Integrated Thematic Assessment on Biodiversity and Nature Conservation in the Baltic Sea

Draft Summary

Helsinki Commission

Baltic Marine Environment Protection Commission

Cover photos: Metsähallitus 2006 and 2007

Contents

1 Towards a favourable conservation status of Baltic Sea biodiversity

The biodiversity segment of the HELCOM Baltic Sea Action Plan (BSAP) reflects the aim to reach a favourable conservation status of Baltic biodiversity by 2021. The variety of management measures agreed in the Action Plan, like those for combating eutrophication or diminishing inputs of hazardous substances, should, when implemented, result in a better conservation status. In order to follow up the effects of actions taken by the HELCOM Contracting Parties, the status of biodiversity and the state of its conservation need to be regularly evaluated. Hence, the need to develop a harmonised approach to assessing the conservation status was identified in the BSAP.

The integrated thematic assessment on biodiversity and nature conservation in the Baltic Sea provides the first comprehensive assessment of the status of biodiversity and human pressures impacting biodiversity in the Baltic Sea. Recommendations on how to reach individual targets of the Action Plan have been provided throughout the report in direct association to the relevant components of biodiversity. This paper provides an overview of the results of the assessment, discusses the challenges and opportunities for protecting the Baltic Sea biodiversity, and identifies the work necessary to develop future biodiversity assessments.


Photo: Metsähallitus 2007

2 Current status of biodiversity and nature conservation in the Baltic Sea

It is clear that the biodiversity of the Baltic Sea has undergone major changes during the past decades. However, the lack of comprehensive data and the natural variability in biodiversity makes it difficult to specify the human contribution to these changes.

The Baltic Sea is inherently a highly dynamic system and concurrently with the observed changes in biodiversity, large-scale climate fluctuations have influenced the Baltic. This has caused changes to salinity and oxygen concentrations in the deep basins, as well as to sea surface temperature (Matthäus & Nausch 2003), which in turn have affected the distribution of species and ecosystem structure. The changes in climate, whether natural or anthropogenic, thus make it challenging to distinguish natural variation from human induced modification of the Baltic Sea biodiversity. Nevertheless, there is no doubt that various human pressures have contributed to the observed changes in biodiversity. While many of the observed changes in biodiversity are slanting towards a deteriorating state, there are also positive trends reported for selected species.

Photo: Metsähallitus 2006

Photo: S. Korpinen

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2.1 Signs of change and deterioration

Phytoplankton. The assessment of phytoplankton points to a number of changes in the community composition during the last thirty years, e.g. a shift in dominance from diatoms to dinoflagellates during spring bloom periods. Seen over a longer time-period, nutrient enrichment has resulted in increased phytoplankton productivity i.e. eutrophication with more prevalent algal blooms. The blooms themselves are a manifestation of reduced biodiversity within the phytoplankton community.

Habitat forming species. Important habitat forming species such as bladder wrack, eelgrass and stoneworts have decreased in abundance in many coastal areas. The decrease is most pronounced in highly polluted and eutrophied areas as well as areas subject to physical disturbance to the bottom. For bladder wrack a decline has also been observed in areas with low disturbance indicating that large-scale hydrological and hydrographical changes in the Baltic Sea area may influence the population.

Zooplankton. The zooplankton community also displays significant changes over the last decades. Climate driven changes in salinity and temperature are likely important factors behind the observed changes in the offshore copepod communities in the Baltic Proper and the Southern Baltic Sea presented in this assessment. In addition, eutrophication has contributed to the decreasing volume of oxygenated water below the halocline in offshore areas, thereby reducing the volume of water suitable for reproduction of zooplankton species that require higher salinities.

Soft-sediment macrofaunal communities in the open-sea areas of the Baltic Sea are naturally constrained by the strong horizontal and vertical gradients in salinity. Currently macrobenthic communities are severely degraded and abundances are below a 40-year average in the entire Baltic Sea. The increased prevalence of oxygen-depleted deepwater is perhaps the single most important factor influencing the structural and functional biodiversity of benthic communities in the open sea areas of the Baltic Sea.

Fish. Since the mid-1980s, the Baltic fish community has undergone a shift from dominance of demersal communities to clupeids. The shift was caused by a combination of natural (i.e., climate variability) and human-mediated factors like eutrophication and fishing. In a number of coastal areas, species benefiting from or tolerating eutrophication such as percids

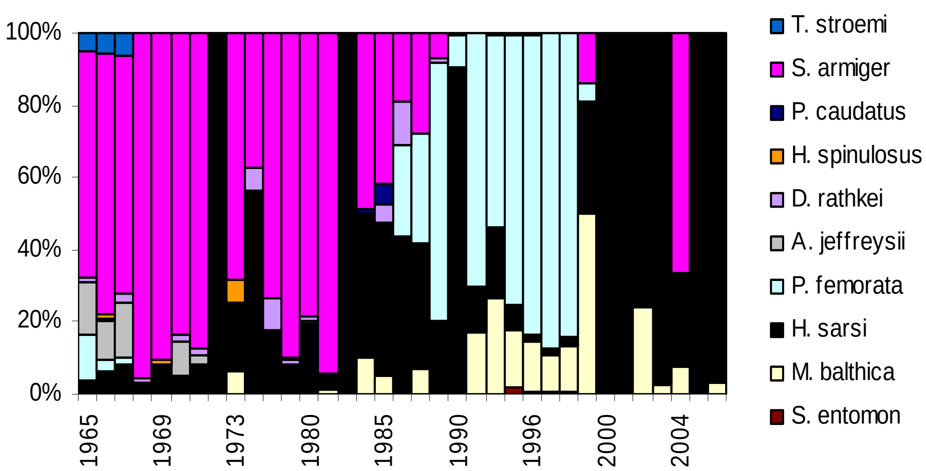


Figure. Long-term changes in benthic community abundance and composition (illustrating species turnover) are depicted for station BCSIII10 (SE Gotland Basin).

and cyprinids are currently flourishing. Warm summers may also have contributed to this development. In many areas fish stocks have declined due to high fishing pressure. Several stocks of migratory fish species are in a poor condition because of damming or blocking of migratory pathways.

Birds. Among the assessed birds a long-term population decline is evident for dunlin, and a recent decline for eider and long-tailed duck. The causes behind the decline are not well understood, but climate change (in case of the dunlin), shipping induced oil spills, fisheries by-catch and habitat detoriation (in case of the ducks) may have contributed to the decline.

Mammals. Among the mammals, the population of harbour porpoise, especially in the Baltic Proper is in a precarious state and the status of ringed seals is still unfavourable. The grey seal population has increased steadily after 1988, but the recovery of grey seals south of 59° North, where they were regularly present before they were hunted to extinction in the beginning of the 20th century is still very slow. Fisheries by-catch and prey depletion are among the most prominent and continuing threats to these populations, while the impacts of hazardous substances on seals have been reduced.

Alien species. About 120 alien species have been recorded in the Baltic Sea since the early 19th century. So far, alien species have mostly had an impact in coastal areas while there are only a few alien species which have been introduced to the open sea environment. Certain coastal lagoons especially in the southern Baltic have been heavily impacted by the introduced species. Most of the observed alien species that have spread to the Baltic Sea have not yet turned out to be invasive and have in fact enriched the species and functional biodiversity of the Baltic Sea. However, new introductions pose a threat to the whole ecosystem and its functions, and the risk of new invasions remains high.

Threatened and declining species. There are currently 59 species that are considered as

Photo: P. Blankett

threatened or declining in the Baltic Sea. The only known extinct species is the sturgeon. All mammals are under threat or in decline at least in some parts of the Baltic. The largest single group of threatened or declining species is fish and lampreys which includes 23 species.

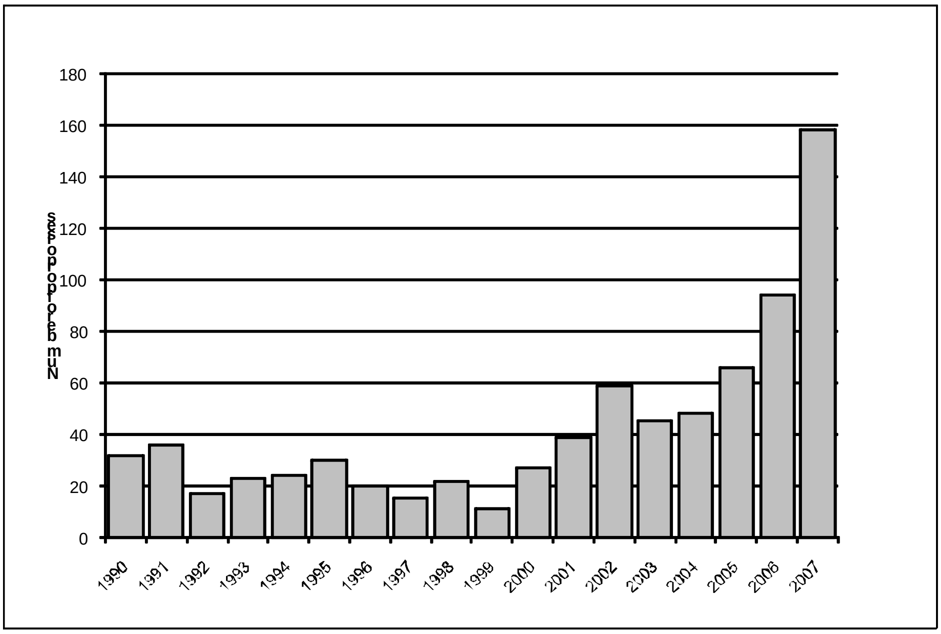


Figure. Number of stranded (including by-caught) harbour porpoises recorded at the German Baltic Sea coast between the years 1990 and 2007. Sources: Siebert et al. 2008, unpublished report to the Ministry for Agriculture, the Environment and Rural Areas; as well as the data-base of the German Oceanographic Museum, Stralsund.

Biotopes. The coastal biotopes and habitats are largely in an unfavourable conservation status and continue to be under increasing pressure in many sub-regions. Many, if not all habitats are being impacted by eutrophication. In addition, physical disturbances such as dredging, disposal of dredged material and constructions are rated as major pressures on these coastal habitats. The poor environmental status of the habitats has implications far beyond that of the local scale since the habitats are important living, feeding, reproduction and nursing environments for associated flora and fauna.

The Baltic Sea biodiversity is inherently sensitive to disturbances due to its relatively limited number of species, low genetic variation, and few species within important functional groups. Deterioration of the status of biodiversity as manifested by the decline of communities and key species is critical since it diminishes the resilience or buffering capacity against large-scale shifts of the Baltic Sea ecosystem and increases the risk for escalating deterioration of the environment.

2.2 Signs of improvement

Protection of threatened species has been a central theme in nature conservation in the Baltic Sea area since the 1950s and improvements have been achieved among bird and mammal populations that have been subject to protective measures.

Birds. The previously threatened white tailed eagle and great cormorant show considerable increase in population size, particularly in comparison to the beginning of the 1980s.

Grey seals. The population of grey seals in the northern Baltic Sea is increasing at rates almost maximal for the species.

Fish. There are several positive signs for the Baltic fish in recent times. These include amongst others an improvement of the natural smolt production of certain salmon populations, improvement of sea trout populations in the western Baltic, significant improvement of the smelt stock in the Gulf of Riga, and increase of the share of pisciviorous fish and the trophic level of fish communities in some coastal areas.

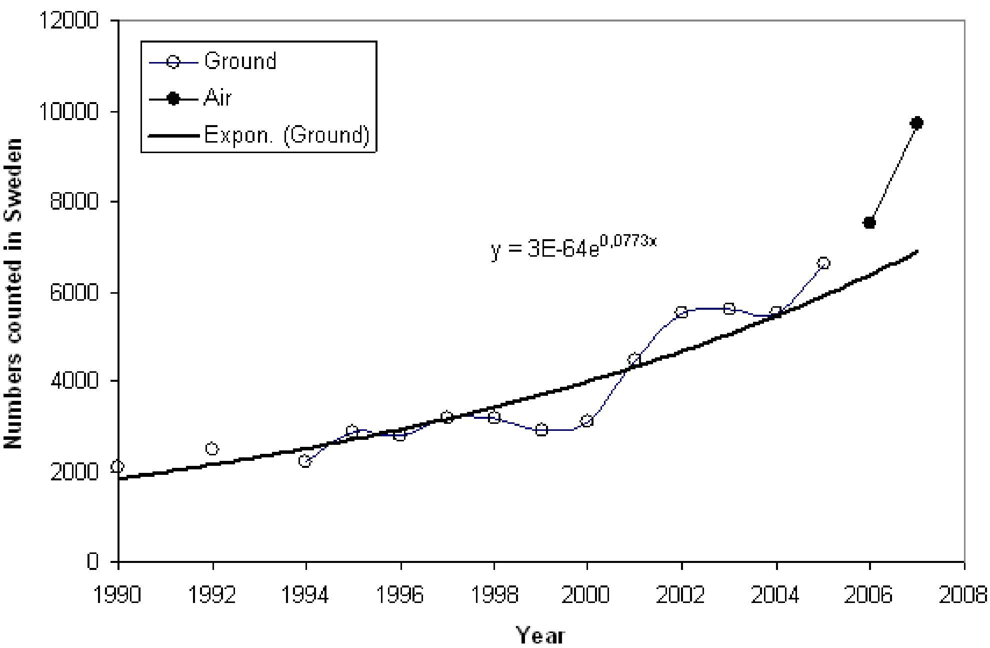


Figure. Numbers of grey seals counted from ground along the Swedish coast. The annual rate of increase was 8% up to 2005. Surveys from air started in 2006 give higher point estimates.

Aquatic vegetation. In a number of coastal areas of the Baltic Sea, e.g. in the northwestern and northeasten Baltic Proper, also submerged aquatic vegetation shows signs of recovery after years of deterioration.

These improvements display results of restrictions or bans of hunting, reductions in inputs of certain hazardous substances, protection of important habitats, biotopes and species and to some extent improvement of water quality. The improvements also show how concerted and inter-sectoral management actions have reversed precarious states of certain species in the Baltic Sea to a better status.

A crude Baltic-wide overview of the conservation status of Baltic biodiversity was compiled based on the status of some of the elements of biodiversity, mainly species and communities addressed in this assessment with sufficient data availability (Table). Favourable conservation status of species, taxonomic groups and communities is more prevalent in the northernmost sub-basins of the Baltic Sea, especially the Gulf of Bothnia. This result is in agreement with the pilot testing of the Biodiversity Assessment Tool BEAT (see section 4 in this paper) and also the results of the integrated thematic assessment of eutrophication (HELCOM 2009) where areas unimpacted by eutrophication were mainly found to be located in the Gulf of Bothnia.

The better conservation status in the northern parts can likely be attributed to the lower degree of human disturbances and eutrophication in the relatively less populated drainage basins of the Bothnian Bay and Bothnian Sea. In addition, the Gulf of Bothnia is physiographically less prone to oxygen depletion and associated impacts.

Table. A crude Baltic-wide overview of conservation status of biodiversity in approximately 2000-2006 in the different sub-regions of the Baltic Sea presented as an estimation of favourable (green) or non-favourable (red) conservation status of different elements of biodiversity based on the information compiled into the assessment report and on expert judgement. NA – Not applicable, ? – data not available.

Biodiversity element	Kattegat and Danish Straits	Southern Baltic Proper	Northern Baltic Proper	Gulf of Riga	Gulf of Finland	Gulf of Both-nia
Benthic invertebrate communities	?			?		
Harbour porpoise				NA		NA
Grey seal						
Ringed seal	NA	NA				
Harbour seal			NA	NA	NA	NA
White-tailed eagle						
Cormorant						
Long-tailed duck					NA	NA
Dunlin						
Bladder wrack						NA
Eelgrass				?	?	NA
Charophytes						?
Pseudocalanus				?		NA
Acartia						
Temora						NA
Limnocalanus	NA	NA				

3 Extent of human pressures

The Baltic Sea biodiversity of all levels, be it landscape, community or species, is simultaneously affected by various human pressures and activities. Quantitative information on the extent of these pressures is in many cases scarce and geographically scattered. However, based on the available information this assessment shows that many pressures are of a considerable magnitude and not sufficiently covered by management plans or regulations to protect the biodiversity in Baltic Sea.

Eutrophication has for long been identified as the major problem of the Baltic Sea ecosystem having a significant impact on biodiversity (HELCOM 2007a). The HELCOM integrated thematic assessment of eutrophication reported most of the Baltic Sea to be an eutrophication problem area (HELCOM 2009). However, there are also signs of improvement since a slight decrease of nutrient inputs to the Baltic Sea has been recorded between the late 1990s and 2001-2006 and decreasing nutrient concentrations have been observed in a number of areas. Nevertheless, solving the eutrophication problem will take time due to time lags caused by long water residence times. In addition, oxygen depleted deep bottom sediments coupled to internal loading of especially phosphorus maintain the vicious cycle of eutrophication and slow down the process of burial in sediments.

Fishing on Baltic cod stocks has for many years been unsustainable. In the Baltic Sea, as well as globally, unsustainable fishing on top predators has resulted in trophic cascades effecting biodiversity far beyond the targeted population (Frank et al. 2005, Casini et al. 2008). In addition to the critical effect on the trophic structure of the ecosystem, fisheries by-catch is also causing considerable negative impact on birds and mammals in the Baltic Sea.

Alien species keep entering the Baltic Sea resulting in a homogenising of the Baltic Sea biodiversity with other regions. The risk that alien species become invasive increases with other disturbances to the ecosystem. In the Black and Caspian Seas an initial disturbance to the ecosystem caused by excessive fishing and deterioration of water quality is believed to have triggered massive invasions of the jellyfish *Mnemiopsis leidyi* (Daskalov et al. 2007). This species has now been observed in the Baltic Sea.

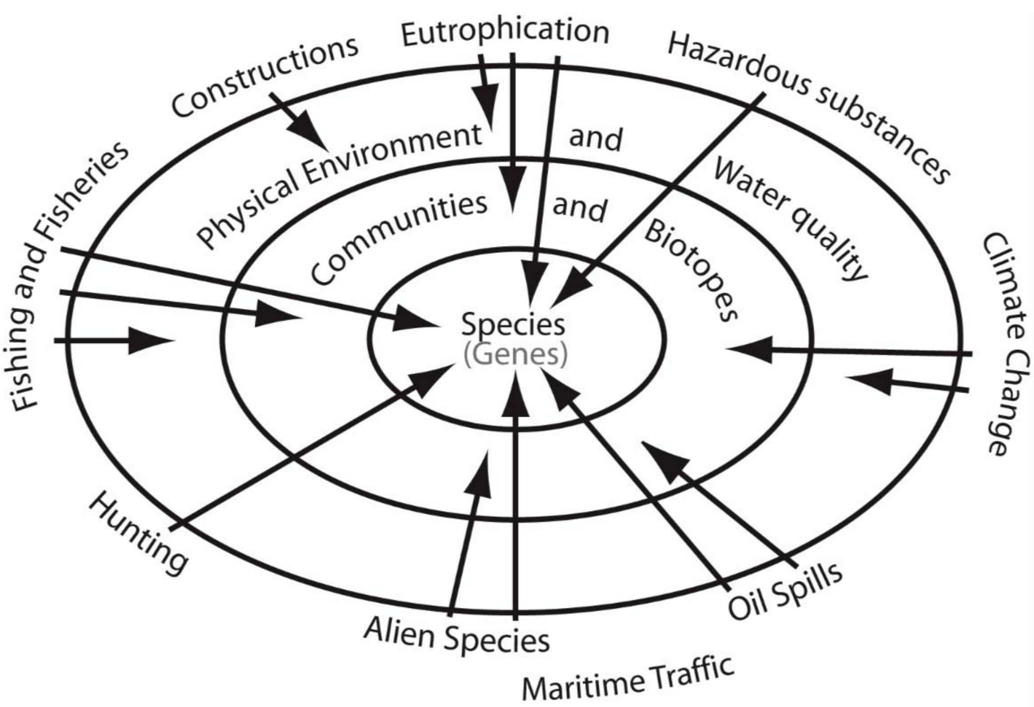


Figure. Human pressures in the Baltic Sea region act on different levels and scales of biodiversity.

Physical disturbances, such as sand and gravel extraction, dredging, dumping of dredged spoils, construction of coastal defence structures and offshore installations may cause harm and degradation to benthic communities and habitats. Indirect effects to pelagic and coastal communities are also significant. Seafloor resource exploitation and wind farm construction have increased steadily during recent years and numerous confirmed plans for future activities are currently under evaluation.

Hazardous substances. The inputs of heavy metals, such as cadmium, mercury and lead and of certain organic chemicals like PCDD/Fs to the Baltic Sea have decreased since the early 1990s and a reduction of these particular compounds has been observed also in the Baltic biota. However, the concentrations of certain new compounds, such as PFOS and HBCDD are increasing and their impacts on species and the ecosystem are often largely unknown.

Maritime traffic increasingly contributes to nutrient enrichment, physical disturbance and operational oil spills. Above all, the increasing maritime transport adds a considerable threat to the Baltic biodiversity due the risk of a major oil spill which in the Baltic conditions would cause deep, long lasting and wide spread harm. In addition, maritime transport is the primary vector of alien species.

Noise in the Baltic Sea is a less studied concern but it is potentially harmful particularly for mammals but also to fish species that depend on hearing. With the anticipated increase in maritime traffic and coastal construction works, noise in the Baltic Sea environment will increase in the future.

Recreational activities add stress primarily locally in coastal areas. They often cause physical disturbance to shallow benthic habitats, they may be a source of nutrients, marine litter and noise, and through recreational fishing and hunting they contribute to the disturbance and decline of some species.

Climate change. The predicted changes in climate as a consequence of global warming may have profound implications for Baltic biodiversity. In particular, the predicted decrease in salinity is expected to shift the distribution limits of several important habitat structuring species and key species to the Baltic ecosystem, such as bladder wrack, eelgrass, blue mussel and cod. The projected increase of temperature and decrease in ice cover is also likely to have an impact on species ranges. As examples, decreasing ice cover will have a direct impact on ringed seals whose breeding is linked to the ice and with increasing temperatures alien species of southern origin will be more prone to spread to the Baltic. Climate change is also likely to exacerbate eutrophication through changes in precipitation, river inflows, hydrography and effects of eutrophication on biodiversity. Climate change is thus expected to add considerable stress to the Baltic biodiversity in addition to the present human activities.

Taken together, eutrophication and fisheries stand out as the two most prominent human pressures behind observed changes in biodiversity in offshore areas of the Baltic Sea. Climate driven changes in salinity and sea surface temperature, as well as deep bottom oxygen depletion have enhanced the negative impacts of eutrophication and fisheries during the last decades. This view is supported by other recent reports on the Baltic Sea (HELCOM 2007b, ICES 2008). In coastal areas, physical disturbance, such as construction works and the almost ubiquitous human impact add significant stress on the biota.

Furthermore, the assessment indicates that many pressures are anticipated to increase in the Baltic Sea in the near future. This is the case for activities that make direct use of the sea and seabed such as maritime traffic, coastal and offshore technical installations and recreational activities. Currently these activities have a minor impact on the environment compared to inputs of nutrients and hazardous substance from land-based activities or the impact of the commercial fisheries. However, unless properly regulated, the relative contribution from these activities will increase.

4 Development of an indicator-based biodiversity assessment tool

Twenty-two national case studies from all HELCOM Contracting States (nine countries) were made available for testing in an indicator-based biodiversity assessment tool (BEAT). The location of the study sites is shown in Figure below.

Mainly status indicators were assessed in this trial using PSR/DPSIR terminology (OECD 1993). Assessing the status of marine biodiversity within a given area requires that a number of challenges are addressed. The first challenge is to gather data for a sufficient number of indicators, describing a sufficiently broad array of biodiversity components for a given site or area. The second is to define a desirable state for the selected indicators. In the approach used here this includes both a quantitative reference ("pristine" or RefCon) status, as well as an acceptable deviation (AcDev) from this reference. If reference status can not be defined, a tentative target value can be specified. Using the information from these two steps the status of a single indicator from the site can be defined.

The third and final challenge, from the status assessment's perspective, is to assess the overall status of biodiversity. This can be accomplished by using the indicators, and their reference levels, and acceptable deviations, as components in an overall assessment matrix. A matrix tool called BEAT was used to assess the overall status of biodiversity divided to three categories of "Landscapes", "Communities" and "Species", according to the biodiversity segment of the HELCOM Baltic Sea Action Plan.

The BEAT matrix divides the range of possible values into five classes: high, good, moderate, poor and bad. In this system 'high' and 'good' are more or less equivalent to 'favourable conservation status' (~ 'good environmental status') and 'moderate', 'poor', and 'bad' are equivalent to 'un-favourable conservation status' (~ impaired status).

Seventeen of the 22 national case study areas were classified as having an unfavourable condition in terms of the indicators reported while five of the areas had either good or high status indicating favourable conservation status of biodiversity. The areas having good or high status were somewhat limited in terms of thematic coverage of indicators. More biodiversity indicators are needed in order to be able assess the overall status of the Baltic Sea environment.

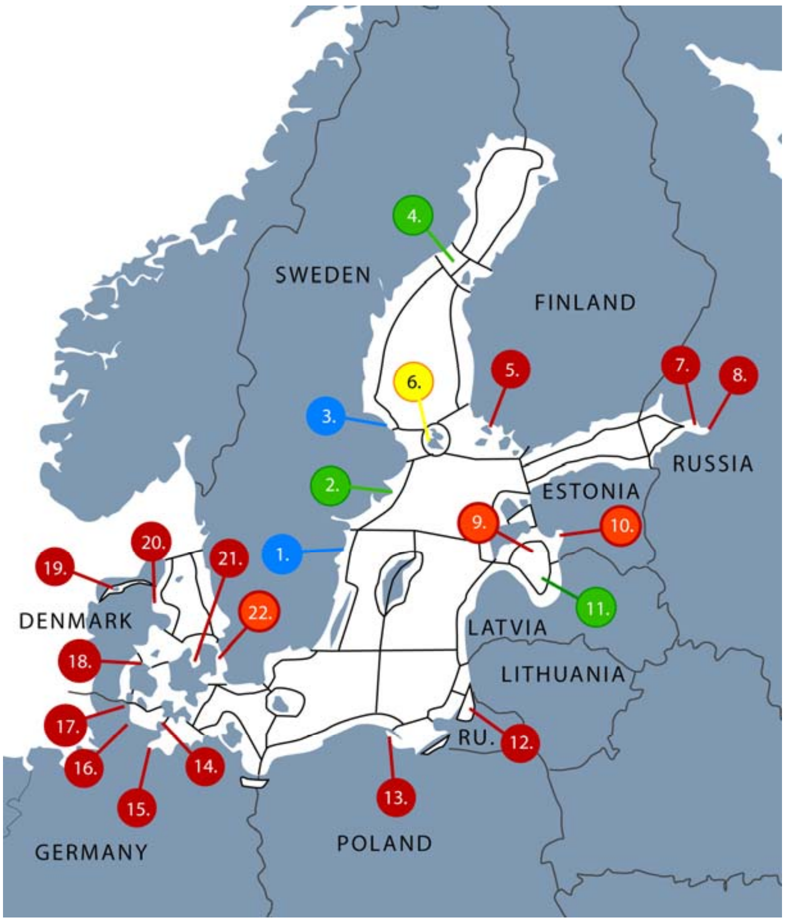


Figure. The locations and status classifications of the twenty-two national case study sites. Seventeen of the 22 national case study areas were classified as having an unfavourable condition in terms of the indicators reported (yellow='moderate', orange= 'poor', red='bad'). Areas indicated with green or blue have a favourable overall conservation status based on the limited number of available indicators.

5 Challenges and opportunities for the protection of the Baltic Sea biodiversity

Protection of the marine environment of the Baltic Sea has in HELCOM evolved to embrace a full ecosystem approach to management of human activities. The Baltic Sea Action Plan (BSAP) is a strategy for implementing the ecosystem approach at the Baltic Sea regional level.

A key feature of the ecosystem approach is the recognition of the tight interconnectedness between the *eco*-system and the *human*-system, including the need of humans to use the goods and services provided by an ecosystem. Use of ecosystem goods and services should however be carried out in a way that assures long-term survival and sustainability of all ecosystem components. The need to ensure the sustainable use of natural resources by taking appropriate measures within the Baltic Sea area is also recognised in Article 15 of the Helsinki Convention.


Photo: M. Lahtinen

The results of this assessment show that management of human activities in the Baltic Sea area is still far from being satisfactory and does not put the principles of the ecosystem approach to management of human activities into practice. There are therefore numerous challenges ahead before the BSAP goal of a favourable conservation status of Baltic biodiversity by 2021 will be achieved, but there are also numerous opportunities available. The improvements that have already taken place due to changes in management practices show that the potential for recovery of the Baltic ecosystem is in many cases substantial.

Throughout this report, recommendations on how to achieve specific targets of the action plan have been provided. This section provides an overview of more overarching policy options and management measures that provide opportunities for reversing the – in many cases – unfavourable state of biodiversity in the Baltic Sea.

Type of benefit	Value of (million €)	Number of employed	Value per capita, €
Fisheries			1.6-2
Eastern Baltic	673-1 747		
Western Baltic	766-1 520		
Aquaculture	348		0.9
Fish-processing	4 497	49 380	
Tourism	89 292	2 000 000	1160
Cruise tourism	343 - 443	11 500	34-541
Recreation	5 - 7		

Table. The implementation of the Baltic Sea Action Plan will not only restore a healthy environment but will also be a driving force for economy and employment in the Baltic Sea area (HELCOM and NEFCO, 2007).

5.1 Decoupling economic development and environmental degradation in the Baltic region

Even though economic growth is currently facing a slow-down, economic development tends to be coupled to increasing environmental degradation. According to Eurostat the Baltic Sea region has been one of the economically fastest growing regions in Europe during the past decennium (http://epp.eurostat.ec.europa.eu/). This has resulted in increased pressure on the Baltic Sea ecosystem. A concrete example from the Baltic Sea region is the increase in maritime transport and the resulting increase in the risk of major oil spills, nitrogen emissions and spreading of alien species. In addition, agriculture, in particular animal farming, in the region has developed from small-scale farms to industrialised enterprises. EU policies such as the Common Agricultural Policy support the shift in the newest Baltic region EU member states to modern practices with intensified use of chemical fertilizers and larger units of animal rearing, resulting in increased nutrient pollution to the Baltic Sea especially in the southern and south-eastern area. Moreover, the World Tourism Organization forecasts that increase in tourism will be larger in the Baltic Sea region compared to other regions (HELCOM & NEFCO 2007).

The actions to combat climate change, such as the requirements adopted by the EU to reduce CO_2 emissions and to achieve the level of 20% of renewable energy of all consumed energy in the EU by 2020 (e.g. Anonymous 2008a) may have an indirect negative effect on Baltic Sea biodiversity. It is highly likely that such a target will result in an increased number of wind farms to be located in the Baltic Sea putting further pressure on the use of the marine space.

Growing demand for carbon capture and sequestration (CCS) technologies and sites, as is also being put forward by the EU institutions (Anonymous 2008b), may mean that potential sites will be explored from the Baltic seafloor with yet unknown effects on the benthic ecosystems. The energy targets will also likely be linked to installations of new underwater cables and pipelines. An increase in bioenergy production, like increased cultivation of energy crops may result in an increase in use of currently set aside land and also of chemical fertilizers, consequently leading to increased nutrient loading.

Thus, while the biodiversity of the Baltic Sea is already exposed to high levels of human pressures, future activities may result in even more extensive pressures. Hence, it is of utmost importance that development will be sustainable and takes into account the potential impacts on Baltic Sea biodiversity. For the purpose of better linking the environmental impacts and human economic activities, true policy integration in the Baltic Sea region needs to be enhanced.

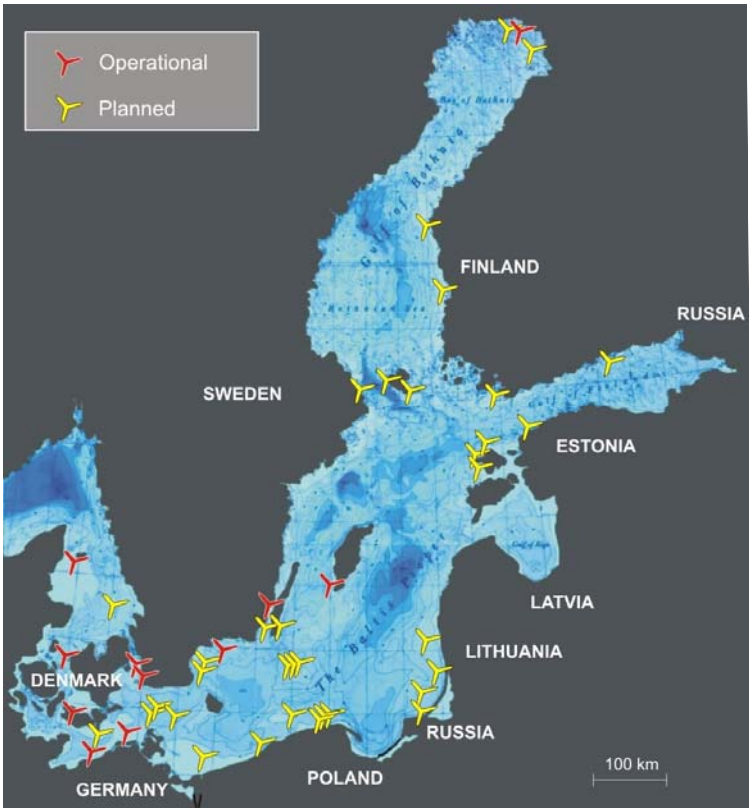


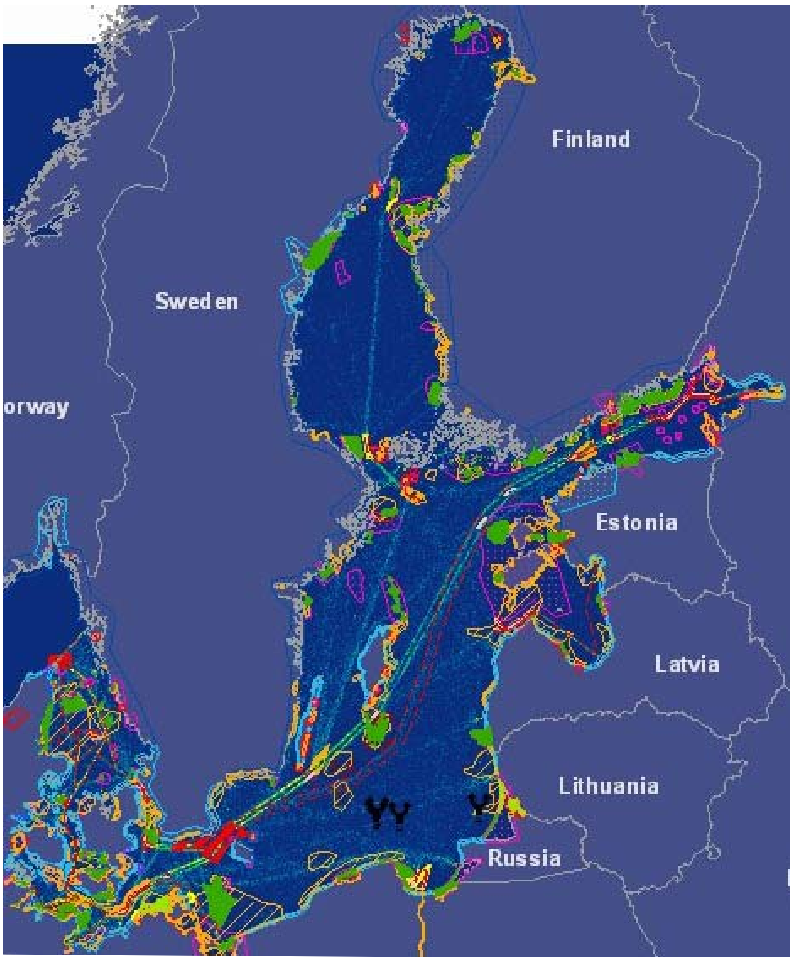
Figure. Location and status of wind power farms in the Baltic Sea (Compiled from: BSH - German Hydrographic Agency; EWEA - The Europ. Wind Energy Assoc; Elsam Engineering A/S, 2004 – Denmark; Georg Martin – Estonia; Maritime Offices – Poland; Pasi Laihonen – Finland; Ulla Li Zweifel –Sweden; www.vattenfall.se).

5.2 Enhancing policy integration and developing spatial planning as a practical means for integration

An important task set out by the ecosystem approach and the implementation of the Baltic Sea Action Plan is to shift to a truly integrated management with involvement of all economic sectors and stakeholders and to a system where the environmental targets and objectives are integrated with economic and socio-economic goals.

Policy integration requires an institutional framework that promotes incorporation of environmental concerns into sectoral policies and overbridges the common sectoral compartmentalisation. While policy integration has been called for in a number of global high-level policy documents like the UN Conference on Environment and Development in 1992, is part of the EC Treaty, as well as the Marine Strategy Framework Directive Article 1, there are still relatively few examples of its successful implementation across European countries (EEA 2005). With integrated policies in place it will be possible to avoid the current situation where non-environmental policies are commonly adjusted only as a response to negative environmental impacts that have already occurred.

Marine spatial planning is a tool providing an opportunity for practical manifestation and implementation of policy integration. It has to be based on good scientific knowledge of the natural features and of the mechanisms by which the human activities are affecting them. Already implemented regional spatial controls in the Baltic Sea include marine protected areas and Traffic Separation Schemes (TSS) but a Baltic-wide co-ordinated way to address spatial issues in the form of marine spatial planning does not yet exist. With the BSAP, the HELCOM Contracting Parties committed themselves to develop, by 2010, as well as to test, apply and evaluate by 2012, in co-operation with other relevant international bodies, so called “broad-scale, cross-sectoral, marine spatial planning principles based on the Ecosystem Approach”. Fulfilling this task will be the beginning of better integration of planning systems.



Integrated management has been addressed already earlier by EU’s Recommendation concerning integrated coastal zone management in Europe (2002/413/EC) and by HELCOM Recommendation 24/10 on Integrated Marine and Coastal Area Management of 2003. Spatial planning was recognised as a component of integrated management in the coastal zone.

5.3 Designation of protected areas

The network of Baltic Sea Protected Areas (BSPAs) was the first European regional network of marine protected areas covering a whole regional sea (HELCOM 1996) – but the network is still not ecologically coherent. In recent years the BSPAs have been integrated with the Natura 2000 network and the areas are thereby subject to legally binding regulations for Natura 2000 protection features.

The completion of an ecologically coherent network of well-managed BSPAs by 2010 is a fundamental target set forward already by the 2003 Bremen Ministerial Meeting. Establishment of protected areas is also an explicit measure of the Habitats Directive, Bird Directive and Marine Strategy Framework Directives as well as of the Convention of Biological Diversity. At present, the network of BSPA is however not ecologically coherent and recommendations on how to fulfill this commitment by 2010 have been outlined in detail in the integrated thematic assessment on biodiveristy and nature conservation in the Baltic Sea (to be published in 2009). The recommendations include e.g. designation of additional BSPAs, particularly in offshore areas, and the development and implementation of management plans or measures for all BSPAs.

Importantly, in order to maximize the benefit of the protected areas there is a pronounced need for a multinational perspective in the designation of BSPAs and Natura 2000 sites in the Baltic Sea. With site-selection tools such as the MARXAN tool exemplified in this assessment, it is possible to apply a systematic Baltic wide approach to ensure a proper distribution of protected areas that can improve the current network.

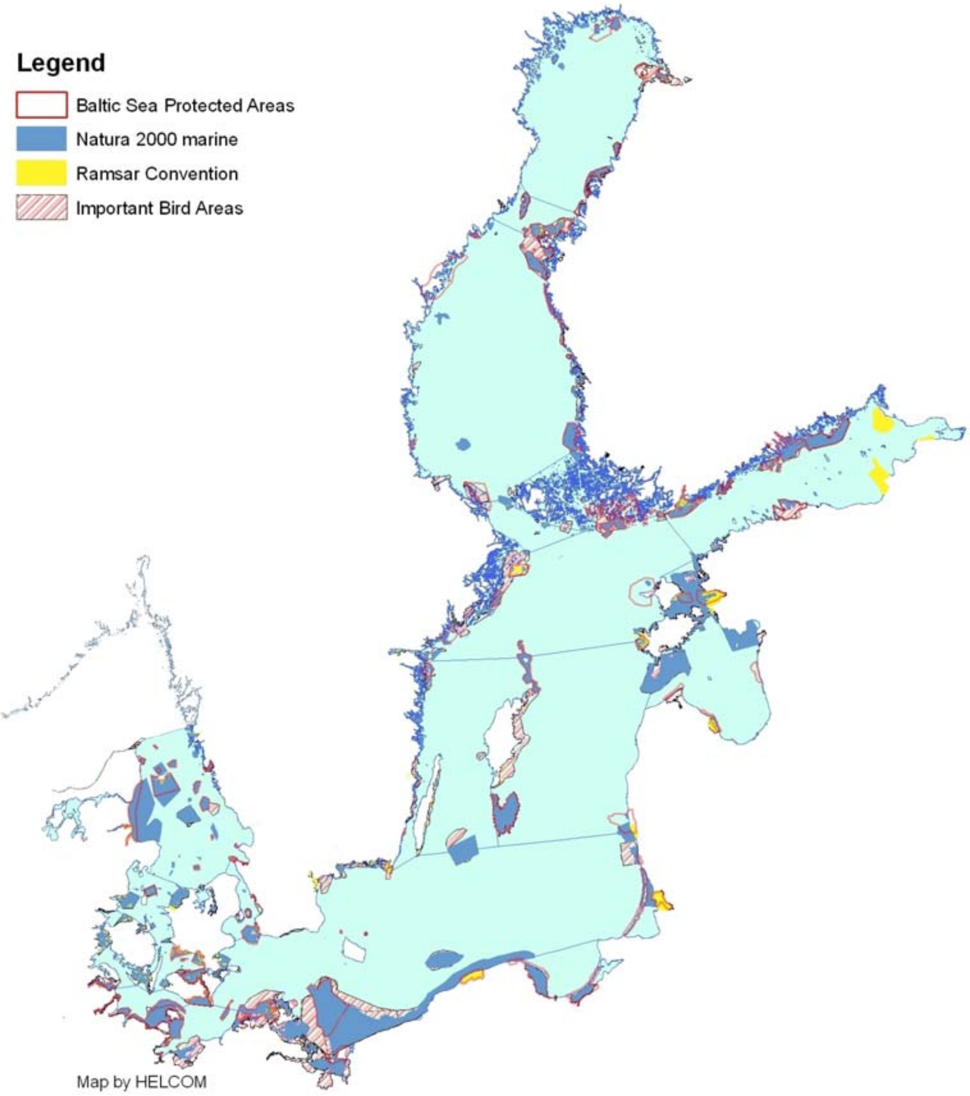


Figure. Overview of MPAs in the subregions of the Baltic Sea area, as of January 2009. Note that the sites overlap in the order indicated in the legend. Important bird areas are sites proposed by BirdLife International and they have no protection as such.

5.4 Reduction of human pressures

While protected areas can preserve landscapes and habitats of particular importance and protect against resource extraction, this measure must be complemented with efforts to reduce pressures that are effecting the water quality, protect the system against invasive species, and ensure sustainable resource use in areas outside the marine reserves.

At present there is not enough information or knowledge to estimate the relative influence of individual pressures on the status of biodiversity in the Baltic Sea. Nonetheless, as indicated above, eutrophication, fisheries and physical disturbance in the coastal zone are undoubtedly the cause of severe impacts on Baltic biodiversity. Implementation of the agreed provisional country-wise reductions of the nutrient load included in the eutrophication segment of the BSAP is therefore a prerequisite for reaching also the objectives of the biodiversity segment. The severe impacts of fisheries on the ecosystem structure and the status of birds and mammals as shown in this assessment emphasize the need to implement an ecosystem approach to fisheries management, as agreed in the BSAP, in order to ensure that fisheries is conducted with minimal impact on the ecosystem as a whole. The considerable impacts of physical disturbance in the coastal zone stress the importance to follow up integrated coastal zone management as recommended already in HELCOM Recommendation 24/10 and the EU Recommendation (2002/413/EC).

However, while a number of dominant pressures on the Baltic Sea can be outlined, it is important that the magnitude and impact of all pressures and activities are considered when developing the means to control their impact: it is the cumulative and synergetic effects that determine the state of biodiversity. This again emphasizes not only the need for an integrated approach to the management of human activities, but also the application of six basic principles: the precautionary principle, the best environmental practices (BEP), best available technologies (BAT) and polluter pays principle, the compensation or substitution principle, and the avoidance principle. There are, however, several HELCOM Recommendations in place that are based on these principles, and, once fully implemented and applied, will help to mitigate conflicts between human activities and the marine environment.

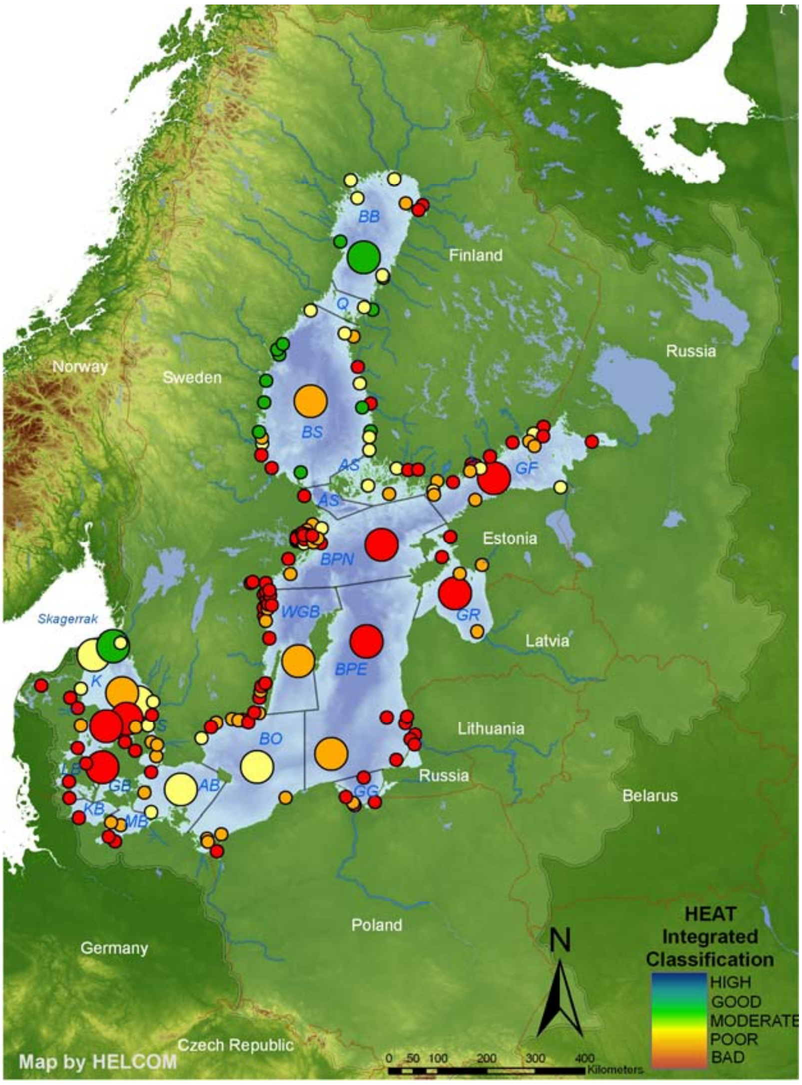


Figure. Integrated classifi cation of eutrophication status based on 189 areas. Good status is equivalent to 'areas not affected by eutrophication', while moderate, poor and bad are equivalent to 'areas affected by eutrophication'. Large circles represent open basins, while small circles represent coastal areas or stations.

HEAT = HELCOM Eutrophication Assessment Tool.

5.5 Restoration of severely damaged components

In areas where the capacity of the system to recover has been severely reduced, active restoration measures may be necessary in order to reach the conditions that correspond to a favourable conservation status.

Examples of restoration methods already in practice include restoration of coastal wetlands, re-construction of spawning sites and migratory routes for migrating fish species, and the re-establishment of water circulation in artificially enclosed bays. These are all based on reinstallation of the physical elements necessary for recovery of natural communities and populations.

When the natural recovery rate is very slow, transplantation of selective biotic attributes such as seagrasses has been used to enhance recovery in other sea areas (Fonseca et al. 1998, Thom et al. 2005). The BSAP emphasizes the need for research on possibilities of reintroducing valuable phytobenthos species, especially in the southern Baltic Sea. Similarly, the BSAP includes development of breeding and restocking practices for salmon and sea trout to safeguard the genetic variability of native stocks. In case of extinctions, transplantations or re-stocking are the only alternatives. This is the case for the sturgeon whose population in the Baltic Sea is virtually zero and for which natural recovery is considered impossible. However, transplantation and re-stocking are only alternatives when the causes behind environmental degradation have been identified and properly mitigated. Restorations are moreover costly and clearly “last resort” options. When viewed as such, and when conducted with best available knowledge and precautionary principles, restorations may however be a tool to ensure return to a favourable conservation status of previously damaged components of biodiversity.

Table. Overview of the conservation status of the Baltic Sea marine Natura 2000 habitats in comparison to HELCOM threat assessment (HELCOM 1998).

	Denmark		Estonia		Finland		Germany		Latvia		Lithuania		Poland		Russia	Sweden	
	N2K	HEL	N2K	HEL	N2K	HEL	N2K	HEL	N2K	HEL	N2K	HEL	N2K	HEL	HEL	N2K	HEL
Sandbanks	Bad	3	Favourable	3	Inadequate	3	XX	2	Favourable				Favourable	3	2-3	Inadequate	3
Estuaries	Favourable	3	Favourable	3	Bad	3	Bad	2		2	Favourable	3	Inadequate	3	2-3	Inadequate	2
Mudflats or sandflats	Bad	3	Favourable	3		3	Inadequate	3		3		P		3	2-3	Inadequate	
Coastal lagoons	Bad	3*	Favourable	3*	Inadequate	2	Bad	2*	Favourable	2*	Favourable	2*	Inadequate	2*	2-3*	Bad	3
Large shallow inlets	Bad	3	Favourable		Inadequate	3	Inadequate	2					Inadequate		3	Inadequate	
Reefs	Bad	3	Favourable	3	Inadequate	3	XX	2	Favourable	3	Favourable		Favourable		Presumably not endangered	Bad	3
Submarine structures	Bad	2-3															
Baltic esker islands		P			Inadequate	2									Presumably not endangered	Favourable	3
Baltic narrow inlets					Inadequate	3										Inadequate	3

* These results represents the assessment of biotope complex Lagoons.

N2K: Conservation status of Natura 2000 habitat types. Bad Inadequate Favourable

HEL: Threat status according to HELCOM 1998. 0 Completely destroyed 1 Immediately threatened 2 Heavily endangered 3 Endangered P Potentially endangered Presumably not endangered

5.6 Adaptive management

Adaptive management with regular monitoring of implementation of the plan, complemented with necessary review and adjustments, are an inherent feature of the BSAP. This approach includes recognition of the dynamic nature of ecosystems and the use of the most up to date environmental targets, data and information.

In the light of the change due to anthropogenic climate change, the need for an adaptive management framework will be ever more important. If the climate will change as predicted, so will also the potential abundance and distribution limits of specific species and communities. The highly likely acceleration of eutrophication resulting from higher runoff and changes in hydrography will also affect biodiversity. This means for example that management measures to protect Baltic Sea biodiversity also need to be adjusted and in some cases re-inforced. This will require effective and continuous feedback between different activities such as monitoring programmes and management measures, and importantly, the results of assessments and analyses must be turned into decisions and implementation.

5.7 A good knowledge base to support well informed and cost-efficient management decisions

The most cost-efficient protection measures can only be chosen based on good knowledge, including both environmental and economic considerations. Only in this way will it be possible to make the necessary balancing between the three pillars of sustainable development – the economic, social and environmental.

There is a wealth of still unrevealed biodiversity of underwater and small organisms in the Baltic Sea, not to mention the genetic diversity. Knowledge on the distribution of many underwater ecological features is in principle lacking. Even for larger organisms which include threatened or declining species, such as harbour porpoise, the distribution information is incomplete. It is also somehow surprising that despite the extensive research on the Baltic Sea ecosystem many mechanisms of human impacts on species or habitats are still not known or they are under heavy debate, such as causes of the M74 syndrome of Baltic wild salmon, potential impacts of fishing of top predators to eutrophication through food web cascades or the effects on the species of the numerous harmful substances that enter the Baltic Sea.

In order to protect as well as to assess Baltic biodiversity it is necessary to increase the knowledge. In particular, it is important that causal interactions are better known i.e. that the driving forces behind changes of biodiversity are understood and that human impacts are distinguishable from natural variations. Currently cause-effect relationships have only been established for a limited number of interactions, such as the effect of some hazardous substances on selected biota like seals, between nutrient concentration and phytoplankton biomass, or for the effect of fishing on fish population dynamics. However, cause-effect relationships between multiple pressures and state of biodiversity are in principle lacking and difficult to prove scientifically. Although a full understanding of all possible interactions is unrealistic, better knowledge can certainly be achieved by dedicated research and modeling directed towards selected components of biodiversity.

6 Steps for future assessments of biodiversity in the Baltic Sea

The BSAP identified the need for continuous monitoring of the conservation status of biodiversity and the need for regular assessments of whether the targets of the Baltic Sea Action Plan have been reached. The Plan also recognized the need to develop a harmonised approach to assess the conservation status of Baltic biodiversity in order to ensure comparability between biodiversity assessments of different Baltic regions. The indicator-based Biodiversity Assessment Tool BEAT intirduced in section 4 in this paper could serve as such an approach. However, in order to reach a fully functional and reliable tool there is need for further iterative development.

Continue the development of suitable biodiversity indicators and develop an appropriate monitoring programme for biodiversity

The BSAP initiated the work of identifying suitable biodiversity indicators for the Baltic Sea and this assessment employed a number of indicators both in the theme specific chapters and testing of BEAT. The development of indicators should however continue in order to arrive at a coherent core set of HELCOM biodiversity indicators for use in future assessments.

When a core set of biodiversity indicators has been established for the Baltic Sea, monitoring programmes must be considered with the specific aim of collecting the necessary data to assess the conservation status of Baltic biodiversity. For several of the indicators used in the test-application of BEAT it has not been possible to make a Baltic-wide evaluation since the geographic data coverage is limited. This is for example the case for coastal fish for which monitoring is lacking in Denmark and Germany. For a species like the harbor porpoise there is clearly not enough data or monitoring to follow-up the status or targets of the Baltic Sea Action Plan. For birds, monitoring data is already collected with good geographic coverage but a Baltic-wide assessment framework is missing. These are just a few examples of biodiversity relevant parameters that are currently not monitored at a scale or frequency necessary to provide regular and harmonized biodiversity assessments.

Establish reference conditions and acceptable deviations

Definition of a reference condition is a prerequisite for the use of indicators in the HELCOM Biodiversity Assessment Tool (BEAT). The work of determining reference conditions for ecologically relevant indicators is ongoing in most countries in the Baltic Sea area as a follow up to the EC Water Framework Directive. Implementation of the MSFD will require similar work to be carried out for the open sea ecosystem. However, for several of the time-series discussed in this assessment, indicators still need to be developed and reference conditions have to be set. As a starting point, efficient data management with Baltic wide data sets whenever appropriate would greatly facilitate and improve the work of establishing reference conditions for biodiversity in the Baltic Sea. Further challenges will emanate from the highly likely changes in the ecosystem resulting from climate change. The changes will mean that reference conditions, as tested in the biodiversity assessment tool BEAT, must be adapted to match the prevailing environmental conditions.

Another prerequisite of BEAT is the definition of a coherent classification system such as an acceptable deviation from the reference conditions for the chosen indicators, a value that critically determines the classification of status into favourable or non-favourable and provides a quantitatively specified ecological target. In the cases presented in this report the acceptable deviation has in many cases been set based on expert judgment. In preparation for future HELCOM biodiversity assessments, determination of acceptable deviations should take place through a process that takes into account the range of natural variation and threshold values that are linked to risk of population collapse and regime shifts.

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HELSINKI COMMISSION

Baltic Marine Environment Protection Commission

Katajanokanlaituri 6 B
FI-00160 Helsinki
Finland

http://www.helcom.fi