely collected monitoring data. Additionally, the group pointed out that attention should be given to measurements that allow estimating primary and secondary production.

Cost-effective productivity monitoring methods discussed at the meeting included:

- Satellite imagery;
- Towed undulating devices.

Satellite imagery can provide information relevant to productivity assessment, especially chlorophyll-*a* distribution, sea surface temperature, surface winds and cloud cover. On the other hand, problems exist with respect to calibration of algorithms for chlorophyll *a* estimation. Remote sensing data characterize only the water surface. While providing a synoptic overview of a marine area, temporal coverage is restricted by cloudiness. Therefore remote sensing information supplements ship-board observations, but cannot replace them.

SGPROD also discussed new technologies to support productivity monitoring. Fast repetition rate fluorometry (FRRF) can produce primary production estimates, which can be calibrated against C^{14} measurements. The group felt, that technologies for measuring primary production should be discussed at a dedicated workshop.

Towed undulators are devices, which are towed from research vessel, undulating between selected depths through the water column. They can carry a variety of sensors, including CTD, oxygen, fluorometer, fast repetition rate fluorometer, PAR, continuous plankton recorder, and potentially also sensors for hydrogen sulfide and analysis packs for nutrients.

Further the group recommended to initiate statistical optimization of the existing HELCOM monitoring program to estimate the effective coverage of the station network and recommend cost-effective sampling strategies.

In the discussion of the report the SG addressed also the new technological development regarding advanced AUV, e.g., Slocum Gliders, which do not require full ship time as, for example, towed instruments.

5.2.1 BSRP Productivity Coordination Centre Activities

The Productivity Module of the BSRP focuses on describing productivity and designing indicators to characterize the lower part of the foodweb, i.e. within the system nutrients – phytoplankton – zooplankton. Following the BSRP Project Implementation Plan, a variety of near shore and open sea activities as well as capacity building and training efforts within the BSRP productivity module have been started during 2004 and are planned for 2005.

Near-shore activities

Phytobenthos monitoring, with integrated pelagic productivity data collection, is planned at selected coastal sites for summer 2005. A preparatory workshop from 6–7 September 2004 in Tallinn served to select study sites and to initiate the analysis of existing data. ECOPATH models constructed during a training workshop from 18–22 October 2004 in Jūrmala increased the understanding of ecosystem processes in each study area.

Open-sea activities

The BSRP is initiating a new ship-of-opportunity (SOOP) line in the Southern Baltic, covering a transect from Gdynia to Karlskrona. SOOP data collection will cover surface layer temperature, salinity, nutrients, and phytoplankton from flow-through measurements. Additional, regular CPR tows will provide information on zooplankton biomass and species composition.

A joint open-sea survey, which integrates productivity data collection into the fishery data collection, is planned in cooperation with the Latvian Fisheries Resource Agency during the hydroaccoustic survey for herring and sprat in May 2005. The survey will investigate the relationship between herring and sprat and lower trophic level components.

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

The Chair of SGEH, Eugeniusz Andrulewicz, presented a brief overview on the SGEH main topics/tasks, which are reflected in SGEH Terms of Reference and justification for ToRs. They can be grouped in two parts: i) Regarding effects of pollution on structure and functioning of marine ecosystem:

- Biological effects of eutrophication;
- Biological effects of harmful substances (contamination);
- Ecosystem effects of fishing;
- Effects of shipping;
- Loss of biological diversity (including loss of habitats and xenodiversity);
- Nature conservation (including protection of species and management of HELCOM Baltic Sea Protected Areas (BSPAs);
- Multiple Marine Environmental Disturbances (MMED).

And, ii) Regarding developing scientific tools for ecosystem-based management:

- Ecological Quality Objectives (EcoQOs);
- Indicators (PSR and DPSIR frameworks);
- Environmental reference conditions.

Until now, SGEH has held two meetings: in Gdynia, 9–12 November 2003 and in Vilnius, 2–5 November 2004. These meetings were open to outside experts and attended by scientists from outside the ICES structures: governmental institutions, NGOs as well as representatives from HELCOM and US EPA. SGEH 3 is planned in November 2005, or in early spring 2006, as a back to back meeting with SGPROD.

SGEH plans to hold an Ecosystem Health Indicator Worksop (Sopot, Poland, 30 March–1 April, 2005). This Workshop will be sponsored by ICES, HELCOM, and UNEP Regional Seas Programme. One of the aims of the Workshop will be to review developments by ICES, HELCOM, OSPAR, EEA and US-EPA. Further, work on developments of EcoQOs, Indicators and Reference Conditions will be carried out in four subgroups:

- Effects of eutrophication;
- Effects of harmful substances;
- Effects o fishing;
- Biodiversity loss.

SGEH is also carrying out activities for capacity building in the New Baltic Countries. These activities include: creating a network of eastern experts, facilitation of participation of Eastern experts at ICES WG/SG meetings, planning and carrying out dedicated studies. The following issues have been selected for this activity:

- Biological Effects of Contaminants (BEC);
- Fish diseases, histopathology, and parasitology;
- Biodiversity (in relation to species, communities, and habitats);
- Marine habitat mapping and classification of biotopes (MHM);
- Nature conservation.

The SGEH Chair stressed the need for modelling in relation to the Baltic Ecosystem Health. As an example of expected developments he mentioned:

- Modelling of structure and function of the Baltic ecosystem and/or its natural subsystems;
- Modelling of anthropogenic pressure on the marine environment in relation to eutrophication, contamination and fishery;
- Modelling of environmental impact of various technical activities: new constructions, dredge spoils, beach nourishment, etc.);
- Modelling of scenarios of different management measures.

These areas should be a subject for closer cooperation between SGBEM and SGEH.

5.4 Working Group on Modelling of Physical/Biological Interactions (WGPBI)

Several members of the Study Group are also members of the parent ICES WG on Physical Biological Interaction. This opens the possibility to interact with a wider community outside the Baltic, however, this WG has decided to look mainly at the lower part of the foodweb up to the level of zooplankton.

6 Results and Recommendations

The meeting brought together modellers working on biogeochemical models and stock assessment fish and fishery models, i.e., at different trophic levels of the marine foodweb, to discuss their approaches.

Two types of models were considered:

- Coupled physical-chemical-biological models, which provide consistent descriptions of bottom up effects and included nutrient and oxygen dynamics, but which see the action of fish in terms of prescribed mortality rates.
- Fish stock models without spatial resolution that see lower trophic levels in terms of prescribed prey biomass, or implicitly through data from surveys or landing reports.

The development of model systems which cover the foodweb (nutrients to fish) is a grand challenge but seems to become feasible in the coming next years. The SG discussed theoretical difficulties associated with the problem of incorporating fish in spatially resolved model system.

Although such models become rather complex, they can be considered as a theoretical pillar for ecosystem based advice.

7 Workplan

The future work of the Study Group will focus on:

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

h) 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.

i) 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.

j) Discuss and initiate attempts to bridge the gap between fish stock models and ecosystem models for the Baltic (prepared intersessionally),.

k) Report on spatial distribution of fish (prepared intersessionally),

l) Establish contacts to relevant projects, such as the German GLOBEC and the WGMAS.

m) Provide input and specific contributions to the Theme Session on Regional Integrated Assessments in 2006.

Justification:

(a) Several model systems were developed and are used in the Baltic. Comparison of the structure and properties of the models, including new developments outside the Baltic helps to ensure that best knowledge and most advanced systems are applied.

(b) Although the Baltic is known as an intensely observed sea, observational undersampling of chemical biological state variables requires improvements of observational techniques. New opportunities may arise through the BSRP. Models can provide abundant simulation data, which are available in terms of products, such as gridded data sets or animated pictures. The bi-directional exchange of data can be used to optimise observational monitoring programmes.

(c) Attempts to quantify bottom up and top down fluxes of nutrients through the foodweb up to the trophic level of fish were published in recent year. A discussion of the current knowledge and indication of gaps is important to better understand the whole system. This ToR was addressed in the second meeting and needs to be reconsidered, because the responsible scientist could not attend the first two meetings.

(d) An important challenge in the modelling of the marine foodweb is to bridge the gap between lower and higher trophic levels. Theoretical studies on future model generations that include fish in terms of state variables are initiated by the SG.

(e) A key issue in three dimensional modelling of fish distribution is a general description of spatial distribution and a quantitative understanding of the relevant processes which control the distribution patterns and their changes with time.

(f) The SG is aware of relevant research activities, in particular the German GLOBEC the WGMAS. A close cooperation will be ensured by the members of the SG which are involved in the relevant projects.

(g) An important final product of the SG is a significant contribution to the 'Theme Session on Regional Integrated Assessments' which is planned in 2006.

Deliverables

A tentative list of contributions to the 'Theme Session on Regional Integrated Assessments' talks was considered:

- The state of the art of modelling the Baltic ecosystems;
- Integration of data set and model products;
- Approaches to connect lower and higher trophic levels in three dimensional ecosystem models.

The final list needs further discussion and will be finalised at the next meeting.

Membership

Membership issues were briefly discussed. There was general agreement that the expertise of the members of the group basically covers the relevant trophic levels of the Baltic ecosystem in relation to the tasks of the SG.

Next meeting

The Finnish participant offered to host the next meeting in Helsinki, Finland. The meeting will be in end of March or early April in 2006 to ensure a back to back meeting with the SGGIB.

Closing

The Chair closed the meeting at 16 February at 12.00.

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Annex 2: Action Plan Progress Review 2005

Year	Committee Acronym	Committee name	Expert Group	Reference to other committees	Expert Group report (ICES Code)	Resolution No.		
2004/2005	BCC	Baltic Committee	SGBEM		2005:\H:XX	XHXX		
Action Plan	Action Required	ToR's	ToR	Satisfactory Progress	No Progress	Unsatisfactory Progress	Output (link to relevant report)	Comments (e.g., delays, problems, other types of progress, needs, etc.
No.	Text	Text	Ref. (a, b, c)	S	0	U	Report code and section	Text
1.2	Increase knowledge with respect to the functioning of marine ecosystems. This will be achieved through continued basic research on the biological, chemical, and physical processes of marine ecosystems and specific activities directed at improved understanding of observed and potential variability in the marine environment due to physical forcing and biological interactions. [MHC/OCC/LRC/RMC/BCC/DFC].* Particular planned activities include the following:	Report on and synthesize existing community models for the Baltic ecosystems and new developments also in the Baltic, and other areas through cooperation with and active participation in the WGPBI	a)	S				
1.5	Increase knowledge of the effects of physical forcing, including climate variability, and biological interactions, on recruitment processes of important commercial species. [MHC/OCC/RMC/LRC/MARC/BCC/DFC]*	Report on and synthesize existing community models for the Baltic ecosystems and new developments also in the Baltic, and other areas through cooperation with and active participation in the WGPBI	a)	S				
5.6	Collaborate with and support the Baltic Global Environmental Fund Project for the Baltic Large Marine Ecosystem, and related projects from other areas such as NATO, IMO, etc. to develop integrated approaches for specific sea areas. [BCC]	Report on and synthesize existing community models for the Baltic ecosystems and new developments also in the Baltic, and other areas through cooperation with and active participation in the WGPBI	a)	S				
1.3	Increase knowledge of the effects of physical forcing, including climate variability, and biological interactions, on recruitment processes of important commercial species. [MHC/OCC/RMC/LRC/MARC/BCC/DFC]*	Identify data sets of high priority for modelling issues and ensure a bi-directional exchange of information with the other ICES-BSRP study groups;	b)	S				
1.5	Develop and apply biophysical modelling, and improve capacity in such modelling to cover biological–physical interactions in the sea. [LRC/OCC/BCC/MHC/DFC]*	Identify data sets of high priority for modelling issues and ensure a bi-directional exchange of information with the other ICES-BSRP study groups;	b)	S				
1.12	1.12 Address the substantial need for improved data and information on components of the marine ecosystem in the Baltic Sea including: 1.12.1. Meteorological and oceanographic conditions (exchange processes, input to the Baltic); 1.12.2 Nutrient productivity and toxic blooms; 1.12.3 Evaluation of the biomass and production of the main prey of intensively exploited fish stocks; 1.12.4 Evaluation of the condition of seabirds and marine mammals; 1.12.5 Improved application of technology to surveys and monitoring; 1.12.6 Evaluation of the state of the Baltic Sea ecosystem. [BCC/OCC/LRC/RMC/MHC/FTC/DFC]	Identify data sets of high priority for modelling issues and ensure a bi-directional exchange of information with the other ICES-BSRP study groups;	b)	S				
5.6	Collaborate with and support the Baltic Global Environmental Fund Project for the Baltic Large Marine Ecosystem, and related projects from other areas such as NATO, IMO, etc. to develop integrated approaches for specific sea areas. [BCC]	identify data sets of high priority for modelling issues and ensure a bi-directional exchange of information with the other ICES-BSRP study groups;	b)	S				

(Action Plan Progress Review. Continued).

1.5.	Increase knowledge of the effects of physical forcing, including climate variability, and biological interactions, on recruitment processes of important commercial species. [MHC/OCC/RMC/LRC/MARC/BCC/DFC]*	Report on and synthesize knowledge of the effects of fish acting down the food web to nutrients, and to which extent variations in nutrients may act up the food web to fish;	c)			U		Withdrawn participation of responsible member
5.6	Collaborate with and support the Baltic Global Environmental Fund Project for the Baltic Large Marine Ecosystem, and related projects from other areas such as NATO, IMO, etc. to develop integrated approaches for specific sea areas. [BCC]	Report on and synthesize knowledge of the effects of fish acting down the food web to nutrients, and to which extent variations in nutrients may act up the food web to fish;	c)			U		Withdrawn participation of responsible member
1.5	Increase knowledge of the effects of physical forcing, including climate variability, and biological interactions, on recruitment processes of important commercial species. [MHC/OCC/RMC/LRC/MARC/BCC/DFC]*	Discuss and initiate attempts to bridge the gap between fish stock models and ecosystem models for the Baltic.	d)	S				
5.6	Collaborate with and support the Baltic Global Environmental Fund Project for the Baltic Large Marine Ecosystem, and related projects from other areas such as NATO, IMO, etc. to develop integrated approaches for specific sea areas. [BCC]	Discuss and initiate attempts to bridge the gap between fish stock models and ecosystem models for the Baltic.	d)	S				
1.5	Increase knowledge of the effects of physical forcing, including climate variability, and biological interactions, on recruitment processes of important commercial species. [MHC/OCC/RMC/LRC/MARC/BCC/DFC]*	Provide input and specific contributions to the Theme Session on Regional Integrated Assessments in 2006	e)	S				
5.6	Collaborate with and support the Baltic Global Environmental Fund Project for the Baltic Large Marine Ecosystem, and related projects from other areas such as NATO, IMO, etc. to develop integrated approaches for specific sea areas. [BCC]	Provide input and specific contributions to the Theme Session on Regional Integrated Assessments in 2006	e)	S				
1.5	Increase knowledge of the effects of physical forcing, including climate variability, and biological interactions, on recruitment processes of important commercial species. [MHC/OCC/RMC/LRC/MARC/BCC/DFC]*	To plan its next meeting as a joint or overlapping meeting with at least one other Baltic SG (e. g., SGGIB, SGEH) in order to promote the development of integrated ecosystem knowledge and the integration of work across expert groups.	f)	S				
5.6	Collaborate with and support the Baltic Global Environmental Fund Project for the Baltic Large Marine Ecosystem, and related projects from other areas such as NATO, IMO, etc. to develop integrated approaches for specific sea areas. [BCC]	To plan its next meeting as a joint or overlapping meeting with at least one other Baltic SG (e. g., SGGIB, SGEH) in order to promote the development of integrated ecosystem knowledge and the integration of work across expert groups.	f)	S				

Annex 3: 2005 Draft Terms of Reference

2HXX The **Study Group on Baltic Ecosystem Model Issues in Support of the BSRP [SGBEM]** (Chair: W. Fennel, Germany) will meet in Helsinki, Finland, from xxx April 2006 to:

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) Discuss and initiate attempts 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) Establish contacts to relevant projects, such as the German GLOBEC and the WGMAS;

g) Provide input and specific contributions to the Theme Session on Regional Integrated Assessments in 2006.

SGBEM will report by xxx 2006 for the attention of the Baltic Committee.

Supporting Information

Priority:	The current activities are part of the BSRP under the umbrella of ICES to issues related to the ecosystem effects of fisheries, especially with regard to the application of the Precautionary Approach. Consequently, these activities are considered to have a very high priority.
Scientific Justification and relation to Action Plan:	1.2 –a 1.3 - b 1.5 - all 1.12 - b 5.6 - all Ecosystem models of the Baltic covering the foodweb from nutrients to zooplankton while the top-down control is truncated and parameterised in terms of mortality. Fishery models ignore widely the bottom-up effects and spatial distribution. Future generation of models can be envisaged which bridge the upper and lower trophic levels. Such approaches need to be encouraged by quantitative studies of bottom up and top-down controls in the foodweb and by discussion of possible modelling approaches. This will also help to identify data types needed for the interaction of observation and modelling. (a) Several model systems were developed and are used in the Baltic. Comparison of the structure and properties of the models, including new developments outside the Baltic helps to ensure that best knowledge and most advanced systems are applied. (b) Although the Baltic is known as an intensely observed sea, observational undersampling of chemical biological state variables requires improvements of observational techniques. New opportunities may arise through the BSRP. Models can provide abundant simulation data, which are available in terms of products, such as gridded data sets or animated pictures. The bi-directional exchange of data can be used to optimise observational monitoring programmes. (c) Attempts to quantify bottom up and top down fluxes of nutrients through the foodweb up to the trophic level of fish were published in recent year. A discussion of the current knowledge and indication of gaps is important to better understand the whole system. This ToR was addressed in the second meeting and needs to be reconsidered, because the responsible scientist could not attend the first two meetings. (d) An important challenge in the modelling of the marine foodweb is to

	bridge the gap between lower and higher trophic levels. Theoretical studies on future model generations that include fish in terms of state variables are initiated by the SG. (e) A key issue in three dimensional modelling of fish distribution is a general description of spatial distribution and a quantitative understanding of the relevant processes which control the distribution patterns and their changes with time. (f) The SG is aware of relevant research activities, in particular the German GLOBEC the WGMAS. A close cooperation will be ensured by the members of the SG which are involved in the relevant projects. (g) An important final product of the SG is a significant contribution to the 'Theme Session on Regional Integrated Assessments' which is planned in 2006.
Resource Requirements:	The BSRP will provide all necessary resources as far as the eastern Baltic countries are concerned.
Participants:	Participants should be scientists primarily, but not exclusively, from the Baltic area, with experience in modelling ecosystems or fish stock dynamics, and scientists with strong interest to interact with modelling. All Baltic Countries must be represented Members of WGPBI who overview similar issues in a more global framework should be involved where appropriate. The Group is normally attended by some 20–25 members and guests
Secretariat facilities:	N/A
Financial:	BSRP covers costs of 5 member/eastern Baltic country
Linkages To Advisory Committees:	ACE
Linkages To other Committees or Groups:	Strong linkage to the WGPBI, SGGIB, and the other BSRP Study Groups
Linkages to other Organisations:	BOOS, EUROGOOS
Secretariat Marginal Cost Share:	BSRP: 100%