The Recovery and Sustainability of the Baltic Sea Large Marine Ecosystem

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The Baltic Sea Large Marine Ecosystem (BSLME) is a unique and productive ecosystem under stress from harmful and unsustainable human activities and practices. Efforts are now gaining momentum to enhance cooperation between the riparian countries and the main international institutions involved in the science, advice and management of the marine environment including the region's fisheries, with a view to the recovery of the Baltic Sea Large Marine Ecosystem (BSLME) and the sustainability of socioeconomic benefits for the coastal nations and their communities.

Main characteristics of the Baltic Sea Large Marine Ecosystem

Geologically, biologically and in human terms, the Baltic Sea LME is a young, relatively shallow semi-enclosed sea. About 15,000 years ago, the thick ice belt which then covered the whole of Scandinavia started melting and a fresh water Baltic ice lake was established. During the following 9,000 years, this water area developed into a wholly marine area, then, once more, into an enclosed fresh water area before it again developed into a marine area, about 6,000 years ago. At its present state of development, the Baltic Sea's marine life is less than 4,000 years old.

Today, the Baltic Sea LME is a semi-enclosed brackish water area, the second largest in the world after the Black Sea, with a surface area of about 415,000 km^2. The average depth of the Baltic Sea is around 50 meters. The deepest waters are in the Landsort Deep in the Baltic proper, where depths of 459 meters have been recorded. More than 200 rivers empty into the Baltic Sea, providing a catchment or drainage area of about 1,700,00 km^2, that is approximately four times larger than the Baltic Sea itself. This catchment area is viewed as a component of the Baltic Sea LME, as it is now recognized that natural (e.g. precipitation and floods) and anthropogenic (e.g. pollution) effects occurring in the land-based watershed result in impacts on the living resources of the Baltic Sea LME.

The Baltic Sea is characterized by a persistent vertical stratification of its water layers, with a residence (turn-over) time for full exchange of its water mass

estimated at 30 years. These features are major factors that increase the susceptibility of the Baltic Sea to accumulate pollutants.

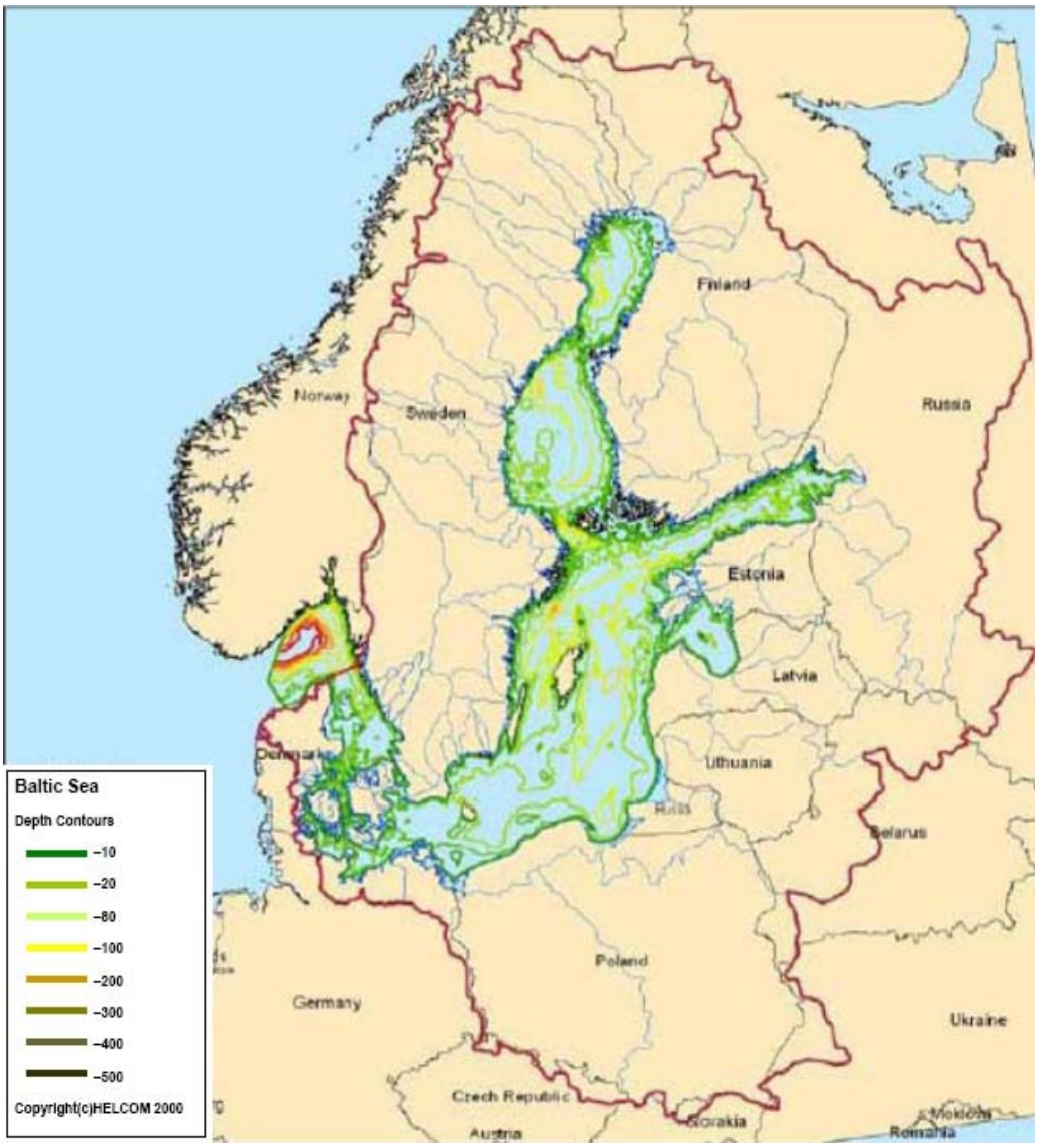

Figure 1. The Baltic Sea LME catchment area (outlined in dark red).

The Baltic Sea comprises three deep basins separated by shallow sills: the Arkona Deep, at the entrance to the Baltic Sea, the Bornholm Deep, and the Gotland Deep, farthest inwards. Saltier, heavier and oxygen-rich water from the North Sea enters the Baltic Sea through the shallow, narrow entrance and propagates along the deeper regions, while a counter current of freshwater flows outwards at the surface. This results, throughout most of the ecosystem, in two vertically stratified parts of the water column, which rarely mix. This stratification significantly limits the passage of oxygen from the surface into the deeper waters. The inflows of oxygen-rich water are of vital importance for the well-being and

productivity of the biota and determine the environmental quality of the Baltic Sea LME. Unfortunately, these inflows causing flushing of the Baltic Sea are unpredictable and infrequent, with periods of stagnation between flushing events that last as long as several decades, such that oxygen levels decline over time between each inflow due to the biological oxygen demands of living organisms and the breakdown of organic material. Although the influxes are basically random and connected with climatic variability that is not due to human influences, it appears that these influxes since the second half of the 20th century are decreasing in both frequency and magnitude.

Because of its history and brackish environment, the Baltic Sea LME is characterized by the low number and biodiversity of plant and animal species than in more saline waters. The brackish water is too salty for most freshwater species and too fresh for most marine species. For example, the number of macroscopic and microscopic animal species west of Sweden is roughly 1,500; in the southern Baltic there are only about 150 species, and in the water around Gotland only about 80 species. The same applies to fish: the Kattegat has around 100 marine fish species, while the Sound has only 55 and the Archipelago Sea only about 20. Other fish species are representative of those normally found in freshwater lakes and rivers all over the region, so that a single catch in the Bothnian Bay might consist of a unique combination of cod, herring, perch, and pike. The salinity gradient is paralleled by a climatic gradient with up to six months of ice cover, a productive season of 4-5 months in the northern Gulf of Bothnia, and an 8-9 month productive season in the southern sounds near its entrance. Besides these variations in biodiversity, it is typical that the few species penetrating into brackish waters are typically slower growing and of smaller size than in their original habitats, irrespective of whether their original habitats are marine or freshwater. Thus, the Baltic Sea environment and its biological diversity are unique. Its associated biota is facing a special challenge in living under a difficult natural environment that is particularly vulnerable to pollution and other human-caused stresses.

Despite the limited number of species, the structure and functioning of the BSLME is not simple. Typically, energy flows in shorter or longer food chains of up to a maximum of about five trophic levels, from the primary production originating from plants living in the sea and coastal areas, via grazing by herbivorous animals (e.g. zooplankton), and successive levels of predation to the higher level predators such as fish, seabirds and shorebirds, and marine mammals. Besides this typical 'grazing' food chain, we also have a microbial food chain that is longer and accordingly less efficient but no less important. The whole picture is complicated by important multispecies interactions, e.g. predator-prey relationships, interlinking the various food chains into a food web. The abundance of species and the structure and function of the food webs and ecosystems vary as a result of changing environmental conditions and human impacts.

Since the 1940s, the accelerated industrialization and exploitation of natural resources in the Baltic Sea have resulted in the deterioration and degradation of this vulnerable marine ecosystem. Today, close to 90 million people inhabit the Baltic Sea drainage basin, and their activities impact and change the Baltic Sea environment. The Baltic Sea LME is among the most scientifically investigated sea areas in the world. Its environmental conditions, the possible impacts of human activities and the major threats to the ecosystem have been known and well documented for a long time. The key environmental issues and threats to the Baltic Sea ecosystem are: eutrophication, overfishing, chemical pollution, changes in biodiversity and, especially in recent years, climate change.

International Management and Advisory Systems

In the Baltic Sea LME, fisheries management (e.g. the setting of total allowable catches and quotas) was conducted between 1973 and 2005 by the International Baltic Sea Fishery Commission (IBSFC), situated in Warsaw, Poland. In 2004, with the accession to the European Union (EU) of Estonia, Latvia, Lithuania and Poland, the EU, via the European Commission, and Russia began managing Baltic Sea fisheries. The management of environmental issues (e.g. pollution and biodiversity conservation) is conducted by the Helsinki Commission–Baltic Marine Environment Protection Commission (HELCOM), in Helsinki, Finland). The Contracting Parties of these commissions are the 8 Baltic EU countries (Denmark, Estonia, Finland, Germany, Latvia, Lithuania, Poland, and Sweden), and the Russian Federation. These management bodies receive the best available and politically neutral scientific information and advice for regulatory purposes from the International Council for the Exploration of the Sea (ICES), situated in Copenhagen, Denmark. ICES utilizes a consensus-based peer-reviewed advisory process with national representation. Fundamental inputs are the annually compiled reports of its numerous oceanographic, environmental and fisheries working groups that address key practical tasks as required. HELCOM and the European Commission together with their member states use the ICES advice to make management decisions. However, they are not obliged to act in accordance with the advice provided to them.

In response to calls from stakeholders in the fisheries sector who wanted to be more involved in fisheries management, the EU in 2006 created the Baltic Sea Regional Advisory Council (BS RAC) in Copenhagen, Denmark. Similar advisory councils have been established in six other EU regions. The main aim of the BS RAC is to prepare and provide stakeholder advice on the management of Baltic Sea fisheries in order to support the implementation of the EU's Common Fisheries Policy. The BS RAC meets frequently with ICES for cooperation and mutual updates on fisheries and science-based activities.

The last two decades have seen considerable political and socioeconomic changes in the Baltic Sea area. A major change was the collapse of the Soviet

Union in 1991 and disappearance of the “iron curtain” which separated the people of the eastern Baltic from the richer western countries. This resulted in the re-establishment of the three Baltic republics of Estonia, Latvia, and Lithuania, the reunion of East and West Germany, and, as mentioned earlier, the accession to the European Union of the Baltic Republics and of Poland. This led to improved communication and cooperation both in science, management and societal issues among the nine Baltic Sea countries. However, the countries in transition are still hampered, mainly for economic reasons, in meeting scientific standards and fulfilling their obligations to the managing bodies of the Baltic Sea. The transboundary nature of threats to the BSLME requires the coordinated actions of all riparian countries for their solution.

The Baltic Sea Regional Project

In the late 1990s, Estonia, Latvia, Lithuania, Poland and Russia, requested the funding support of the Global Environment Facility (GEF) and western Baltic countries to participate in coordinated actions to establish the sustainable management of the Baltic Sea LME’s natural resources.

After several years of preparation, the Baltic Sea Regional Project (BSRP) was launched in 2003 and continued through the first phase until July 2007. The main aim of Phase one of the BSRP was to create conditions for the application of the ecosystem approach in managing the Baltic Sea Large Marine ecosystem and sustaining its biological productivity. The BSRP was coordinated, monitored and evaluated by HELCOM (Executing Agency) and ICES in collaboration with the IBSFC (dissolved in January 2006), and with the Swedish Agriculture University (SLU) in Uppsala, Sweden. The GEF and World Bank provided a grant of $5.5 million to support the project. Other co-financing was provided by Denmark, Finland, Germany, Norway, Sweden, the United States (NOAA), the World Wildlife Fund (WWF), and the Nordic Environment Finance Corporation (NEFCO) increased the total budget to $16 million. Thirty partner institutions in the beneficiary countries and about 10 institutions in the donor countries were involved in the BSRP which had an overall staff of over 70 people during the first phase.

The BSRP and its two main components, the LME activities and the land and coastal activities, were based on the Large Marine Ecosystem concept launched by Dr. Kenneth Sherman in the US. The LME concept advances activities and assessments of key environmental issues within 5 modules: (1) Productivity, (2) Fish and Fisheries, (3) Pollution and Ecosystem Health, (4) Socioeconomics, and (5) Governance. The BSRP working structure (**Figure 2**) was built in accordance with this 5-modular system through the establishment of Coordination Centers for each of the 5 modules and with activities reported from designated Lead Laboratories (LL).

Over the years the BSRP has produced over 3,000 pages of scientific and public outreach reports and made about 150 power point presentations. It is considered a major key player in strategies and actions to improve the status of the Baltic Sea environment. The following is a brief review of some of the key problems and threats to the Baltic Sea LME, and some of the BSRP activities and solutions to cope with them.

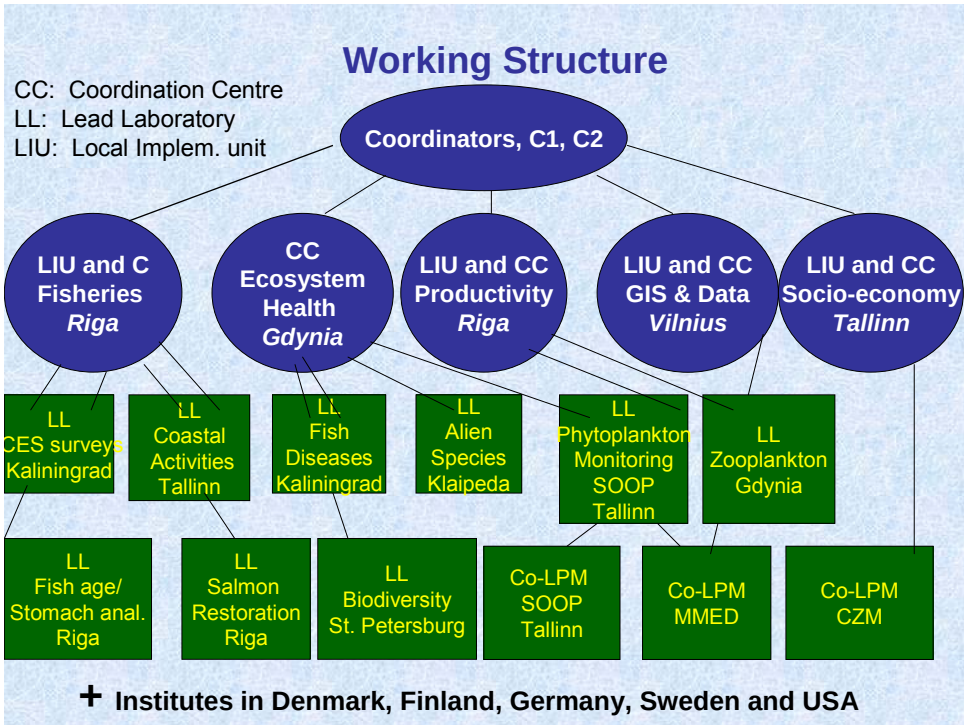

Figure 2. The working structure of the Baltic Sea Regional Project (BSRP), with Coordination Centers, Lead Laboratories and Local Implementation Units in different countries adjacent to the Baltic Sea LME.

Productivity and Ecosystem Health

Eutrophication, or nutrient over-enrichment, is the biggest problem facing the Baltic Sea. Increasing amounts of nutrients in the marine environment result in increased plant biomass and production, which in turn lead to elevated amounts of organic matter circulating in the ecosystem. The excess organic matter requires more oxygen, both when it is alive and when it is decaying. In the Baltic Sea LME, which experiences only rare major flushing events, eutrophication frequently leads to serious oxygen depletion and the formation of toxic hydrogen sulphide in the deeper regions. This has resulted in so-called dead bottom areas, nearly devoid of typical benthic animals and bottom living fish, covering nearly a third of the bottom area of the Baltic Sea LME. The input of nutrients to the Baltic Sea has increased greatly since about the 1940s, with nitrogen and

phosphorous rising by about three to five times the 1940s level. The most important human-related source of these nutrients in the Baltic Sea is agriculture, where farmers use excessive manure and artificial fertilizers for the production of their crops, and the surplus runs into the sea via streams and rivers. This is especially true for the eastern Baltic countries, i.e. the BSRP recipient countries. Additionally, the situation is exacerbated by changes in land use and the loss of wetlands, as well as by the discharge of sewage from urban and industrial sources. Other complicating environmental factors affecting eutrophication trends are increased temperatures due to climate change in the Baltic Sea area.

Plankton production often gives rise to harmful blooms such as the potentially toxic blue-green cyanobacteria blooms in the summer that can be seen from satellite imagery. These excessive blooms of plant material and associated decay cause major problems by reducing water quality through oxygen deficiency and increased turbidity. This makes it difficult to meet bathing water standards on the beaches. Thus, eutrophication is often associated with declining recreational and tourist amenities. Furthermore, increased levels of nutrients lead to the loss of rare species and habitats that are adapted to low nutrient levels.

Due to the major impact of agriculture on eutrophication in the Baltic, the BSRP component “Land and Coastal activities, C2” concentrated its efforts on increasing awareness in the agricultural sector on environmentally sustainable farm management practices. For this purpose, a series of seminars was held in all rural districts of the beneficiary countries and the seminars were attended by approximately 1,200 farmers. Furthermore, economic support and subsidized loans were given to follow the results. In addition these BSRP activities included the establishment of a system for monitoring and assessment of non-point source pollution originating from farms. In cooperation with WWF, the BSRP C2 intensively promoted community based coastal zone management activities by holding training and awareness activities in more than 120 schools for about 16,000 pupils. The BSRP further performed a series of demonstration activities including work in rivers to restore crayfish and trout habitats, and restoration of over 300 hectares of coastal wetlands/meadows in the three Baltic republics.

The BSRP Coordination Center of Productivity (CCPROD) together with its Lead Laboratories (LLs) (Figure 2) have performed a number of major and innovative activities to improve cooperation and assessment of productivity parameters. Soon after its establishment, the CCPROD integrated environmental aspects and productivity into fisheries assessments. This was one significant step that improved the sustainable management of Baltic Sea fisheries. The CCPROD also tested and implemented ECOPATH modeling for comparative productivity analysis, and improved zooplankton modeling by methodological inter-comparisons. These activities and the results thereof were discussed and considered in projects and working groups at both HELCOM and ICES. In collaboration with the Algaline project at the Finnish Institute of Marine Research,

and with the Swedish Meteorological and Hydrological Institute (SMHI), the BSRP established a contract with the Stena Line, the owner of the passenger ferry *Stena Nordica*, for this ferry to be used as a Ship of Opportunity (SOOP) on the route from Karlskrona, Sweden to Gdynia, Poland. This aimed to extend existing spatial and temporal sampling of SOOP vessels to the Southern Baltic east of Bornholm, a key area for the Baltic cod stock. The new route is now contributing to the re-establishment of lower trophic level productivity assessments, including pelagic autotrophs, phytobenthos and zooplankton, and is improving the data needed to develop spring bloom and other relevant indices.

For several decades many toxic substances have been known to threaten the Baltic Sea environment. This includes heavy metals, persistent organic pollutants (POPs), oil pollution, artificial radionuclides and dumped munitions. Many of the heavy metals and POPs can become magnified in the higher levels of the food chain. Halogenated hydrocarbons such as polychlorinated biphenyl congeners (PCBs), the pesticides DDT, Lindane, their metabolites and isomers, and unintentional by-products of combustion processes, are classed as xenobiotics, i.e. unknown to the environment before their human production. Most are accumulated in the fatty tissues of organisms, and many are harmful even at low concentrations. The PCBs and DDT are toxic substances that became well known and frightening to the public around the Baltic Sea in the late 1960s and 1970s. At that time, the Baltic grey seal population decreased considerably and it was discovered that up to 80% of their females were sterile, mainly due to total or partial obstruction of the uterine tubes (Bergman and Olsson, 1985). It was thought that the main reason was the high concentrations of PCBs and DDT in their tissues. At that time the presence of these pollutants in guillemots and white eagles were also correlated to their decrease in populations. After international measures were implemented in the late 1970s to reduce and ban the input of PCBs and DDT, concentrations decreased in body tissues for all three species mentioned and their populations have steadily increased. The DDT and PCB problem in the Baltic has successfully been addressed through legislation and governance. Since the implementation of the 1988 HELCOM Ministerial Declaration, the load of hazardous substances to the Baltic Sea has diminished by 20-50%. However, there are many hundreds of potentially hazardous chemicals emitted to the Baltic Sea and some new contaminants have been recently reported for the area that may create future environmental problems. These are endocrine disrupting chemicals, polybrominated flame retardants (PBBs and PBDEs), complex chlorinated chemicals from pulp and paper mills, and dioxins that accumulate in fatty fish such as herring and sprat.

With the establishment of a BSRP ICES Study Group on Baltic Ecosystem Health Issues (SGEH), the concept of Ecosystem Health was introduced into the Baltic Sea science community and into the work of ICES and HELCOM. The SGEH became instrumental in linking conventions, stakeholders and science. In the application of the ecosystem approach for the management of the Baltic Sea, ecological quality objectives (EcoQOs) were developed. This became a key

issue for the CCEH and its three lead laboratories. Since such indicators had been developed and applied earlier by the US Environmental Protection Agency (EPA) in the Great Lakes, the EPA was invited and a highly qualified person participated in the whole process. The work resulted in a list of indicators to be used in assessments of the Baltic Sea LME. The indicators will likely be used in HELCOM's thematic assessments on biodiversity, hazardous substances, and monitoring of biological effects of harmful substances.

New alien species appearing in the Baltic Sea have been the responsibility of the Lead Laboratory (LL) for Alien species. In the last 150 years, with accelerating speed over the last two decades, the Baltic Sea has received over 100 alien species, several of which may cause biodiversity loss and adverse environmental, economic and social impacts. Most of them have been transported and released into the Baltic Sea by ships, especially tankers releasing their ballast water. The best known alien fish species in the Baltic is the Ponto-Caspian round goby, *Neogobius melanostomus*. This 25 cm long, edible fish was first observed in the Gulf of Gdańsk in 1990. Today it is distributed all along the southern and eastern part of the Baltic Sea where its aggressive and territorial behavior dominates the habitat (Almqvist 2008). Its successful reproductive and opportunistic behavior makes it a threat to native fish species and their habitats. A recent invader to the Baltic Sea also represents a major threat to the ecosystem: the American comb jelly *Mneiopsis leidyi*. It was found for the first time in the southern Baltic in the Fall of 2006 and in the northern Baltic in 2007. Its abundance in August 2008 was 40-60% higher than in August 2007, thus indicating an adaptation to Baltic Sea conditions (Letiniemi 2008).

Fish and Fisheries

The commercially most important fish species in the open Baltic Sea are cod, herring, sprat and Baltic salmon. The total annual catch of these fish stocks has increased 10-fold during the past 50 years. Until the 1930s, catches remained at about 120,000 tonnes, then increased to about 500,000 tonnes in the late 1950s and, after a steep rise in the mid 1960s, reached almost a million tonnes by the end of the 1970s. In the last 20-30 years however, overfishing and the failure of fisheries management to maintain sustainable fisheries and conserve commercial fish stocks have become increasingly more pronounced. Nearly all commercially important fish stocks have been severely depleted and have been outside of safe biological limits due to decades of unsustainable fishing effort resulting from excessive fishing capacity and inappropriate fishing practices. Cod is the most important fish in the Baltic. From a maximum annual catch of cod in the mid 1980s of nearly 450,000 tonnes, the nominal catch steadily declined by 1992 to about 50,000 tonnes and has hovered around 100,000 tonnes since then (**Figure 3**).

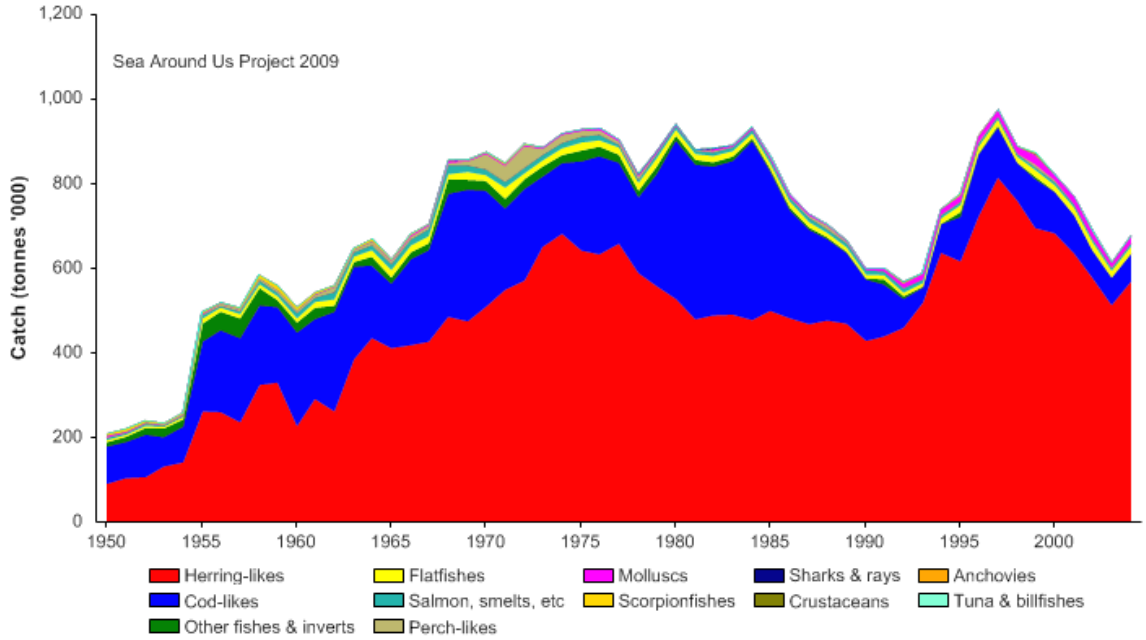

Figure 3. Fish landings in the Baltic Sea. Herring and cod are the most important fish species. From the SeaAroundUs Project at www.seaaroundus.org.

As a result of management failures due to the managing agencies setting cod total allowable catches (TACs) that have frequently exceeded the levels advised by ICES, the stock size of Baltic Sea cod reached its lowest level on record in 1991. Levels since then and up to 2007 have been close to this historic minimum. Overfishing of larger fish-eating fish, e.g. cod, has allowed increased industrial fishing of sprat and herring. The economic yield per unit biomass of the fishery has declined, with a smaller proportion of the catch being directed for human consumption and food security. Unsustainable fishing has also caused further impacts on marine ecosystems through by-catch and the discarding of fish, and on bottom living animals, seabirds and marine mammals. Bottom trawling has degraded vulnerable habitats. This has had a negative impact on ecosystem structure and function. Fisheries enforcement has been ineffective against bad fishing practices. Catch statistics misreport landings outside legal channels to the detriment of official statistics on catches and landings, the exceeding of quotas, fishing in closed areas and unacceptable discards. Where regional international regulatory commissions have agreed on remedial actions, there has often been a lack of political will at the national level to fully implement agreed actions to restore depleted fish stocks and protect marine ecosystems.

However, in the last two years, public awareness of the Baltic and its fish and fisheries, especially cod, has grown considerably in most of the Baltic riparian countries. The media has dealt in detail with the failure of the Common Fisheries Policy, and in Sweden, for example, the publication of the book “Tyst Hav” (Silent

Sea) which in a popular way deals with the political, biological and economical issues of Baltic fisheries, received a strong reaction from the public (Lovin 2007). As a result, people started to boycott cod, fish dealers stopped selling cod, restaurants stopped serving it, and NGOs red-listed many Baltic Sea fish species. In Poland, fishermen and fisheries officials admitted to the heavy overfishing of TACs and high frequency of illegal fishing. Baltic Sea managers had long been aware of the situation and had already prepared a recovery plan for the Baltic cod. For the first time in years, ICES made a statement about the eastern Baltic cod population in 2008 indicating that "an increase in spawning stock biomass has been observed since 2005 although it is still at a historical low level." ICES in 2008 classified the stock as being harvested sustainably (ICES 2008).

In 2003, the BSRP coordinator stated in an interview that "Baltic fisheries have to get rid of the Klondyke mentality and stop overfishing." He referred to a possible 30-50 percent gap between reported and real amounts of fish caught in the Baltic Sea (Baltic Times 2003). From the very start of the BSRP, the Coordination Center for Fish and Fisheries (CCFF) has been engaged in the improvement of fish stock assessments, data reporting and advisories. It has improved commercial fish stock assessments by extending survey areas into northern and coastal parts of the Baltic and by initiating joint surveys. It has improved on the quality of fish stock assessment data by coupling bottom trawling with pelagic acoustic surveys of the stocks and by harmonizing fish growth and feeding analysis methodology. The CCFF was also able to improve landing statistics by upgrading the biological data collection from commercial catches. In a series of workshops, the BSRP Lead Laboratory (LL) for Coastal Fish has acted as co-chair and has cooperated with HELCOM, ICES and the Swedish National Board of Fisheries to improve the coastal fish monitoring programmes around the Baltic Sea with an aim to contribute to overall assessments of the Baltic Sea LME.

Present and Future

In recent years and paralleling the activities of the BSRP a series of management and science activities, crucial for the future of the BSLME, have been initiated. A European Maritime Policy and a Marine Strategy have been developed by the European Commission for the Baltic Sea, considered as one of three European regional seas. For each regional sea the Marine Strategy calls on the parties to: (1) Assess the current environment status; (2) Define good ecological status; (3) Establish environmental targets and indicators; (4) Develop monitoring programs; and (5) Achieve good environmental status by 2020. For this activity, HELCOM has developed a Baltic Sea Action Plan (BSAP) which was adopted by the contracting parties at the end of 2007. The plan aims "to safeguard the Baltic's natural ecosystem while allowing valuable marine resources to be used sustainably in the future." The action plan is based on the ecosystem approach and is in a broad sense using the LME approach of the BSRP. In fact, the BSRP

has been instrumental in the preparation of the action plan. For example, the plan will be based on Ecological Quality Objectives and indicators. The key issues prioritized for actions in the BSAP are eutrophication, hazardous substances, maritime activities, and biodiversity.

To address future needs for scientific advice ICES has produced a science plan built on the ecosystem approach, which integrates fisheries and environmental issues. One BSRP group that has been a driving force in this work of integration and in bridging ICES and HELCOM activities is the WG on Integrated assessment in the Baltic (WGIAB).). ICES has also been re-organized from thematic advisory committees to a single Science committee and a single Advisory Committee, both supported by expert groups.

Through the BSRP and its LME activities, ICES has become involved in an EU project called “Baltic Sea Science–a Network of Science Agencies” (BONUS). In 2005, this project was charged by the EU to produce a Baltic Sea science plan and implementation strategy. The task to accomplish this was given to BSRP/ ICES. This plan will convert research needs arising from management agencies into scientific questions to which the Baltic Sea science community can respond with research ideas. The Baltic Sea Science Plan is written in accordance with the LME concept and contains all its major elements (Figure 4) (Hopkins et al. 2006). In September 2007, the BONUS science plan called for project proposals. In June 2008, 16 projects were granted money for three years with a total budget of 22 million Euros.

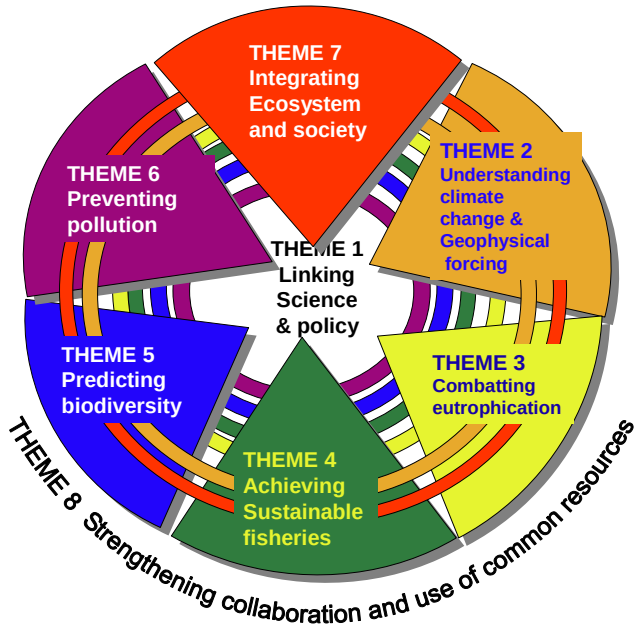

Figure 4. Illustration of the Baltic Sea Science Plan of the **BONUS** project.

To summarize the ecological and management status of the Baltic Sea Large Marine Ecosystem, we can state that it looks much brighter and more hopeful today than it did five years ago. There is public awareness of its environmental issues and a political will to improve and care for the marine environment and its resources.

BSRP activities were recently evaluated (ICR 2008) and it may be relevant to quote the last paragraph on lessons learned: "The lessons of the project have been incorporated into the BSAP, BONUS +, and other programs whereby they will inform improved management of the Baltic environment in the future." Through these initiatives, the Baltic Sea LME is also providing a pioneering example for implementation of the new EU Marine Strategy Directive, as well as global commitments made under the convention on Biological Diversity, The World Summit on sustainable Development and the Rio Declaration. Although the BSRP was officially completed in 2007, its spirit is still in the area, its network is still up and running and its footprint is clearly visible.

References

Almqvist, Gustaf. 2008. Round goby *Neogobius melanostomus* in the Baltic Sea – Invasion Biology in practice. http://urn.kb.se/resolve?urn=urn:nbn:se:su:diva-7450 (2008-12- 02).

The Baltic Times. 2003. Overfishing devastating Baltic Sea Ecosystem. The Baltic Times, October 2, 2003. 1p.

Bergman A. and Olsson M. 1985. Pathology of Baltic grey seal and ringed seal females with special reference to adrenocortical hyperplasia: Is environmental pollution the cause of a widely distributed disease syndrome? *Finn Game Res* 44:47-62.

Bergman, A., and Olsson, M. (1989). Pathology of Baltic grey seal and ringed seal males. Report regarding animals sampled 1977–1985. In: *Influence of Human Activities on the Baltic Ecosystem. Proceeding of the Soviet-Swedish Symposium* "*Effects of Toxic Substances on Dynamics of* ***Seal*** *Populations,*" *Moscow, USSR, April 14–18.* (A. V. Yablokov and M. Olsson, Eds.), pp. 74–86. Leningrad Gidrometeoizdat.

Fonselius, S.H. and J. Valderrama. 2003. One hundred years of hydrographic measurements in the Baltic Sea. J. Sea Res. 49:229-241.

Hopkins, C.C.E., J. Thulin, JG Sutinen, K. Kononen, P. Snoeijs, S. Johansson & HO Nallbach. 2006. BONUS-169 Baltic Sea Science Plan and Implementation Strategy. BONUS Publication No. 5. 59p.

ICR, 2008. Implementation Completion and Result Report (WBTF-51286), Baltic Sea Regional Project.

Letiniemi, M. 2008. The recent aquatic invasive species American comb jelly *Mnemiopsis leidyi* in the northern Baltic Sea. HELCOM Indicator Fact Sheets 2008. Online (2 December 2008), at http://www.helcom.fi/environment2/ifs/en_GB/cover/.

Lövin, I. 2007. Tyst hav - Jakten på den sista matfisken [*Silent sea - the race for the last food fish* (Ordfront publishers)].