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Report of the Study Group on Baltic Fish and Fisheries Issues in the BSRP (SGBFFI)

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1 Introduction

1.1 Participants

The Study Group on Fish and Fishery Issues in the BSRP (SGFFB) was formed to guide the Fish and Fishery module in the Baltic Sea Regional Project (BSRP). The first meeting took place 3–5 February 2004 in Riga. There were 19 participants from Denmark, Estonia, Finland, Germany, Latvia, Lithuania, Poland and Sweden. The list of participants is included in Annex 1.

1.2 Terms of Reference

The meeting address the following terms of reference:

a) review existing knowledge on environmental processes affecting fish stock dynamics in both the open sea and coastal areas of the Baltic;

b) determine those oceanographic processes and their temporal and spatial variability in the Baltic that influence the distribution and productivity of the fish, including consideration of open sea-coastal interactions;

c) suggest ways to integrate the above mentioned processes into enhanced assessment models for commercial fish stocks and new models of coastal fish community structure (in collaboration with SGMAB)

d) prepare a workplan, including a schedule for deliverables, in cooperation with the other BSRP Groups, including considerations of potential contribution to the 2006 Theme Session on Regional Integrated Assessment.

1.3 Overview of Baltic Sea regional Project in relation to fishery issue

Andris Andrushaitis, Component 1 assistant coordinator introduced the goals of the BSRP, which is part of a series of GEF funded Large Marine Ecosystem projects. The BSRP aims to:

- Develop and apply an ecosystem-based management strategy to the Baltic;Facilitate strengthening of regional institutions through capacity building efforts;Inform and engage stakeholders and decision-makers on the project approach and objectives;Assess and evaluate the socio-economic effects of the ecosystem-based management for farming, fishing and coastal communities.

First ideas for the project were discussed already in 1995, and GEF funding for the project was applied for in 1998 and approved by GEF in 2001. After the presentation of the final project documentation, the project won ultimate approval by GEF and the World Bank on 25 February 2003 and with the signing of a grant agreement between HELCOM and the World Bank the first phase of the project implementation started on 17 March 2003.

The BSRP is organized in four components – Large Marine Ecosystem Activities (Component 1, managed by ICES), Land and Coastal Management Activities (Component 2, managed by HELCOM and the Swedish University of Agricultural Sciences), Institutional Strengthening and Regional Capacity Building (Component 3, supervised by the ICES Baltic Sea Steering Group and supervised by the HELCOM Project Implementation Team), and Project Management (Component 4, managed by the Project Implementation Team and the Baltic Sea Steering Group). Component one consists of five modules (fisheries, ecosystem health, productivity, socio-economy, and a GIS data center) each corresponding to a coordination center, and several lead laboratories (Fig. 1). The total budget of the BSRP Component 1 for the period 2003–2005 is 7.5 Mio USD, of which 2.76 Mio USD will be contributed as cash, the remainder constitutes in-kind contributions of ship-time, equipment and work-time.

ICES began the implementation of the Large Marine Ecosystem Activities with the formation of a Planning Group on the Implementation of the Baltic Sea Regional Project and the formation of four study groups to support the BSRP (Study Group on Baltic Fish and Fisheries Issues in the BSRP [SGBFF], Study Group on Baltic Sea Productivity Issues in support of the BSRP [SGPROD], Study Group on Baltic Ecosystem Health Issues in support of the BSRP [SGEH], Study Group on Baltic Ecosystem Model Issues in support of the BSRP [SGBEM]).

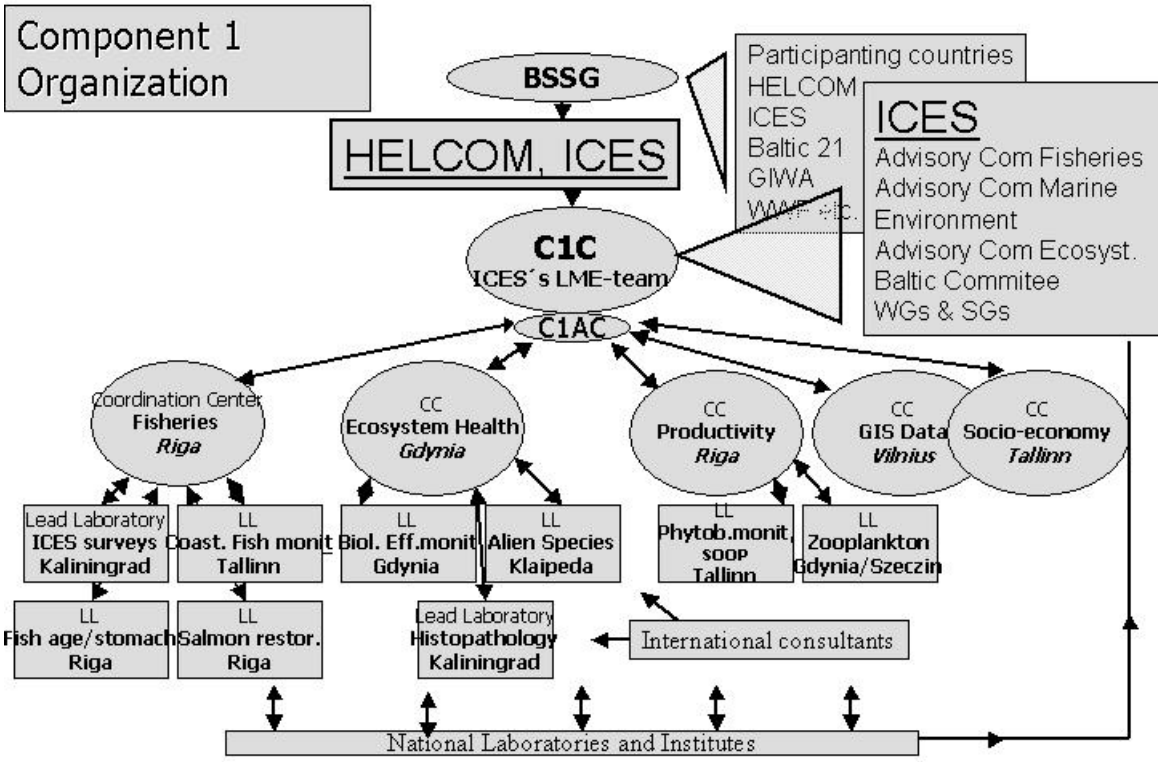

Figure 1. Organization of the Large Marine Ecosystem Activities (Component 1) in the BSRP.

The following priority issues of Fish and Fisheries module in the BSRP is set:

i) Improvement of the assessment and management scheme for main commercial demersal and pelagic fish stocks in the Baltic;

ii) Improvement and implementation of the assessment and management measures for sustainable exploitation of coastal fish resources;

iii) Implementation of IBSFC Salmon Action Plan 1997–2010;

iv) Evaluation of the impact of fisheries upon the ecosystems of the Baltic Sea

2 Present knowledge on environmental processes affecting fish stock dynamics

2.1 Fish stock dynamics in the open sea

Herring

Both open-sea herring and gulf herring populations inhabit the Baltic Sea. The gulf herrings spend all year in the big gulfs, while open sea stocks perform annual migrations between spawning grounds and feeding/wintering areas, located in the Baltic Proper. However, both herring groups spawn in coastal zone. There are indications that the reproductive success of herring essentially depends on conditions of spawning grounds (e.g., on composition and coverage of macrophytes). Thus, spawning success on different spawning grounds is usually different. In 1980s it has been stated for several regions of the Baltic Sea that pollution has decreased the areas of the spawning grounds and increased the mortality of eggs during embryonal development. Unfortunately the knowledge of the present conditions on the spawning grounds in the Baltic Proper is poor.

Despite of rather wide distribution of spawning grounds along the Baltic coasts, the annual spatial and temporal pattern of spawning of different herring populations is driven by the environmental conditions, particularly water temperature pattern in previous winter and spring as well as by wind activity during the spawning season.

In general, the concentration of spawning on the short time period can yield in poor recruitment, while the prolonged spawning season seems to favor the survival of herring larvae.

A positive correlation between the biomass of meso-zooplankton and the year-class abundance (1982–1991) was detected for spring spawning herring from Gdansk Basin (Grygiel, 1999)

Also, there are indications, that the herring year-class abundance in the period 1976–1991 was lower in the years when the water temperature in the layer 0–20 m. in the coastal zone in April–May was higher and the salinity was lower than long term average (Grygiel, 1999).

The SSB of the local population of the open sea herring in NE Baltic gradually increased from the 1940s to the mid-1950s to decrease again during the following stagnation period up to the early 1960s. Thereafter its SSB substantially grew and remained on a high level during the intense influxes of saline water from the North Sea and some years after, up to the second half of the 1980s. In the period of extending stagnation the SSB of this population rapidly sank. The SSB of the population of the Gulf of Riga has increased in the periods of domination of western winds, mild winters and warm springs. The dynamics of SSB of spring spawning herring of the Gulf of Finland differs clearly from the former populations reflecting both the influence of environmental conditions and exploitation pattern in its area.

The probable background of these differences lays in the conditions of formation of the abundance of year-classes in various herring local populations. It has been stated that in the populations with their spawning grounds at the open sea coasts, abundant generations appear in the periods of higher salinity and intense water exchange between the Baltic and the North Sea favouring vertical mixing of water layers and up-mixing of nutrients to support high biological production and abundant stock of copepod *nauplii* in herring spawning and larval retention areas in the period of transfer of herring larvae to exogenous feeding. In the populations of gulf herring, (e.g., the Gulf of Riga herring), spawning in the gulfs, strong year-classes are formed mainly in warm springs with dominating westerly winds promoting rich biological production in the period of larval development and favouring their high survival (Rannak, 1971; Ojaveer, 1988; Raid, 1997; Grygiel, 1999). Therefore, present differences in the herring stock abundance between various parts of the Baltic Sea cannot be taken as a constant phenomenon that is characteristic for this sea. The present situation is an extreme one reflecting the recent abnormally long stagnation period in the Baltic Sea.

Growth changes of pelagic fish species (herring, sprat)

One of the most prominent trends in Baltic commercial fish species is the drastic change in growth of herring and sprat (Cardinale & Arrhenius, 2000; 2002). For herring this decrease was observed in almost all age groups and in all open areas of the Central Baltic, with the exception of the most northerly. The low WAA has dramatic effects on the biomass and further on the catches of herring. Additionally the poor condition of the fish (i.e., low fat content) has important implications on the marketing for human consumption (Raid & Lankov, 1995).

Generally 3 different hypotheses have been put forward to explain the decrease in WAA of Baltic herring, which involve (i) a reduction in selective predation of cod on smaller herring (Sparholt and Jensen, 1992; Beyer and Lassen, 1994), (ii) an influx of slow-growing individuals from the northern areas (ICES, 1997a, b), and (iii) a real decrease in growth rates due to changes in stock size and feeding environment.

The latter hypothesis has been addressed by Flinkman *et al*. (1998) showing changes in WAA in the Northern Baltic to be related to the mesozooplankton species composition. For the Central Baltic Horbowy (1997) modelled growth of herring in relation to the biomass of *Mysis mixta*. Similarly Szypula *et al*. (1997) stressed the importance of the macrozooplankton fraction in the diet of planktivores. A number of studies indicate the outstanding importance of the copepod *Pseudocalanus* for nutrition of Baltic herring (Davidyuk *et al*., 1992; Naglis and Sidrevics, 1993; Davidyuka, 1996; Möllmann *et al*., 2003a). The copepod is during stagnation periods under considerable environmental stress and consequently the abundance and biomass drastically decreased during the recent 2 decades (Möllmann *et al*., 2003b).

Cod and sprat

Recruitment and stock dynamics of Central Baltic cod and sprat have been extensively studied during the EU-funded projects **CORE** "*Mechanisms influencing long term trends in reproductive success of Baltic cod: Implications for fisheries management*", and **STORE** "*Environmental and fisheries influences on fish stock recruitment in the Baltic Sea*", using international collaboration with all countries bordering the Baltic Sea (STORE 2003). A summary of the main results is given below. An elaborated description of the stock dynamics is given in Köster *et al*. (2003a).

One of the basic assumptions in today's fisheries management, that spawning stock biomass is a reliable measure of viable egg production, was found to be invalid for both cod and sprat in the Baltic. The reproductive potential of the stocks depends on the size/age structure of the population, sex ratios, sex specific maturation processes and individual egg production in dependence of age specific mortality caused by the fishery, food availability and hydrographic conditions. In contrast, an impact of contamination with toxic substances on the reproductive potential could not be verified.

In the Central Baltic hydrographic conditions are the main determinant for early life stage survival. While salinity and oxygen concentration, depending mainly on the magnitude of inflows of saline, oxygenated water from the western Baltic and the North Sea affect cod egg survival, sprat egg survival depends on temperature conditions in intermediate water layers and thus on the severity of the winter preceding the spawning season (Köster *et al*. 2003a).

For cod, a review of the compiled time series of potential and realised egg production, egg abundance, reproductive volume, modelled oxygen related egg survival, late egg stage production, larval abundance and recruitment at age 0 revealed discrepancies between modelled and observed egg survival in eastern spawning areas, i.e., the Gdansk Deep and the Gotland Basin (Köster *et al*. 2001). Although hydrographic conditions were mostly unfavourable, regularly surviving egg production and larvae were encountered in ichthyoplankton surveys. A high egg

production and high modelled egg survival in the Bornholm Basin after the major Baltic inflow in 1993 did not result in increased larval abundance indicating high early larvae mortality, explainable by limited food availability for first feeding larvae. In general variability in modelled oxygen related egg survival was in good agreement with observed survival rates, however, the former being approximately three times higher than the latter indicating other sources of egg mortality.

Predation by sprat and herring was found to be an important process affecting egg survival of both species in the Bornholm Basin, being the only successful spawning area for cod since the mid 1980's (Köster and Möllmann 2000). Predation pressure is considerably lower in other deep Baltic basins, being successfully utilised by sprat as spawning areas. Predation pressure was found to be linearly related to cod egg abundance if the vertical overlap between predator and prey is considered. As the dwelling depth of sprat and herring during their daily feeding period depends on the oxygen concentration in the bottom water and the floating depth of cod eggs depends mainly on salinity, the main hydrographic factors directly affecting cod egg survival are also forcing egg predation mortality (Köster *et al*. 2003b).

Investigating the food availability on growth and survival of cod larvae with a coupled hydro/trophodynamic individual based model revealed a food limitation of first feeding cod larvae since the early 1990's caused by a decline in the abundance of the calanoid copepod Pseudocalanus elongatus (Hinrichsen *et al*. 2002). The decline of P. elongatus is coupled to decreasing salinities in the Central Baltic and thus also dependent on large scale atmospheric forcing conditions affecting the hydrography of the Central Baltic (Möllmann *et al*. 2003). The model output has been validated by independent survival estimates from late egg production to the 0-group stage, but has scope for considerable improvement in different process formulations as well as extension to other life stages.

Juvenile cod suffer from cannibalism and as in other cod stocks the intensity of cannibalism is related to predator abundance, but also to the juvenile concentrations and spatial overlap of predator and prey depend on hydrographic conditions. Nursery areas of cod have been identified by the International Bottom Trawl Survey along the southern Swedish and Polish coast, which could be confirmed by hydrodynamic modelling. These particle tracking exercises indicated besides inter-annual variability in transport depending on the wind forcing, a shift in transport regimes between the 1980's and the 1990's with enhanced transport to southern nursery areas during the latter decade (Hinrichsen *et al*. 2003).

In summary, the decline of the Baltic cod stock was caused by a continued high fishing pressure and a concurrent recruitment failure, which was mainly driven by: i) anoxic conditions in deep water layers of spawning sites causing high egg mortalities, ii) high egg predation by clupeid predators in the only productive spawning area, iii) reduced larval survival due to the decrease in abundance of the main food item *P. elongatus*, and iv) high juvenile cannibalism at high stock size. The intensity and significance of all these processes are in one way or the other steered by the hydrographic conditions, which were in the 1990s characterized by low salinity due to a lack of inflow of highly saline water and increased run off, but as well by warmer thermal conditions.

The decline of the cod stock released sprat from predation pressure, which in combination with high reproductive success, due to in general favourable temperature conditions enhancing egg and larval survival, resulted in exceptionally high sprat stock sizes in the 1990s. As a result of these processes, the dominance of one of either predator may stabilize a cod-dominated or a sprat-dominated system. Destabilization of the sprat dominated system may be caused either by unfavourable hydrographic conditions for reproduction, e.g., low water temperatures in spring following severe winters and subsequent recruitment failures of sprat, or high mortalities caused by the fishery, with concurrent low fishing pressure on cod and the presence of North Sea inflow events in the deep layer.

Utilising the compiled data series and gained process understanding, relatively simple spatially explicit and environmentally sensitive stock recruitment relationships have been established (Köster *et al*. 2003b). The models explain a considerable part of the variance encountered in cod recruitment, but less in sprat. Established recruitment models were utilised in short- and medium- to long-term predictions of stock and catch development. Scenario predictions using these models demonstrate that incorporation of environmental variability significantly alters the perception of future stock development assuming specific fisheries management actions. Similarly, biological reference points are sensitive to environmental changes affecting growth, maturation, egg production and survival of early and juvenile life stages.

2.2 Fish stock dynamic in the coastal zone

Distribution of fishes of local importance is mostly confined to near-shore areas. Research and management of these stocks are national responsibility and only a few international joint efforts in this regard have been undertaken (e.g., Thoresson *et al*. 1997, Adjers *et al*. 2000). Therefore, the level of research and, thus, quality of the scientific advice for management vary between the Baltic countries. However, coastal fishery serves in several areas as a livelihood for a much larger number of fishermen and associated people than the open-sea fisheries. Therefore, regional socio-economic aspect is very often more important in coastal than in open-sea fisheries.

Coastal ecosystems are the first recipients of various land-based autochthonous substances. Other important human activities affecting directly or indirectly fish stocks are maritime traffic, various activities in port areas and tourism. Their influence is especially strong in coastal areas. This poses an additional stress for coastal ecosystems and their components, and may increase the risk of commercial fish stock decline if adequate management decisions are not implemented.

2.2.1 Environmental effects on coastal fish: natural causes

Changes in the essential indicators of the marine abiotic environment (temperature and salinity), governed partly by climate dynamics, have been shown to exert significant influence upon population dynamics of several fish species and their prey items in the Baltic Sea (e.g., Ranta and Vuorinen 1990, Viitasalo *et al*. 1995, Laine *et al*. 1997, Ojaveer 1998, Tunberg and Nelson 1998).

Abundance and recruitment of fish populations

The atmospheric winter circulation over the North Atlantic could be characterised by two modes of the North Atlantic Oscillation (NAO), which has been considered as the dominant mode of climatic variability in this region, describing the difference in sea level air pressure between the Icelandic Low in the north and the Azores High in the south. NAO +: low sea level pressure in Iceland, strong meridional pressure gradients over the North Atlantic and intensified westerlies. This situation is accompanied by the inflow of cold air masses from Alaska/Greenland, which are heated over the ocean. As a result, intensified westerly winds transport air masses of moderate temperature towards Europe and form mild winters there. The opposite situation is NAO –: westerly winds of minor importance, the inflow of cold Greenland/Alaska water masses is reduced and the inflow of Siberian air masses into Eastern Europe intensifies. As a result, severe winters occur in Europe (Rogers 1984, Alheit and Hagen 1997). Relationship between the NAO index and Bohuslän herring, *Clupea harengus*, periods was recently studied by Alheit and Hagen (1997). Records of the herring fishery off the Swedish west coast of Bohuslän in the Skagerrak date back to the 10th century. Nine periods, each lasting several decades, have been identified during which large amounts of herring were caught close to the shore. The study showed a close connection between these: periods of high landings coincided with negative anomalies of the NAO index. Therefore, it was concluded that climate variation governed the alternating herring periods. However, the mechanism remains unclear.

As a result of the adaptation to heterogeneous environment of the Baltic Sea, herring has developed several populations for both spring and autumn spawners. Spring-spawning herring could be divided into two major groups: populations spawning in deeper areas have developed abundant year-classes in the periods of low river runoff when the intensity of inflows through the Danish Straits is high (Rannak 1974, Ojaveer 1998). Populations spawning in coastal areas have rich year-classes during the periods of Atlantic type atmospheric circulation (mainly westerly and southerly winds) in winter enabling upmixing of biogenes into the coastal zone (but not beneath the halocline), which is usually accompanied by rich river discharges that bring biogenes to herring spawning areas. The year-class abundance correlated with air temperatures in January–May, surface water temperature in April and the strength of westerly winds in January–March. Also, a good correlation between the herring year-class abundance in the Gulf of Riga and the food supply – *nauplii* of copepods – has been recorded. In years when cod is abundant in the open Baltic and enters the Gulf of Riga, herring recruitment could be significantly influenced by predation (Rannak and Simm 1979, Kornilovs 1995, Ojaveer 1998 and references therein). The most important factor limiting the abundance of autumn-spawning herring year-classes is temperature and the type of air circulation (direction of winds) during the first year: the milder the winter the more abundant will be the year-class. The year-class abundance correlated also with the intensity of westerly winds during herring spawning and early larval period, i.e., August–September (Ojaveer 1998).

Of the coastal species, perch and pikeperch have been investigated. Böhling *et al*. (1991) studied variations in the year-class strength of 23 perch populations over the Baltic Sea. It was found that variations in the year-class strength of perch were similar in populations over a large area and attributed to large-scale weather variations influencing the water temperature. Year-class strength correlated with an index based on temperature and day length during the whole first year of life. The deviating areas were exposed to environmental disturbances (such as acidification, oxygen deficit, pulp mill effluents and thermal discharge) or situated in small near-shore fresh waters where water-level fluctuation probably is of essential importance.

Pikeperch occur mainly in eutrophicated areas where the spring and summer temperatures are high. The long-term dataset from the years of 1959–1992 suggests that amongst abiotic indices, water temperature is probably the most important single factor causing variations in the abundance of 0-group pikeperch and commercial catches of this species in Pärnu Bay. Fish abundance and the cumulative water temperature between August and October inclusive in five consecutive years prior to the recruitment into the commercial fishery explained ca 90% of the variation in catches (Lappalainen *et al*. 1995). Winter mortality of 0-group pikeperch in Pärnu Bay is dependent on the size of the fish. Therefore, growth during the first summer and the length attained in the first autumn are of crucial importance. In addition to abundance, the mean length of 0-group in autumn correlated positively with summer water temperature. Results also suggest that winter mortality may be stronger after a cold summer than after a warm summer whereas longer winters appeared to reduce size-dependent mortality (Lappalainen *et al*. 2000).

Predation by marine mammals

The effects of seal predation on fish are poorly known. However, some calculations made during the 1970s, when abundance of seal populations were low, indicated that although commercially exploited species (mostly clupeids, but also whitefish, cod, eel, smelt, salmon trout (*Salmo trutta*), flounder (*Platichthys flesus*) and others) were important in the diet of seals, the total consumption of fish by seals made only ca 2% of the total fish catch from the Baltic Sea by man in the mid-1970s (Pilats 1989 and references therein). Therefore, at this time, the impact of seals on commercial fish stocks should be considered as minimal. However, a recent increase in seal populations especially in northern

Baltic can substantially cause increase off natural mortality of locally important commercial fish stocks, for example eel (Lunneryd 2001).

Predation by fish-eating birds

The number of cormorants (*Phalacrocorax carbo*) has recently increased in some areas of the north-eastern Baltic Sea. Predation of these fish-eating birds on fish was studied in the Väinameri Archipelago (western coast of Estonia). The total consumption of fish in 1998 amounted to ca. 463 tons, which corresponds to the commercial catch (excl. herring).

The length distribution of roach (*Rutilus rutilus*) and perch consumed was similar to that in experimental fishing whereas pike, pikeperch and turbot were consumed as juveniles (Eschbaum and Veber, in press). It can be concluded that cormorants and fishermen compete for fish resources in this area.

Studies in Kalmarsund area shows that predation by cormorants is of great importance and will reduce the possibilities for the stocks to recover (Saulamo *et al*. 2001).

2.2.2 Environmental effects on fish in coastal zone: human impacts

Eutrophication

Eutrophication has been a major environmental change affecting the water quality both in coastal and open sea areas of the Baltic Sea since middle of the 20th century.

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

Long-time series on the size of coastal fish stocks, their age composition and individual growth rates exist only from very few areas in the Baltic. Fish monitoring has been performed in Kvädöfjärden Bay (Baltic Proper) since the 1960s. A considerable decrease in the Secchi depth has been recorded, indicating that these coastal waters have become more eutrophic. The relations between fish species have changed correspondingly towards a community dominated increasingly by roach and other cyprinids. Individual growth rate of perch has increased during the last decades, but this is more likely an effect of higher temperatures than improved feeding conditions as a result of the increase in primary production. A system of reference area monitoring, COBRA (Cooperation Organ for Baltic Reference Areas) has been developed in a cooperation between Sweden, Finland, Estonia, Latvia and Lithuania. Although this monitoring still does not cover sufficiently long time periods for analysing fish community changes, there are observations in one area in the Archipelago Sea of a similar character as in Kvädöfjärden (Adjers *et al*. 2000). Other studies on fish community, conducted in the Aland Archipelago, demonstrated that an increased productivity in the pelagic and benthic systems could be reflected in the fish biomass. Roach has gained in importance, which may be a consequence of improved recruitment, increased food supply and altered predator regulation (Bonsdorff *et al*. 1996 and references therein).

Eutrophication or eutrophication-like symptoms of ecosystem change are seen in most pulp and paper mill effluent areas except when the discharge is on an open coast. Fish community reactions reveals a shift towards domination of roach, other cyprinids and ruffe (Neuman and Karas 1988, Sandström *et al*. 1991, Sandström 1994, Sandström and Neuman 2001). Discharge of organic substances has been considerably reduced at almost all mills since the 1970s, by internal process changes and an increased secondary effluent treatment in aerated ponds or activated sludge systems. Some mills also have been able to reduce the discharge of plant nutrients, but this is technically more difficult to achieve. The reactions of the fish community are generally positive, and recoveries towards more natural species assemblages have been documented (Sandström and Neuman 2001).

The shifts in species dominance often seen in eutrophic habitats are likely an effect of changes in the quality and size of recruitment areas. This has been studied in a Swedish research project analyzing pike, perch and pikeperch feeding, growth and survival in the field as well as in laboratory experiments. The study demonstrated that the poor visibility in highly eutrophic waters evidently inhibits a normal growth of species within the group of visual feeders, where perch and pike belong. This was demonstrated by field sampling supported by a bioenergetics model and laboratory experiments (Sandström and Karas 2002). Pikeperch feeding behaviour is less sensitive to poor visibility, indicating that this species is better adapted to eutrophic conditions. The importance of substrates such as submersed vegetation for a successful recruitment was also tested. It was found that lack of benthic macrophytes often seen in eutrophic waters may increase the predation risk for young-of-the-year perch (Sandström and Karas 2002).

Fishing activities

Drastic effects of increased fishing activities on coastal commercial fish stocks are seen in several countries in the eastern part of the Baltic Sea. These can be contributed to the free market for fishery products since the early 1990s. The situation has been monitored in the Väinameri Archipelago. In this area, commercial catches of several valuable species have considerably decreased during the last decade. Most drastically, perch (*Perca fluviatilis*) catch in 2000 made up ca 1% of the long-term mean for the period 1961–1999 (Saat and Eschbaum, in press); the downward trend in official commercial catches being confirmed by the decline of the indirect measure of stock abundance (CPUE) in experimental fishing (Adjers *et al*. 2000). The main reason behind the declines of the most important coastal fish stocks and obvious changes in their age composition is too intensive exploitation. Not surprisingly, this has led to substantial changes in the local fish community. Abundance of predatory fish was low during the 1990s and decreased further as a result of removal of large (predatory) perch during the late 1990s. This and partly also favourable environmental

conditions (warm summers, progressing eutrophication) has resulted in a sharp increase in the share of cyprinids in the local fish community, in some areas from <10% during the beginning of the 1990s up to ca 90% in 1998–1999 (Saat and Eschbaum, in press).

Nonindigenous species

World-wide human-mediated spread of nonindigenous aquatic organisms due to both ecological and economic impacts (incl. maritime tourism and fisheries) is one of the recent major concerns, amongst others, of scientists, managers and resource users. Their impacts, which are often unpredictable and irreversible, are seen at all trophic levels of aquatic ecosystems, by involving also substantial changes in food web interactions, modifications of abiotic habitat, alterations in energy flow patterns and transformations in the cycling of contaminants (Leppäkoski *et al*. 2002).

The North American soft-shelled clam *Mya arenaria* is probably the first alien species in the Baltic Sea, unintentionally introduced already by the Vikings. The carp *Cyprinus carpio* is one of the first fish species intentionally introduced into the Baltic Sea for enhancement of commercial fish resources. By the year 2000, 97 nonindigenous species had been recorded in the Baltic Sea, of which fewer than 70 have established reproducing populations. Of the 58 unintentional introductions, 38 are transoceanic, with 19 Atlantic species of American origin and 18 of Ponto-Caspian origin. The dominant invasion vectors include unintentional introductions via ballast water, tank sediments and hull fouling, aquaculture and construction of canals, which have facilitated natural dispersal. Other known vectors include use of contaminated fishing nets and traps, research escapes, recreation and the import of live animals accidentally released into the wild (BMB WG NEMO 2001, Leppäkoski *et al*., in press).

Ecological investigations on alien species in the Baltic Sea started only in the late 1980s – early 1990s with the invasion of the polychaete *Marenzelleria viridis*, the round goby *Neogobius melanostomus* and the predatory cladoceran *Cercopagis pengoi*.

3 Possible ways of integration environmental processes into stock assessments models

3.1 Growth changes of pelagic fish species (sprat, herring)

The SG discussed recent findings of growth changes of Baltic pelagics and concluded that the existing knowledge is not sufficient for a sound incorporation of this possibly environmentally driven process into stock assessment models. The SG clearly identified the need for a deeper understanding of the processes behind the phenomenon, which may additionally vary regionally. The future way to go should be a comparative analysis of the different subareas of the Eastern Baltic (e.g., deep basins vs. Gulfs), thereby using the best available time-series. Ideally these will include length, weight and maturity (at age), meso- and macrozooplankton abundance/biomass as well as hydrographic variables. The SG considered that this exercise will be a main task to be conducted by the *BSRP lead laboratory on age-determination and fish stomach analysis* (Chair: G. Kornilovs).

As a first step a review of the existing knowledge in the literature and an inventory of existing time-series and their accessibility will be conducted. The latter will include the database setup during the EU-project BASYS (Subproject 1b: Processing of historical data). Based on the identified and available time-series the meta-analysis of growth changes in Baltic pelagics will be performed and should finally result in growth models incorporating explanatory variables (e.g., food supply, stock biomass etc.). As a last step developed growth models will be used in stock predictions. This work will be conducted in close cooperation with the new-coming EU-Project BECAUSE, were members of the SG are involved.

3.2 Growth and maturation changes of cod

The variability of adult cod growth has been analyzed in the past by using cod weight-at-age and maturation at age and length based on survey data and fisheries data (Aro *et al*. 2000). The main ephasis in this analysis was given to the periods of low abundance of cod in 1970s, high abundance in early 1980s until early 1990s and low abundance again in late 1990s.

In total time series data from surveys, various data bases for stock assessment and environment monitoring were used (33 variables, 20 years ((1977–1996 (MSVPA, 1982–1997 (surveys)) 3 areas and 4 age groups (age groups). According to analysis (log-linear modelling and ANOVA). the main explanatory variables of changes in weight at age of cod were:

- total sprat biomass (higher sprat biomass increases mean weight at age of cod)
- total prey biomass (higher Baltic herring and sprat biomass increase mean weight at age),
- total cod biomass (higher cod biomass decrease mean weight at age of cod)

- oxygen content in and below halocline (lower oxygen content decrease mean weight at age of cod).

Variables not explaining changes in weight at age very well or not at all were:

- ambient temperatures in feeding areas,
- stomach content of cod
- cod consumption rates
- survey estimates of year class strength
- total year class biomass and abundance

3.3 Improvement of S/R relationships and recruitment of sprat, herring and cod depending from environmental conditions and species interactions

There has been a substantial amount of research directed at understanding the recruitment process of the major exploited fish species in the Baltic. However, this research has not generally been incorporated in the routine stock assessments which are used to provide scientific advice on the management of these fisheries. Part of the reason that existing models of recruitment have not been used in stock assessment is that not all such models are suitable for use in stock projections. As ICES (2002) note, the general problem is that at present very few process studies have been directly undertaken with the intention of input to the assessment and management process. By nature process studies are aimed at understanding what has happened in the past, and hence the models they use are detailed and descriptive, and are often based on multiple-regression-type approaches. These models are not usually suitable for use in projections, partly because of the need to forecast a large number of variables, and partly because of undesirable properties such as the possibility of generating negative recruitment or of generating a finite recruitment at zero stock size. Other drawbacks of these approaches are discussed in ICES (2000). ICES (2002) also note that a suitable approach to developing models for use in projection might involve identifying a small number of major factors, and considering how these might be incorporated in a recruitment model of an appropriate functional form, and how they might be projected forward. Similar considerations also apply to the modelling of environmental influences on growth and maturity for projection purposes.

Cod

The recruitment process of the Eastern Baltic cod stock has been well studied during the CORE and STORE projects. This has resulted in a good understanding in the processes influencing recruitment to the stock, and clearly it is desirable that this information should be used in some way in the provision of fisheries management advice. However, while a number of different models have been applied to describe the recruitment process (e.g., Köster *et al*, 2001; Jarre-Teichman *et al* 2000, Cardinale & Arhenius, 2000), none of these approaches have been used operationally in the routine provision of fisheries management advice. The stock-recruitment model most recently used by the Baltic stock assessment WG is a conventional Ricker stock-recruitment which assumes that recruitment is only dependent upon spawning stock biomass. This model is fitted to data from 1982 onwards, based on the period of reduced recruitment noted by Jarre-Teichmann *et al* 2000. As such this represents a compromise, rather than a full incorporation of the influence of environment on recruitment. Some progress in implementing recruitment process information in projections has been made by Reeves (2003a) based on the key life history stages identified by Köster *et al* (2003), but further development of this approach is required in order to make it usable for routine provision of advice.

Although some progress has been made in developing models of recruitment for the Eastern Baltic cod stock, a major limiting factor is the quality of the existing estimates of recruitment. The problems with correct age determination in this cod stock mean that the recruitment estimates arising from the routine stock assessments are ‘smoothed out’, with the stronger year-classes being under-estimated and weaker year-classes being over-estimated (Bradford, 1991; Reeves, 2003a). This means that the estimates do not capture some of the small scale variation in year-class strength, hence attempts to improve recruitment models based on existing estimates would be of limited value. It may be possible to resolve these problems if historic length composition data can be compiled and then allocated to age using a consistent and validated approach. This to some extent depends on the progress made by SGABC in developing improved approaches to age determination for Baltic cod. However it should be recognised that historic data of all sorts are an important resource for National institutes and that it is desirable to get as much historic data as possible computerised to ensure that they can be made available and can be properly archived. The SG identified three main types of data which are relevant to the current context; Survey data, commercial catch data and otolith weight data.

Survey data exist for years prior to 1991 (since when all survey data have been included in the ICES BITS database) in a number of institutes. Plans have previously been made to add data from Polish and Latvian surveys to the BITS database, but no funding was obtained for this. Such data are potentially an important source of information on maturity and growth, as well as abundance and distribution, and it is desirable that these data added to the BITS database.

Commercial catch data consist of catch length compositions which are then allocated to age on the basis of age-length keys. If the historic catch length compositions were available it would be possible to investigate consistent

approaches to allocating these lengths to age, and thus avoiding the existing problems with inconsistent approaches to age determination. Many of these length composition data are available on paper in the original national data reports supplied to assessment Working Groups and it would be very useful if these could be computerised as a first step towards reconstructing the historic catch data.

Otolith weights could potentially be used in the objective determination of age. Some progress has been made on this for Baltic cod (Cardinale *et al*, 2000) although this approach requires that some otoliths are read, which may not be desirable given the problems associated with this in Baltic cod. Otoliths can also be used to investigate many other aspects of fish biology and life history (e.g., Campana & Thorrold, 2001) so where measurements such as weight and size of otoliths have been routinely recorded it is clearly desirable that these data are computerised and made available for research. Data on otolith weights for cod, covering various time periods, exist in the Danish, Swedish, Latvian and Polish institutes, although only the data in the western instutues are currently computerised.

To summarise, the key areas for future development in relation to the operational implementation of recruitment models for Baltic cod are as follows :

- Further development of existing approaches to incorporating environmental influences on key life history stages in models for stock projections
- Computerisation and archiving of existing historic data from research vessels surveys, commercial catches and otolith weights.

Sprat and herring

At present weight at age of both sprat and herring in the open sea areas of the Baltic are at extremely low levels. There are strong indications the low weight at age is related to a change in the physical environment and feeding conditions, e.g., a shift in copepod species composition with decreasing *Pseudocalanus* and increasing *Acartia* populations, and has strong implications for recruitment success of both species.

For open Sea herring a constant decline in recruitment success since mid 80ties is observed, while the situation in Gulf of Riga somewhat improved during most recent years.

Despite a direct correlation of condition to MSVPA derived recruitment estimates and a coupling of herring condition to sprat stock size indicating food competition, the importance of spawning ground quality and quantity for successful herring reproduction was highlighted by SGBFF. It was suggested to initiate further studies on this topic in the frame of BSRP.

SGBFF considers the available information to improve herring S/R relationships at present not to be sufficient to be incorporated in standard assessments procedures.

Thus, it was suggested to initiate process studies dealing with the coupling of climate regime, spawning ground quality, food availability, growth and recruitment success of herring to improve S/R relationships in way that they become operational in stock assessment models.

Compared to herring, for Baltic sprat the data situation is somewhat different. A number of data sets on environmental influences on early life history and survival of different life stages has become available through ongoing international and national programs (e.g., STORE, GLOBEC). From these data a good knowledge base on critical processes for sprat recruitment is already established. A strong coupling of NAO index and ice/temperature conditions to recruitment of Baltic sprat has been demonstrated by MacKenzie and Köster (2004), Köster *et al*. (2003) were able to improve the S/R relationship presently used in the ICES assessment by WGBFAS by almost 50% incorporating SSB, temperature and growth anomaly. Recent results from the German GLOBEC initiative using SSB, growth and a retention index in the sprat S/R relationship explained 74% of the recruitment in ICES SD 25. However, the understanding of the underlying processes is still limited.

In conclusion, processes driving recruitment success of both species, sprat and herring, are not fully understood, yet. The possibility to work up historic data sets on stock size, age, length, weight, and other key variables related growth and recruitment, which are presently not available to BSRP and ICES WGs, should be investigated and if feasible worked up in the frame of the BSRP.

There is still a strong need to conduct further process studies on sprat and herring recruitment processes. Although the data situation in sprat is somewhat better than for herring, for both species S/R relationships are still not applicable in stock assessments. There is a strong need develop operational, environmentally sensitive S/R relationships.

4 Present state of coastal fish stock assessment

Research and management of coastal fish in the Baltic Sea is of national responsibility and there exist a few coordinated activities until now. Therefore, in order to get general overview on the state of coastal fish stocks, the recent situation on the country basis were compiled.

Denmark
No information available to the group.

Estonia
Experimental gillnet surveys were started in the mid 1990s in several locations in the Gulf of Finland, West-Estonian Archipelago area and the Gulf or Riga. Sampling from commercial catches has been performed in the Gulf of Riga since the 1950 and for selected species (perch, vimba, pikeperch, smelt, whitefish flounder) these studies are continued until now. The routinely measure parameters include length, weight, age, developmental stage of gonads and stomach content (non-systematic and if applicable). Tagging of perch, pikeperch and vimba has been performed. During the experimental bottom trawl surveys in the Gulf of Riga in the 1970–1990s, several coastal fish (incl. non-commercial) were caught and analysed routinely, incl. for stomach content and in the 1990s for parasites. Ichtyoplankton studies have been performed in several stations in the NE Gulf of Riga during the 1950–1990s. In these samples, fish larvae were generally identified to the species level.

Finland
There is a exploratory gillnet fishing program ongoing in co-operation with Swedish Institute of Coastal Research covering sampling areas in the Åland Islands, Archipelago Sea and west part of Gulf of Finland. The main species under monitoring are common marine and freshwater species. This monitoring has been ongoing about ten years.

Commercially important coastal fish species under monitoring are sea-trout, pike-perch, perch, pike and whitefish. Of these more emphasis is given for whitefish, pike-perch and sea-trout. According to EU Sampling Directive these species are covered in minimum and extended programs. Tagging studies have been done on whitefish, pikeperch, salmon and sea trout. On average 60 000 individuals are tagged each year. Population genetic studies have been carried out on all salmonid species.

Germany
No information available to the group.

Latvia
Experimental monitoring of coastal fish species is being carried out in two sites (Daugava estuary and open coast near Ventspils) in July-August period since 1993. Experimental beach seine catches have been carried out for flounder studies (incl. calculation of year-class strength) at Kolka area and SW open coast twice a year since 1995. Fish community structure and stomachs of flounder and turbot have been studied from beach seine catches since 1999 at 2 meters depth. Data of much longer time coverage are obtained from experimental bottom trawl surveys in 15 stations in the Gulf of Riga performed twice a year (May and July–August) since 1975. These surveys were especially designed for eelpout research. Ichtyoplankton surveys that are continued currently are being carried out in several stations in two regions (Gulf of Riga and open coast) since 1998. Introduction of the system of fishermen observers allows routine collection of daily log-book data, incl. bycatch of marine mammals and seabitrds since 1994. Sampling from commercial catches dates for some species back to 1992, but for several anadromous species back to 20-years. Important attention in coastal fish studies in the Gulf of Riga was given for stomach analysis of various fish species, incl. non-commercial fish. Tagging experiments were carried out for flounder (in the 1960s), perch and pikeperch (in the 1990s) and routinely for salmonids since 1970s.

Lithuania
Several commercially important species like pikeperch, bream, vimba, roah, perch and twaite shad are experimentally caught in Curonian lagoon on monthly basis (incl. winter time) since 1993. In the open coastal areas, all commercial species are being sampled twice a month since 1994. The following parameters are being determined: CPUE, length, weight, age, gonad status and stomach content (non-systematically) of the fish. The collected data are mainly used for improvement of national fisheries regulations. Due to changes of recording of commercial catch statistics in 1992, fishing intensity indicators are available since the same time. Fish larval studies are being carried out in Curonian lagoon twice a year (May and July, 10–15 stations) since 1993. Tagging studies have been performed for vimba, perch, pikeperch, trout and turbot. Genetic analysis has been made for pikeperch.

Poland
No continuous monitoring program for coastal fish in place. Non-systematic studies were carried out on a few species like turbot, garfish as well the gear selectivity studies with roach, bream and perch in the 1990s. Performed tagging studies involved salmon, seatrout, eel and whitefish. In addition, genetics on seatrout has been carried out. No systmatic ichthyoplankton surveys performed.

Russia
Despite the Russian delegate was not attending the meeting, some information became available for coastal fish research in Russia. In the southern part of the Curonian lagoon, several species like bream, pikeperch, perch, roach, vimba and smelt are studied for population structure by means of experimental trawling three times a year. In addition, stomachs of main commercial species are also analysed. Coastal fishes are also studied on routine basis in Vistula lagoon. However, detailed information was not available for the group.

Sweden
Exploratory monitoring programmes of coastal fish communities in Sweden cover the whole Baltic coast. The programmes have several purposes the most important ones being the environmental and resource monitoring programmes. Test fishing is carried out by gill netting according to standardised Swedish method, and covers a large part of the coastal fish community. The longest series are about 30 years (outside Oskarshamn). There are also special monitoring programmes for the viviparous blenny, pikeperch and turbot. Commercial sampling of turbot has been performed since 1998, of vendace since 1992, and sampling of perch, pikeperch, pike, whitefish, flounder and eel will be implemented according to EU Sampling Directive in 2004. Larval samplings are carried out in several locations each year. Tagging experiments have been performed for perch, pikeperch, eel, sea trout, turbot and taggings of flounder will be initiated in 2004. Population genetic studies have been done for populations of pikeperch, pike, whitefish and vendace, and genetic analysis of perch, turbot and flounder are in progress.

Activities that should be carried out in coastal areas
Based on discussions on coastal fish sub-group the general opinion was that in order to harmonize the coastal activities it is necessary to carry out following:

1) Sampling of fish for biological analysis from commercial catches;
2) Continuation of experimental gillnet sampling with consideration of covering new areas/countries and locally adapted changes in existing guidelines;
3) Additional sampling by means of experimental catches for selected indices (e.g., recruitment, community composition and diversity);
4) Continuation/initiation of ichthyoplankton surveys in selected locations by application of common methodology;
5) Further studies in coastal fish population structure;
6) Systematic recording of basic environmental background data (e.g., temperature, salinity, oxygen content);
7) Systematic sampling on food resources (planktonic, nectobenthic and demersal) and fish stomachs.

The next step, based on available data and knowledge on coastal fish population structure could be considered establishment of **a Study group for evaluation of suitable assessment methods for coastal fish stocks.** Obviously direct usage of VPA type models (used for open sea species: herring, sprat and cod) will not be applicable or their usage will be problematic for coastal species. Hence, available models must be tested and verified on selected populations.

5 Links to other activities

5.1 SGBFF and EU project "BECAUSE"

E. Aro (Baltic Sea Case study coordinator of EU 6th Framework Programme "Critical Interactions Between Species and their Implications for a Precautionary Fisheries Management in a variable Environment – a modelling approach (BECAUSE)") analysed possible cooperation aspects with SGBFF.

Considerations of environmental factors, both abiotic and biotic, can make quite a big difference to how one might manage Baltic fish stocks. Our current perception of the production potential of Baltic Sea benefits of including environment in fish stock assessment and perception is conditioned by our ability to relate environment to population parameters. The benefits of including environmental signals in stock assessment may extend from short-term to medium-term projections but need to be evaluated in the context of specific stocks. The "BECAUSE"work program for (2004–2007) contain four working packages:

- Development of conceptual food web models and analysis of processes driving critical interactions including environment.
- Prediction of stock trends applying improved multi-species forecast models.
- Improving multispecies assessment models.

- Analysis of fisheries management implications

Comparing the BSRP implementation plan and task allocated to SGBFF, there are some parallel, but not overlapping activities in SGBFFI and BECAUSE. For example a compilation of time series of spatial distribution of key predator and prey fish species and other food in relation to environmental parameters is formulated in both programs as well as time series data on growth in length and weight of key fish species.

SGBFF has planned and is able to supply time series data on other food species for cod (i.e., Saduria, Harmothoë, Mysidae etc.), and this is very welcomed by BECAUSE. However, in SGBFF more emphasis has been given for coastal-open sea interactions and BECAUSE will certainly benefit of this kind of analysis. SGBFF will also benefit of the formulation and development of quantitative conceptual (spatially dis-aggregated) food web models and spatial distribution and migration process models, which take into account environmental variability produced by BECAUSE.

5.2 SGBFF and SGMAB

E. Aro, co-Chair of *Study Group on Multispecies Assessment in the Baltic (SGMAB)* summarised possible cooperation aspects of both study groups. It was concluded that SGMAB will benefit from SGBFF work on reviewing existing knowledge on environmental processes affecting fish stock dynamics in both the open sea and coastal areas of the Baltic and SGMAB needs also additional information related to the incorporation of environmental variability and spatial heterogeneity in fish stock modelling.

Its terms of reference are specifically part of the Implementation plan for Component 1 of the BSRP. At this stage a joint meeting day is planned for 2005 for SGBFF and SGMAB at the end of February or at the beginning of March to integrate their findings. SGBFF has planned and is able to supply time series data on other food species for cod (i.e., *Saduria, Harmothoë, Mysidae* etc.), and this is very welcomed by SGMAB.

5.3 SGBFF and SGPROD

Bärbel Müller-Karulis, Chair of the *Study Group on Baltic Sea Productivity Issues in support of the BSRP (SG PROD)* and LPM of the Productivity Coordination center introduced the goals of the productivity module in the BSRP and the results of the SG PROD meeting October 29 – 31, 2003. The productivity module in the BSRP aims to improve the use of productivity indicators to assess eutrophication in the Baltic Sea, focusing mainly on the lower part of the food-web, but taking into account also interactions with higher trophic levels.

SG PROD prepared the work of the BSRP productivity module by reviewing the literature on eutrophication effects in the Baltic Sea, describing the current use of productivity data, and drafting a preliminary set of eutrophication indicators to be used in the BSRP. SG PROD also reviewed the feasibility of expanding the SOOP network in the Baltic Sea and the use of continuous plankton recorders to improve zooplankton measurements.

The BSRP Project Implementation Plan suggests the use of synergy effects between fishery and productivity monitoring by collecting productivity data during fishery surveys. SG PROD identified the May hydroaccoustic survey as the most perspective fishery survey for productivity indicator assessment and asked SG BFF to comment on the common survey concept. In order to maximize interactions with the productivity module, SG BFF should also identify lower trophic level and abiotic supporting parameters, which could improve fish stock assessment.

5.4 SGBFF and SGBEM

C. Möllmann summarized the first meeting of the *Study Group on Baltic Ecosystem Model Issues in support of the BSRP* [SGBEM] (Chair: Wolfgang Fennel, Germany), which took place in Warnemünde, Germany from 12–14 January 2004.

According to the Terms of references, the group reviewed the (i) the scientific basis of ecosystem and fishery models of the Baltic and explored possible connections of them in future generations of Baltic Sea models. This was mainly done by presentations of the participant on various models ranging from primary production to fish stock assessment models. (ii) Further needs for data to initialise and validate models and identify gaps in process descriptions were discussed. The group identified the gap between present state-of-the art ecosystem models and models of fish stock dynamics as a major challenge and thus recommended “spatially- and temporally resolved data on fish distribution, both zooplanktivores and piscivores” as well as “stomach contents and prey selectivity” to describe the predator field for different models. Finally the group (iii) started to prepare a work-plan, including a schedule for deliverables, in cooperation with the other BSRP Groups and including considerations of potential contributions to a Theme Session on Regional Integrated Assessments in 2006.

5.5 German GLOBEC

Introduction GLOBEC-GERMANY

The status of the GLOBEC-programme was presented by G. Kraus. GLOBEC-programme (www.globec-germany.de), presently conducted in Germany under the umbrella of the IGBP core programme (www.globec.org), was introduced. The project called *Trophic Interactions between Zooplankton and Fish under the Influence of Physical Processes*, financed by the German Ministry for Education and Research, has the goal of *Clarification of trophodynamic*

interactions between zooplankton and planktivorous fish in relation to reproductive success under the impact of physical forcing. The study is designed as a comparative study of the Baltic and the North Sea with sprat as the target fish species and *Pseudocalanus* sp., *Acartia* spp and *Temora longicornis* as target copepods. 3 scientific foci frame the project with different working hypotheses below these (see homepage). The project conducted a rather extensive field phase in the Bornholm Basin during 2002/2003 and to a smaller degree in 2004 covering investigations on all trophic levels and supporting experimental work. The results of the effort will be an important source of information for the BSRP. Further the project offers collaboration with BSRP, especially with respect to providing phd-thesis and supervising.

First analyses of field and laboratory studies resolved important aspects of copepod ecology. For *Pseudocalanus*, which is the most important food item for herring, sprat and cod larvae as well, could be shown how major winter inflows (increase of salinity and oxygen in the deep water) to the Central Baltic enhance the habitat quantity and quality which obviously determines reproductive success. *Acartia* spp. dynamics, which could be shown to dominate the diet of sprat larvae, are mainly steered by temperature. This includes the thermal influence on hatching success of resting eggs and reproduction in early spring, while in summer some species might be food limited (*A. bifilosa*). In addition to bottom-up effects, an intensive predation pressure by pelagic clupeid fish on *Pseudocalanus* in spring was detected.

Investigations on sprat maturity detected an unexpected winter spawning after the summer inflow in 2002 which was confirmed by ichthyoplankton sampling. However, the contribution to the overall egg production seemed to be low and larvae were obviously starving due to low winter plankton abundance. Surprisingly the "regular" spring spawning occurred also very early (i.e., March), which is probably due to enhanced condition as a result of a high *Pseudocalanus* stock after the winter inflow.

Simulations of drift patterns with a 3d-hydrodynamic model were used to define a retention index for sprat. The index suggest that retention in the Bornholm Basin is positive for sprat and correlates well with recruitment, especially during the 1990s. However, processes driving this relationship are presently not understood and need clarification with the help of the data derived in GLOBEC-GERMANY. A first exercise to include the retention index in a stock-recruitment-relationship together with sprat growth anomaly yielded a significantly better fit.

6 Conclusions and recommendations

1) The SG strongly recommends that funds from the BSRP will be used to support the completion and continuation of existing time-series as well as the processing of time-series presently only available on paper.
2) For future development and operational implementation of recruitment models for Baltic cod are necessary:
    a) Computerisation and archiving of otolith weight data existing in Denmark, Poland, Latvia, Sweden and Russia;
    b) Compilation of existing historic data from research vessels surveys and commercial catches in order to reconstruct length based cod stock assessment data. In this process all countries supplying data for assessment should be involved.
3) SG recommends that following activities that should be carried out in coastal areas
    a) Sampling of fish for biological analysis from commercial catches;
    b) Continuation of experimental gillnet sampling with consideration of covering new areas/countries and locally adapted changes in existing guidelines;
    c) Additional sampling by means of experimental catches for selected indices (e.g., recruitment, community composition and diversity);
    d) Continuation/initiation of ichthyoplankton surveys in selected locations by application of common methodology;
    e) Further studies in coastal fish population structure;
    f) Systematic recording of basic environmental background data (e.g., temperature, salinity, oxygen content);
    g) Systematic sampling on food resources (planktonic, nectobenthic and demersal) and fish stomachs.
    h) Establishing a study group for evaluation of suitable assessment methods for coastal fish stocks.
4) Due to situation that the present status of research and internationally coordinated research in open sea and coastal areas are significantly different and because of limited expertise (1-2 persons) from countries in both areas for one single meeting is recommended to consider the possibility of establishing two study groups instead of one. The focus of first group should be related to open sea fish species cod, sprat and herring. The main scope of second study group should be focused on coastal fish species and salmonids.

5) It is recommended that next study group meeting is associated with SGMAB and includes one day joint meeting of both.

7 SGBFF Draft Resolutions for 2005

A **Study Group on Baltic Fish and Fisheries Issues in the BSRP** [SGBFFI] **(**Chair: Maris Plikshs, Latvia) will be established and will meet in Riga, Latvia, from …. February/March?? 2005 to:

a) Finalize the inventory on available time-series, start a meta-analysis of growth changes of Baltic herring and sprat and suggest possible ways of growth modelling

b) Review progress in developing operational models for use in stock projections for eastern Baltic cod, sprat and herring

c) Review progress in compiling and computerising historic data from research vessels surveys, commercial catches, fish stomach analyses and otolith biometric studies

d) Rewiew progress in compiling meta-databases of coastal fish

   i. for commercial sampling by country, region, species, years, parameters measured and calculated indices;

   ii. for experimental sampling by country, region, purpose of the study, species, years, parameters measured and calculated indices.

e) Complete and update review of existing knowledge on environmental processes affecting dynamics of coastal fish species;

f) Review knowledge population structure of coastal commercial stocks;

g) Compiling available information on condition of herring spawning grounds

h) Review on rivers (with present and/or potential salmon population) with focusing on special indices:

   i. evaluation on present and/or potential salmon parr and smolt production;

   ii. evaluation on present and/or potential capacity of rivers (salmon spawning and nursery area size);

   iii. evaluation of variability on salmon parr and smolt production (both- spatial and temporal scales)

i) Defining of priorities on salmon population status improvement in the case of selected rivers

SGFFI will report by ….. May 2005 for the attention of the Baltic Committee and ACE.

Supporting information

Priority:	A GEF-World Bank funded project ("Baltic Sea Regional Project" BSRP) on improving the marine ecosystem research infrastructure of eastern Baltic countries started in march 2003 with the ICES Secretariat responsible for hosting component 1, the Large Marine Ecosystem Activities of the project. In order to support these mechanisms and procedures must be put in place in order to incorporate and integrate these new activities into the ICES structure, and provide an interface with existing ICES activities.
Scientific Justification and relation to Action Plan	Action Plan: 1.2 – f, g 1.3 – e 1.5 – b 1.6 – b 1.12 – a, c, d 4.8 – h, i 5.6 – all An improved linkage between scientific activities within physical, chemical and biological oceanography as well as fish stock assessment is a pre-requisite for the ICES Strategic Plan and BSRP goals of developing and implementing a holistic approach to ecosystem and fisheries management in the Baltic. This Group provides an essential interface with the Study Group on Multispecies Assessments in the Baltic. Its terms of reference are specifically part of the Implementation plan for Component 1 of the BSRP. The initiated historic data compilations, revisions and reviews addresses needs of data improvement for Baltic fish stock assessment and prediction purposes. The on of main goals of group is also to develop and implement the environmental information in the fish stock assessment and prediction tools.
Resource Requirements:	The BSRP will provide all necessary resources so far as the eastern Baltic countries are concerned.
Participants:	All Baltic countries specifically should provide relevant experts, and also participants from outside of the Baltic region.
Secretariat Facilities:	None
Financial:	BSRP will pay participations costs of 3 members for each of the eastern Baltic states.
Linkages To Advisory Committees:	ACE, ACFM
Linkages To other Committees or Groups:	SGMAB, WGBIFS, WGBAFS, WGBITS, SGSSR, the other BSRP Study Groups
Linkages to other Organisations	HELCOM, IBSFC
Secretariat Cost Share	BSRP 100%

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